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The Future of Seeds:

Subjectivities of seeds, seed practices, and seed (re)production in Colombia.

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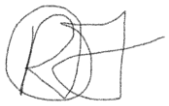
Author's declaration

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.



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The global seed and agricultural systems are inseparable from the capitalist economic system, which exploits environmental resources and human labour to increase productivity. Within the agricultural system, controlling seeds is a highly contested topic. In the highly biodiverse geographical context of Colombia, seed struggles are inseparable from the histories of violence and conflict that have fragmented rural landscapes and displaced marginalised populations. Drawing on the perspectives of 32 practitioners across formal and informal seed system sectors in Bogotá and Cali, I analyse the subjectivities of seeds and sustainability. This thesis uses a Science and Technology framework to show how seeds and peoples are racialised, constructing boundaries that relegate traditional seeds, knowledge, and users, as inferior to genetically pure seeds, users, and scientific knowledge. This research explores the de-territorialisation of seeds in modern breeding and germplasm banks as seeds are disembedded from growing contexts and growers. These seed practices reproduce a dominant sociotechnical imaginary, in which scientists are attempting to solve climate change and global hunger with technoscientific seeds. On the margins of the industrial agricultural system are local small-scale actors that are re-territorialising land and seeds. Using, saving, and exchanging traditional seeds in communities reproduces an alternative imagining of sustainability. Local resistance against hegemonic capitalism and seed enclosure through advocating for seed sovereignty maintains the alternative imagining. Future seed system sustainability needs to address the histories of oppression that condition and constrain it, to enable a more equitable and resilient future food system for all.

Keywords: <seed system sustainability, racialisation, territorialisation, knowledge, sociotechnical imaginary>

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"The seed is the metaphor of existence" – Mario Diez, farmer.

Table of Contents

List of Figures

List of Images

List of Tables

Abbreviations

ACOSEMILLAS	Asociación Colombiana de Semillas y Biotecnología [Colombian Association of Seeds and Biotechnology]
AGROSAVIA	Corporación Colombiana de Investigación Agropecuaria [Colombian Corporation for Agricultural Research]
CENICAÑA	Centro de Investigación de la Caña de Azúcar de Colombia [Colombian Sugar Industry Research Centre]
CGIAR	Consortium of International Agricultural Research Centres
CIAT	Centro Internacional de Agricultura Tropical [International Centre for Tropical Agriculture]
CIMMYT	Centro Internacional de Majoramiento de Maíz y Trigo [International Maize and Wheat Improvement Centre]
DUS	Distinct, Uniform, Stable
FAO	The Food and Agriculture Organisation
FARC-EP	Revolutionary Armed Forced of Colombia
FEDEARROZ	National Rice Growers' Federation
FENALCE	National Federation of Cereal, Legume and Soybean Growers
FIAN	Food First Information and Action Network
FLAR	Fondo Latinoamericano de Reservas [Latin American Reserve Fund]
FUNDAEC	Fundación para la Aplicación y Enseñanza de las Ciencias [Foundation for the Application and Teaching of Science]
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
ICA	Instituto Colombiano Agropecuario [Colombian Agricultural Institute]
IDARTES	Instituto Distrital de las Artes [District Institute of the Arts]
IFAD	International Fund for Agricultural Development
IRRI	International Rice Research Institute
IPR	Intellectual Property Rights
NGO	Non-Governmental Organisation
OSUN	Open Society University Network

PECTIA	Strategic Plan for Science, Technology, and Innovation of the Colombian Agricultural Sector
PBR	Plant Breeders' Rights
RSL	Red de Semillas Libres de Colombia [The Free Seed Network of Colombia]
SNIA	National System of Agricultural Inovation
STS	Science and Technology Studies
TRIPS	World Trade Organisation's Trade Related Property Rights
UNDROP	United Nations Declaration on the Rights of Peasants and Other People Who Work in Rural Areas
UPOV	International Convention for the Protection of New Varieties of Plants
US-FTA	US-Colombia Free Trade Agreement

CHAPTER 1: INTRODUCTION

1.1 Problem definition and sowing the seed

The global seed and agricultural systems are inseparable from the capitalist economic system, which exploits environmental resources and human labour to increase productivity. Within the agricultural system, controlling seeds is a highly contested topic. There are seed debates over sociocultural, ecological, economic, and legal properties at local, national, and international scales (Aistara 2012). The competing crises and discourses surrounding seeds and the people that use seeds extend back to the eighteenth century. In the context of settler-colonial states, Europeans started collecting seeds to be categorised, stored, and selectively reproduced, which reinforced colonial discourses of superiority and racial difference[1] as applied to people. In this process, scientific knowledge was valued over local knowledge and the maintenance of seeds in collections over seeds in communities (Visser et al. 2019). Since the 1960s, the focus has been on germplasm management with *ex situ* versus *in situ* conservation of seeds. *In situ* seed saving is the conservation, maintenance, and recovery of seeds in their natural surroundings (FAO 2001). *Ex situ* seed saving involves taking seeds out of their natural surroundings to be conserved as plant genetic resources, usually in a gene bank (FAO 2001). Throughout this thesis, both practices are explored because *in situ* and *ex situ* seed conservation are often highly linked and complementary despite the imbalance in research and development of *ex situ* management at the detriment of local *in situ* approaches (Visser et al. 2019). The prioritisation of *ex situ* seed practices has implications in how scientific knowledge is valued over and above local knowledge, subjugating the local seeds, knowledge, and seed users as inferior. In the face of climate change and with an increasing need to feed the global population, technoscientific seeds are being reproduced as a silverbullet solution.

As science and technology are deployed by transnational corporations, international development agencies, governments, and research organisations intervening in seed systems, seeds are made to be commodifiable resources. In the agricultural system, technoscientific developments coincide with capitalist market expansion and concentration of wealth and power in the hands of few at the expense of many, particularly growers (Lewontin 1998). The food and seed systems have become increasingly separate and fragmented throughout industrial development. This fragmentation threatens agrobiodiversity, which is the result of interactions between humans and their environments and is therefore embedded in seeds (Visser et al. 2019). Currently, global

[1] This thesis explores racialisation of seeds and peoples in how differences are socially constructed, creating systematic hierarchies of better and worse population groups.

agricultural production uses 80 percent of the available freshwater, produces 20-35 percent of the total greenhouse gas emissions, occupies 40 percent of land and has contributed to a decline of 75 percent in global agrobiodiversity (Clapp, Newell, and Brent 2017; Holt-Giménez 2017). At the same time, the agricultural sector and those working within it are positioned on the front lines of climate change.

Studying the Colombian seed system allows for an exploration of how productivist agricultural capitalism operates in the Global South in relation to neoliberal and colonial discourses that originated from the Global North. Post World War II, discourses of productivism and development were deployed as ambiguous terms referring to positive transformation (Harvey 2005; Rist 2007). Development has become so deeply embedded in intersubjective societal understandings that it is now a normative hegemonic discourse. The transition implied in development primarily refers to economies, which has tangible impacts for environmental degradation and social inequities (Escobar 1997; Rist 2007). The development trajectory has facilitated agroindustrial productivism. The productivist model of agriculture involves farming for increased yields, decreased species variation, and high levels of integration with the market (Iles et al. 2017). This agricultural paradigm is contested by small-scale farmers who advocate for using local and traditional knowledge and practices.

The necessity of plural knowledge was globally addressed in relation to the food system for the first time in the International Assessment of Agricultural Knowledge Science and Technology for Development (IAASTD) (2009). Local and traditional knowledge were positioned in the IAASTD in parallel with scientific and technological knowledge, giving prominence to sustainable agricultural solutions that could combine these systems. The conversation about shifting from top-down to bottom-up approaches notably disappeared again shortly after the IAASTD framework was negotiated, showing the deep contestation around this issue and the inequitable power relations between multilateral actors in the agricultural system. Different visions of sustainability reproduced by technoscientific, industrial, organic, agroecological, and permacultural seed practices create a dilemma of different agricultural futures. In the alternative pathway to neoliberalism's productivist agriculture, organic farming, as it began in the 1970s, incorporated principles of health, care, ecology and fairness (Aistara 2018; IFOAM 2008). Permaculture, coined in 1978, put forward a bottom-up approach to agricultural transformation premised upon enhancing biodiversity and interconnectivity (Whitefield 1993). Since the 1980s, agroecology has been positioned as a normative scientific discipline that allows the study of agroecological systems enhancing resilience through holistic sustainability, transforming biosocial relations (Silici 2014). These different

agricultural systems shape disparate imagined future sustainabilities that are in contest internationally and within Colombia.

Using Colombia as a case study allows the exploration of seed practices and discourses surrounding imagined sustainabilities. In the highly biodiverse geographical context of Colombia, seed struggles are inseparable from its histories of violence (Hernández Vidal 2022b). Colombia has deeply embedded histories of oppression and conflict that have played out through colonisation, slavery, and a civil war in which conflict was ongoing between the government, paramilitary and guerrilla groups for over five decades. In this highly fragmented social landscape, a Peace Agreement was signed between the government and the Revolutionary Armed Forces of Colombia (FARC-EP) in which the guerrillas demanded that food sovereignty be a principle in agricultural development with a territorial approach (Roa-Clavijo 2021). Food sovereignty is the "right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agricultural systems" (La Via Campesina 2007, 1). This call for food sovereignty pointed to the tensions surrounding rural poverty and social inequities in Colombia and it led to the recognition of small-scale farmers and local knowledge (FARC-EP 2016). Colombia has also become a site of corporate industrial development through large-scale monocultures (OECD 2021). It is a country with international involvement in agricultural research and development, specifically in tropical agriculture. In 1967, the Centro Internacional de Agricultural Tropical [International Centre for Tropical Agriculture] (CIAT) opened just outside of Cali in alliance with the Consultative Group on International Agricultural Research (CGIAR). In 2022, CIAT opened the world's largest tropical germplasm bank, Future Seeds, which holds over 250,000 seeds from over 100 countries (CGTN 2023). In this national context, private producer associations and the state also push for seed banking, technological transfer and scientific seed breeding.

Against this backdrop, local actors resist the productivist agricultural system and its capitalist structural roots, mobilising for the free exchange of seeds as part of a global commons (Hernández Vidal 2022b). This resistance was exemplified in social movements against the restrictions on seeds imposed through the ratification of the US-Free Trade Agreement (US-FTA) and has led to changes in legislation and policy environment in Colombia (Roa-Clavijo 2021). Local actors can view seeds as biosocial objects that embody sociocultural histories and networks as opposed to viewing seeds as commodifiable resources (Aistara 2011). The resulting dilemma of perspectives make on-the-ground realities in the seed system more complex than legislation and policies can make it seem.

For this research to take shape, I undertook field research in Colombia. I spent two months between Bogotá and Cali, influenced by institutional connections I established with Universidad de los Andes in Bogotá and CIAT in Cali (Figure 1.1). During this time, I went to various places where seeds were used, saved, exchanged, and (re)produced. Throughout this thesis, I explore the perspectives within the Colombian seed system at international, national, and local levels. Understanding how different actors conceptualise the seed system and sustainability requires an exploration of the different discourses and knowledge systems drawn upon in working towards a sustainable food system. Ultimately, I look to how a sustainable seed system could be imagined and realised through increased participation, action, and collaboration across scales in connecting the fragmented epistemic and material landscape of the Colombian seed system.

1.2 Target audience

The target audience of this thesis includes students, researchers, practitioners, and policymakers in disciplines including but not limited to food system sustainability, seed systems, agricultural studies, agronomics, environmental science, agroecology, and climate change resilience. It also hopes explicitly to reach international, national, and local scale actors in the Colombian seed system. By reading this thesis on the fragmentation of seeds and sustainability in Colombia, readers can better understand the complexity of discourse and power relations in the seed system and be better equipped to work towards a more equitable and sustainable future food system for all.

1.3 Thesis aim

This thesis aims to explore seed discourses and practices of various actors in Colombia and highlight how science, technology and social relations are co-produced through the various ways seeds are used to improve the sustainability of the agricultural system.

1.4 Research questions

How do people think about, use, and (re)produce seeds in Colombia? (Research Question 1).

How are different knowledge systems embedded and fragmented in relation to seeds in Colombia? (Research Question 2).

How are discourses and power reproduced through the governance of seeds and the imaginings of future sustainabilities for the Colombian seed system? (Research Question 3).

Figure 1.1 A map of Colombia showing my two main research locations at CIAT, Cali and Universidad de los Andes, Bogotá (Google Earth 2023).

1.5 Thesis outline

In Chapter 1 of this thesis, I have outlined the problem context of Colombia's highly contested seed system. I put forward an aim for this research to explore how seed discourses and practices relate to science, technology, and social relations and how this could impact future sustainability. In Chapter 2, I will explore the literature on Colombia's seed system. I will then set out a theoretical framework in Chapter 3, introducing Science and Technology Studies and the concepts of boundary work, territorialisation, and sociotechnical imaginaries, linked meaningfully throughout the telling of seed stories. In Chapter 4, I set out the methodology, positionality, and ethics. The analytical chapters that follow are about the seed, the use of the seed, and the (re)production of the seed. In Chapter 5, I show how seeds are selected and reproduced based on socially constructed criteria of difference that map onto and reinforce the racialisation of populations in Colombia. I also demonstrate how categorising seeds leads to genetic and cultural erosion and creates a governable subject. For Chapter 6, I introduce different seed savers, explore the fragmentation in seed practices, knowledge systems, and territories. In Chapter 7, I look at international, national, and local scale sustainability strategies and climate adaptability in the seed system. To conclude, Chapter 8 suggests that future seed system sustainability will require collaboration and cooperation between fragmented actors and seeds that address contextualised histories of oppression.

CHAPTER 2: LITERATURE REVIEW

In this chapter, I undertake a literature review of the politics, legislation, and development trajectories within the Colombian seed system. I look at the context of the Colombian agricultural and seed systems. I show how policies and legislation in the seed system have changed with the influence of colonisation, the Green Revolution, neoliberalism, a civil war, and social mobilisation. There are scalar processes and power between international, national, and local actors. As the land, peoples, and seeds have been controlled through colonial and capitalist processes, it is important to consider how the future might be similar or different, who is involved in deciding how it should look, and what this means for people involved in the Colombian seed system in practice.

2.1 Introduction to the Colombian agricultural and seed system

In Colombia, the agricultural sector plays a key role in the economy, accounting for 16.6 percent of employment and 6.7 percent of GDP (OECD 2021). Colombia's land tenure system is reminiscent of colonialism's impacts, with 67.6 percent of landowners with small-scale land parcels and 0.4 percent of owners holding over 46.5 percent of the land (OECD, 2015). Colombia's geographical location and diversity of climate zones provide environmental conditions for growing almost anything. As described in a CGIAR report, "[Colombia's] agriculture is characterised by technified monocultures by region (such as sugar cane, coffee, flowers, cotton, banana, sorghum, maize, rice, palm, potato and cassava)" (de Jaramillo et al. 2017, 214). The financial support provided by the state is not equitably distributed across these crop sectors. There are higher levels of agricultural support for large-scale producers of rice, maize, and high-value crops for export, including coffee, palm oil, and sugar cane (OECD 2021). More than fifty thousand hectares of transgenic crops are grown, mainly maize and cotton (Fitting 2017). However, most of the agricultural planted area is in the small-scale production of maize, wheat, barley, rice, potato, yuca, plantain, coffee, and various fruits and vegetables (Roa-Clavijo 2021). Small-scale producers[2] make up 31.8 percent of the Colombian population. In 1990, small-scale crops took up 74 percent of the total agricultural area in Colombia, representing 66 percent of the total agricultural production (Roa-Clavijo 2021). In 2010, the representation of agricultural areas associated with small-scale economic activity had increased to 87 percent (Roa-Clavijo 2021). Despite national support for large-scale industrial production, small-scale producers remain critical to the national economy and food provision.

[2] Small-scale producer is an ambiguous term with no universal definition, and it can vary by crop type. Small-scale production often refers to a landholding of fewer than two hectares, but it can also mean limited comparative resources (UNDP 2021)

There is a rift between the agricultural modernisation in policies and legislation and the persistent rural realities of small-scale Indigenous, Afro-Colombian, and small-scale producers. Small-scale producers are critical for national food provision. These actors have also played an essential role in shaping a national trajectory of agrarian social movements contesting rural marginalisation. This social mobilisation has evolved through key stages in Colombia, shaping the agricultural policy environment and reality. In the 1960s, the National Association of Peasant Users was established, which in the 1970s took an ideological standpoint of resisting food imports from the United States (Lamberty 2014). In the 1980s, there was increased violence and oppression of rural (often racially marginalised) communities (Lamberty 2014). This culminated in the formation of the 1991 Constitution that officially recognised Indigenous and Afro-Colombian communities (Lamberty 2014). In the 2000s, food sovereignty's trajectory took shape globally (La Via Campesina 2007). Since 2010 the influence of agrarian strikes has led to the overturning of specific restrictive seed legislation, yet the seed policy landscape remains dominated by industrial interests in line with the requirements of the US-Colombia Free Trade Agreement (US-FTA) (Roa-Clavijo 2021).

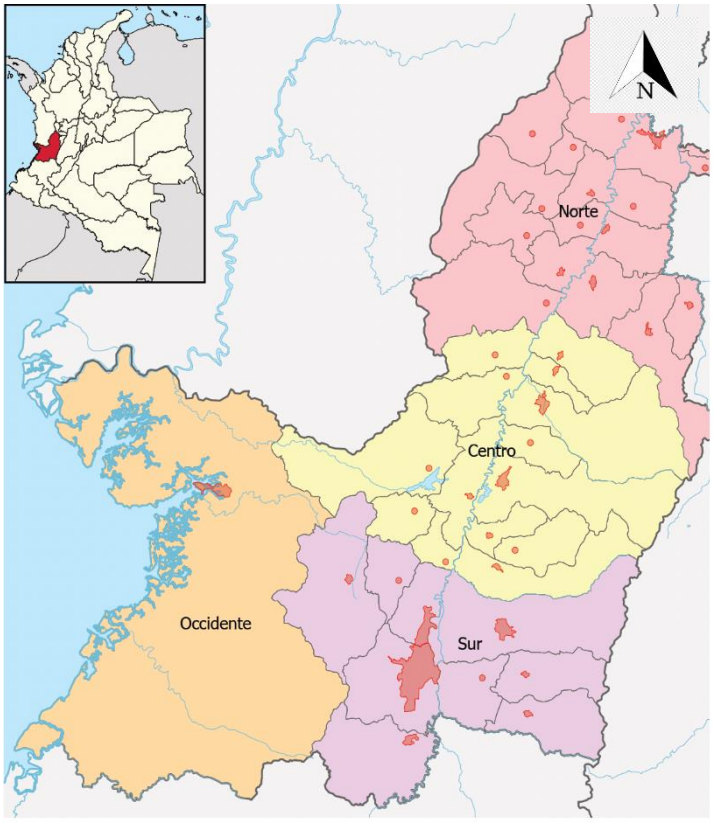

Figure 2.1 A map showing the location of the Cauca Valley department and regions: Norte (North), Sur (South), Occidente (West), Sur (South), where Cali and CIAT are located (Milenioscuro 2022).

Within Colombia, a location that demonstrates the contestation between agricultural production systems and actors is Cauca Valley (Figure 2.1). In this map, the red polygons represent urban areas and Cali is located in the south. Cauca Valley is a department in southwestern Colombia

currently known for the sugar cane industrial production, where I spent time as a visiting researcher at CIAT near Cali. Agricultural industrialisation in Cauca Valley has eroded the previously dominant Afro-Colombian agricultural system, that of the traditional *finca* (farm)—a model of agriculture that is an integrated small-scale design with plants, animals, agroforestry, soil health, humans, and a house for the family (Guaza Mina 2018). In Cauca Valley, Afro-Colombian families currently have approximately 0.6 to 1.0 hectares of land, which is insufficient for subsistence and a sustainable local economy (Semillas n.d.). Approximately 245,000 hectares of Cauca Valley are planted in sugar cane (Zapata-Caldas 2021). As land has been transformed and concentrated for industrialised agricultural development, seeds have been as well. In a community diagnostic of traditional seeds in Cauca Valley, it was identified that 85 varieties are present in the region, 43 of which are scarce, and 28 varieties have already been lost (Semillas n.d.). Many local actors in Cauca Valley and across Colombia are organised in social groups representing Indigenous, Afro-Colombian, and traditional seed savers on the margins and resisting agroindustrial development through revitalising local seed production systems.

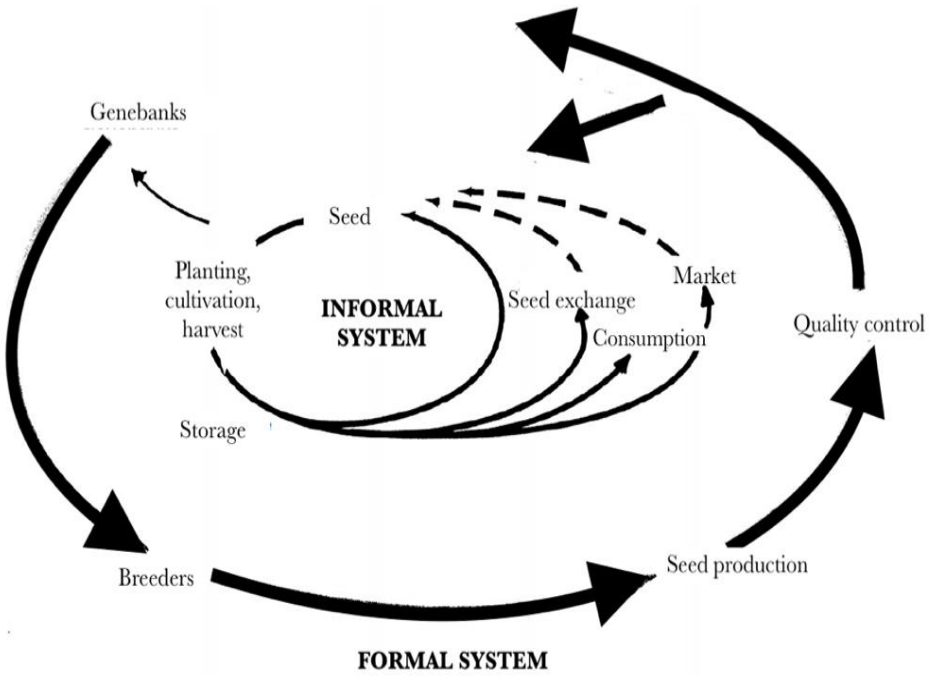

Figure 2.2 The formal and informal seed system showing connections and disconnections between parallel systems (Adapted from Almekinders and Louwaars, 2002, p.27).

Throughout this thesis, the divisions between actors in the seed system and the specific debates over seed control become important in terms of how discourses of development and modernity are woven into technoscientific approaches to sustainability. In this research, the seed system includes all processes related to the maintenance, development, production, storage, and distribution of varieties (Wattnem 2016). In the literature and as became evident in my interviews,

a common distinction is drawn between formal and informal seed systems. The formal seed system is predominated by certified and "improved" seed used and produced by formal actors that undertake and communicate science as part of breeding programmes and agricultural technological research and development (Wattnem 2016). The informal seed system is unregulated and involves the trading and selling of local and traditional seeds through seed networks separate from the commercial and regulated system (Wattnem 2016). *In situ* seed saving is a critical part of the informal seed system, whereas *ex situ* seed saving is central to the formal system. There are disconnects between these two parallel systems, particularly evident where the end-product or improved seed is created without consideration of the local conditions or input from local seed users (Figure 2.2). Almekinders and Louwaars (2008) point to the need to integrate these systems at a policy level through a participatory approach that strengthens the local or informal system. Throughout this thesis, I use the informal/formal[3] binary for seed systems. Coomes et al. (2015) refrain from using informal and formal categorisations to avoid reinforcing misconceptions and separation between groups and their associated knowledge systems. I use these classifications not to reinforce the boundaries but to tell a story of how these differences are conceptualised, produced, and fragmented within the context of the Colombian seed system. In Colombia, diverse and racialised actors operate across the formal and informal seed systems using different seeds and knowledge, which is by association seen as formal or informal reproducing categorical differences.

Within the seed sector in Colombia, there is noticeable fragmentation and contestation. This results from seed struggles that have been ongoing from the onset of seed collection and categorisation by European colonial actors in the eighteenth century to the introduction of patent laws in the nineteenth century (Hernández Vidal 2022b). Later, with the introduction of "improved" high-yield seeds in the Green Revolution of the 1960s to 1980s. More recently, transnational policies and legislation have enclosed seeds by prioritis*ing ex situ* seed saving and privatising seeds and seed knowledge (Hernández Vidal 2022b). This seed enclosure is contested in territories as seeds are removed from communities and growing contexts, seed knowledges are expropriated from bodies and assigned to the disembodied technoscientific industry, and at the same time, the land is appropriated in the cultivation of privatised seeds which is contested by communities with historical ties to the land (Hernández Vidal 2022b). Seed legislation had been present in Colombia for almost thirty years. Nevertheless, it was voluntary until the US-FTA was

[3] After my fieldwork, I decided to categorise my interviewees as formal or informal actors based on the scale of their seed practices. I deemed them formal if they worked in international or national research and agricultural institutions. In contrast, the informal actors worked locally without institutional affiliation or with an organisation that chose to decentre science and technology, prioritising traditional knowledge (Appendix A).

ratified, bringing into force Intellectual Property Rights (IPR) laws over seeds (Semillas and RSL 2015b). The fragmented seed system is important throughout this thesis because, within it, seeds, knowledge, land, and actors that inhabit that land reproduce different visions of seed system sustainability.

The division of actors in the Colombian seed system is evident in the context of the agrarian strikes. In 2013, thousands of *campesinos*[4] (peasants) mobilised in a National Agrarian Strike that lasted three weeks. As rural people left their work, the resulting food scarcity and food price rise drew attention to a deep rural crisis that stemmed from land inequality, high levels of debt, and lack of state investment in agricultural infrastructure, development, and social wellbeing (Roa-Clavijo 2021). The rural actors were contesting the US-FTA and calling on the government to make legislative changes. At first, the government initiated a police response, but after the social unrest from the public continued to heighten, a negotiation led to 22 agreements signed that put an end to the nationwide strikes. Conditions of special assistance and subsidies for disadvantaged agricultural value chains were agreed upon to compensate for the negative domestic impacts of the US-FTA (Roa-Clavijo 2021). Social mobilisation of rural peoples in Colombia has reshaped social life and intervened with agricultural policies in this way.

Since 2013, seed sovereignty has also been discussed in the Colombian context, specifically evident in the work of social organisations and networks of campesinos. Hernández Vidal and Gutiérrez Escobar (2019) draw attention to the conceptualisations of seeds as commodities of biotechnological development or a global common. While Gutiérrez Escobar and Fitting (2016) contribute to literature on this distinction, they also provide a specific example of a well-known seed network in the Colombian seed system that is organised around the principles of seed sovereignty, *La Red de Semillas Libres de Colombia* (RSL) [the National Network of Free Seeds]. The RSL actively resists and contests biohegemony and capitalism, creating an alternative path of seed sovereignty. Seed sovereignty is "people's right to save, replant, breed, and share seeds, and their right to participate in decision-making processes regarding rules and laws that regulate their access and use" (Wattnem 2016, 850). There is extensive literature on seed sovereignty in the global and Colombian context, all of it pointing to the need for native seed availability and access together with a need to resist corporate seed enclosure and the associated certification, regulation, and privatisation of genetic materials (García López et al. 2019; Hernández Vidal 2022b; Kloppenburg

[4] Campesino translates to "peasant"; however, this word is inadequate in representing the true nuances of the associated political, economic, cultural, racial, and ethnic marginalisation that shape rural realities in Colombia. Therefore, I use the word campesino to describe these populations throughout this thesis.

2014). This is important throughout this thesis as the local actors that represent campesino, Indigenous, or Afro-Colombian rural communities are actors that express a clear need for seed sovereignty as an alternative pathway to sustainability.

In the dominant agricultural development trajectory, seed enclosure by legislation, policy, and *ex situ* germplasm management is central to how seeds can be categorised and controlled by creating sustainable subjects through breeding. In Colombia, this has largely mirrored the processes of seed control being imposed across the Global South since the onset of the Green Revolution around the 1970s. There has been a dual impact of regulation imposed in the Global South by the Intellectual Property Rights (IPR) laws and the non-IPR legislation (Wattnem 2016). IPR laws have led to the privatisation of seeds (Wattnem 2016). Non-IPR laws have criminalised informal seed production by targeting certification, registration, and standardisation.(Wattnem 2016). Therefore, the role of both IPR and non-IPR legislation in the seed system should be seen as inextricably connected. These laws are justified in protecting varietal quality, maintaining genetic purity, and preventing phytosanitary contamination as part of a more extensive legal system and agricultural paradigm favouring large-scale corporate agri-food players (Kloppenburg 2014). However, at a global scale, and especially in the Colombian context, small-scale, often racialised seed producers are systematically excluded and disadvantaged through this legislative and policy landscape (García López et al. 2019; Goyes 2018; Goyes and South 2016; Gutiérrez Escobar and Fitting 2016; Hernández Vidal 2018; Peschard and Randeria 2020).

At a farmer level, seed saving is an *in situ* practice of conservation and everyday resistance against seed enclosure (Gutiérrez Escobar and Fitting 2016; Hernández Vidal and Moore 2022; Silva Garzón and Gutiérrez Escobar 2019). This seed saving is broadly defined as contesting seed enclosure and defending rights to seeds as a global commons (Peschard and Randeria 2020). Hernández Vidal and Moore (2022) also classify this everyday seed saving as "generative dissent", which is a pedagogical practice of challenging hegemonic structures through rebuilding discourses, materials, and systems of law and rule (Hernández Vidal and Moore 2022). The generative dissent of seed saving is situated within a sociocultural space in which traditional cultural knowledge is centred, revitalising social capacities and strengthening kinship networks (Hernández Vidal and Moore 2022). It is also situated in a physical territory with cultural practices and knowledge associated with place-based seed saving. Informal seed saving can be ideological, with a complex commitment across political, ethical, and sociocultural spheres (Silva Garzón and Gutiérrez Escobar 2019). But it can also be about practicality, as farmers defend their rights to access seed, engaging in seed sovereignty with economic or subsistence motivations for growing food (Silva

Garzón and Gutiérrez Escobar 2019). Even without political motivations, local actors engaging in local seed saving are contributing to seed sovereignty by recognising the rights of farmers to autonomy from the control of the corporate, capitalist, and industrialised agri-food system (Hernández Vidal 2022b; Silva Garzón and Gutiérrez Escobar 2019).

This glimpse into the complexities of the Colombian seed system shows the critical role of small-scale producers in rural food provision while simultaneously, policies and legislation exacerbate rural inequities for these producers in the name of development. There has been an undeniable influence on the physical and policy seed context by military, paramilitary, guerrilla groups, drug traffickers, mining companies and agro-industry (Celis 2017). Through land grabbing, extractivism, and violence, social inequities in rural communities have been exacerbated. The resulting fragmentation between informal and formal actors' ways of being, doing, and knowing was embedded in the conversations I had in Colombia and are woven into the writing of this thesis.

2.2 International development trajectories in the Colombian seed system

Since the late 1970s, international agri-food policies and frameworks have been dominated by neoliberal norms (Clapp and Fuchs 2009). The co-optation of discourses of development and modernity in the Global North was evidenced in the neoliberalism of Reagan and Thatcher and the articulation of the 1989 Washington Consensus, which saw the transfer of neoliberal policies to the Global South in the Latin American context (Harvey 2005). In Colombia, contentions in the agricultural development trajectory were exacerbated by the Green Revolution, civil war, and intervention from the United States in trade agreements.

Neoliberalism describes a hegemonic discourse and a political and economic system prioritising a globalised free market through privatisation, government regulation, and decentralisation that puts the onus on the individual rather than the collective (Moore et al. 2011). Neoliberal policies are shaped by ideologies of modernity, progress, and development (Moore et al. 2011). The philosophy of individual freedom embedded in neoliberalism is a way to democratically appeal to the freedom and rights of individuals while systematically structuring the social order to concentrate capital and social and political power for the elites (Castree 2010). Despite having varying impacts in different national contexts, neoliberalism can be seen as a mechanism within globalisation that was co-opted by the elites to restore class power based on distinguished differences and dismantle working-class unionism and rights (Castree 2010). It has not led to increased capital for the masses. Instead, it has increased profits for a minority of owners of transnational corporations that directly benefit from economic policies focused on trade

liberalisation, technological innovation, and reduced state expenditure on environmental and social welfare (Moore et al. 2011). Throughout the last 50 years, a specific neoliberal focus has been on market expansion and technological extension in global agricultural development policies (Clapp, Newell, and Brent 2017).

The Green Revolution was a precursor for the global neoliberal development trajectory of the 1980s. The agricultural development of the Green Revolution originated in the Global North and was transferred to the Global South as a productivist paradigm (Holt-Gimenez, Altieri, and Rosset 2008). The characteristics were high-yield crop varieties, mechanisation, and inputs that could be packaged to solve the issues of poverty and food insecurity through increased food production (Holt-Gimenez, Altieri, and Rosset 2008). The resulting increased productivity did lead to an increase in the global food supply but, importantly, did not solve global hunger (Rosset, Lappé, and Collins 2000). There was also a 90 percent decrease in *in situ* agrobiodiversity as hybrids displaced local varieties (Holt-Giménez 2017). At the same time, Lappé et al. (1998) noted that the eight percent yield increase across South America coincided with a 19 percent increase in food insecurity. The Green Revolution is what Pielke and Linnér (2019) termed a "political myth" that misled the public while shaping policy and action with technological interventions. This ultimately increased social inequities and environmental degradation in modes important in considering novel technological solutions to these problems in a Colombian context.

As recognised in the negotiations for the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), there is a need for more effective cooperation between stakeholders and the representation of local marginalised actors and their knowledge systems at a global scale. The IAASTD (2009) called for action in integrating the application of formal, traditional, and community-based science and technological developments. Policy options in the IAASTD included improving accessibility of education, technology, and science, increasing collaboration between government departments, and recognising and recovering traditional and local knowledge (IAASTD 2009). Despite recognising the need for plural knowledge in agricultural development for the first time internationally, a significant critique of the IAASTD was the lack of explicit recognition of political influence over knowledge, governance, and imagined futures (Scoones 2009). The FAO International Seed Treaty (2001), as a multilateral instrument, also set out a framework for collaborative action towards a food-secure future that could be adaptable to the impacts of climate change. It encouraged access, benefit-sharing, capacity-building, and collective learning (FAO 2001). On one hand, there is a recognition that more inclusive and reflexive governance is needed in any approach towards increasing the

sustainability of the global agri-food system (Scoones 2009). On the other hand, it has been recognised that global decision-making in the agricultural system is predominantly undertaken by corporate and government actors (Feldman, Biggs, and Raina 2010; Byerlee et al. 2008). Despite some recognition of the critical role of small-scale producers and local knowledge in agricultural systems, there is still a fundamental gap in actionable implementation.

For the most part, corporate interests and government development agendas have neglected the recognition and rights of small-scale farmers, and multilateral institutions have been part and parcel of this agenda. Recent efforts by the United Nations have attempted to address some of this harm by recognising vulnerable rural populations and their rights to seeds. In Article 19 of the United Nations Declaration on the Rights of Peasants and Other People Who Work in Rural Areas (UNDROP) (2018), the right to seeds is recognised under the right to the protection of traditional knowledge; the right to equitable participation in the distribution of the benefits derived from the seeds; the right to participation in decision-making on issues relating to its conservation and sustainable use of the seeds; and the right to use, exchange, save, and sell farm-saved seeds or propagation material. The state is also instructed to support peasant seed systems, promoting using peasant seeds and biodiversity. In Article 19 of UNDROP and the International Seed Treaty, there is also recognition of the role of the state in regulating seed policies, Plant Breeders' Rights (PBR), IPRs, registration and certification schemes, and seed marketing laws to ensure the rights, needs, and realities of rural people are considered. UNDROP (2018) also referred to the right to food sovereignty.

The vast range of actors and divergent interests make the international agricultural policy context a politically contested space where power plays a crucial role in which discourses dominate, what projects receive funding, and what material and epistemic realities are produced. I will explore the role of international-scale influence and intervention in the Colombian seed system through the stories, practices, and discourses reproduced in and by international agricultural research and development organisations.

2.3 National development trajectories in the Colombian seed system

Colombia's national agricultural policies are not markedly different from the international neoliberal context. A specific focus has been on trade liberalisation, export-based agri-economies, technological innovation and Intellectual Property Rights (IPR) systems (Moore et al. 2011; OECD 2015). Within this context, the Colombian state has ratified seed certification and regulation requirements, PBR, and seed commercialisation laws that force seed producers to align their

systems with unified international standards, undermining the rights of farmers and free access to seeds (Hernández Vidal 2018). I will draw upon Colombia's national development trajectories to show how debates between formal and informal seed actors play out in discourses and practices. Policies that patent seeds allow for the commercialisation and use of transgenic cultivars and restrict the free exchange and use of non-certified or native seeds. This reproduces an inequitable power dynamic between large-scale industrial and small-scale producers. Colombia has also recognised the critical role of small-scale farmers in food production, the identities of racialised rural communities, and the need for increased rural support to compensate for deep social inequities. This rift is central to people's contesting discourses and visions for Colombia's future sustainable seed system.

2.3.1 Colombia's agricultural policies: pre-1990s-2011

Prior to the 1990s, Colombia was focused on import substitution policies and price stabilisation in agricultural policies, with payments to producers when the prices of products fell below a minimum (OECD 2021). Then with the introduction of high-yield seed varieties to Colombia throughout the Green Revolution, Intellectual Property Rights (IPR) laws were introduced to control and regulate the seed system (Hernández Vidal 2022b). During this period, Colombia's commercial agricultural sector exponentially increased in growth (OECD 2015). Notably, this commercial growth did not include the local agricultural sector. Between 1990 and 2013, the focus shifted to trade liberalisation and protective measures to offset a financial crisis (OECD 2021). Genetically modified seeds have been contested in Colombia since 1998, when regulations were implemented for biotechnological crops (Hodson de Jaramillo 2020). Since 2002 when the first biotechnological plant was approved for non-restricted commercial cultivation, there has been a wave of approvals for cultivation, development, and commercial trials for genetically modified and transgenic plants in Colombia (Hodson de Jaramillo 2020). Maize and soybeans are the primary transgenic cultivars relevant to the food system. The commercial release of genetically modified seeds was enabled through the approval of Decree 4525 of 2005, implementing the Cartagena Biosafety Protocol that regulated the introduction of Living Modified Organisms (LMO) in the country (Hernández Vidal 2022a; Semillas 2023). Resolutions are also continuously issued by the Colombian Agricultural Institute (ICA) on a case-by-case basis for commercial trials of genetic modifications at the cultivar level (Semillas 2020). Despite less of a specific focus on seed control prior to 2011, these agricultural policies introduce neoliberal discourses of development, modernity, and productivism, which act together with IPR legislation and the introduction of "improved" seeds to set seeds up to be categorised and controlled based on that categorisation.

2.3.2 Colombia's agricultural policies: 2012-now

In 2012, Colombia adopted the *International Convention for the Protection of New Varieties of Plants* (UPOV) 1991 Convention. This replaced UPOV 1978 in complying with the conditions of the US-Colombia Free Trade Agreement (US-FTA) (Wattnem 2014). A stipulation for signing the US-FTA was that Colombia must submit to the World Trade Organisation's Trade Related Property Rights (TRIPS) (Gutiérrez Escobar and Fitting 2016). This served the primary purpose of protecting PBR by prohibiting farmers from saving protected "new" seed varieties for any purpose but independent use (Wattnem 2016). PBR is recognised when a variety meets the 'DUS' criteria which refers to a distinct, uniform, and stable novel variety (UPOV 2002). It is almost impossible and also often not the aim for local varieties to fit these criteria, as farmers select seeds that are healthy and adapted to local conditions at the population, not variety level (Aistara 2011). Therefore, PBR and the UPOV Convention are widely realised to impinge on farmers' rights through displacing and criminalising informal seed systems (Parthasarathy 2017; Kloppenburg 2005; Hernández Vidal 2018).

In Colombia, Resolution 970 of (2010) specifically restricted the commercialisation and exchange of all non-certified seeds (Wattnem 2016). Law 1518 of 2012 approved the adherence to UPOV 1991, guaranteeing PBR (Gutiérrez Escobar and Fitting 2016). This agricultural legislative environment is a testament to state interventions contributing to a regulated seed sector whereby non-registered and non-certified seeds cannot be marketed or exchanged (Wattnem 2016). Since 2013, the public has increasingly influenced Colombia's agricultural policies through social movements. As a result of the 2013 National Agrarian Strike and rural contestation, the ratification of UPOV 1991 without consultation of traditional communities was found to be unconstitutional in court (Sullivan 2012). This resulted in a two-year suspension of Resolution 970 to give time for amendments (Gutiérrez Escobar and Fitting 2016). In its place, Resolution 3168 of 2015 contained small changes related to farmers' privilege, only applicable to certified seeds (Silva Garzón and Gutiérrez Escobar 2019). Seed no longer had to be registered in the information system (Gutiérrez Escobar and Fitting 2016). However, Resolution 3168 maintained that all marketed and exchanged seeds must be certified (Semillas and RSL 2015a). In this Resolution, the regulations apply to seeds that result from "genetic improvement" (Semillas and RSL 2015a). This was posited to mean the Resolution does not apply to native or creole seeds (Silva Garzón and Gutiérrez Escobar 2019). However, genetic improvement was defined as altering the inheritance of plants to obtain cultivars adapted to specific conditions, which is technically not only the work of breeders but also the practice of Afro-Colombian, Indigenous, and small-scale farmers (Semillas and RSL 2015a). This ambiguity means that local trading of native seeds that are not registered or certified can be

rendered illegal (Semillas 2023). Therefore native and creole seeds remain criminalised, and all seed-saving and commercialising activities of certified seeds remain restricted in Colombia (Gutiérrez Escobar and Fitting 2016).

In the 2016 Peace Agreement, the first item focused on Comprehensive Rural Reform. This shared vision contained sections on access to land and land use, special development programmes to improve productivity, poverty reduction, and creating a food security system with better collaboration between ministries (Roa-Clavijo 2021). The Peace Agreement also explicitly stated, "the integral agrarian development policy must be aimed at progressively ensuring that all people have access to healthy and adequate food and that food is produced under sustainable systems" (FARC-EP 2016, 33). The Peace Agreement promoted the protection of native seeds and community seed banks through participatory processes, contributing to their improvement and incorporating their knowledge to strengthen the productive capacities of the peasant, family, and community economy and stimulate technological innovations (FARC-EP 2016). There were steady increases in budget allocation for agricultural support between 2007 and 2016 (OECD 2021). In the context of the negotiations surrounding the Peace Agreement, it was highlighted that the state must implement a system to guarantee human rights to food (FARC-EP 2016). Law 171 (2020), led by the Food First Information and Action Network (FIAN) Colombia, also proposed the restructuring of the Intersectoral Commission for Food Security and Nutrition (CISAN) (2009) to prioritise the human right to food and the adoption of a National Public Policy on Food and Nutrition created with participatory processes.

Since 2016, budget allocation for agricultural support has decreased in absolute and relative terms (OECD 2021). In 2017 the government issued the Strategic Plan for Science, Technology and Innovation of the Colombian Agricultural Sector 2017-2027 (PECTIA) (Semillas 2023). This policy instrument prioritised the optimisation of procedures, access to biological and genetic resources, and protection of intellectual property (Semillas 2023). PECTIA guided the National System of Agricultural Innovation (SNIA), created under Law 1876 of 2017 (Semillas 2023). The SNIA does not recognise or protect agrobiodiversity and knowledge of peasant communities. It also does not recognise traditional seed practices carried out by peasants, as required in the Peace Agreement (Semillas 2023). Law 1955 of 2019 approved the National Development Plan 2018-2022, in which, Article 253 established the role of the government in building public policy for the peasant population through participatory processes. Directive 007 of 2019 of the Office of the Attorney General of the Nation also provided guidelines for the recognition, prevention,

promotion, and defence of the rights of the peasantry following the jurisprudence of the Constitutional County.

Despite some shifts in national policies to recognise the rights of small-scale producers, the policy inertia is highlighted in the high levels of food insecurity and diet-related disease and obesity experienced disproportionately by rural racialised communities. In Colombia, 54 percent of households are food insecure, increasing for Indigenous and Afro-Colombian households to 77 and 69 percent, respectively (Instituto Colombiano de Bienestar Familiar 2015). In line with other lower economically developed countries, there is a higher proportion of food insecurity in food-producing rural areas at 64 percent of households, compared to 52 percent in urban areas (Instituto Colombiano de Bienestar Familiar 2015). While in 2015, the national rates for diet-related diseases for adults and school-age children were 54 and 24 percent, respectively (Instituto Colombiano de Bienestar Familiar 2015). There is an overrepresentation of racialised communities, with Indigenous and Afro-Colombian populations consistently reporting higher prevalences of poor health outcomes (Agudelo-Suarez et al. 2016). In Colombia, a systematic review of research tied this disproportionate representation of food insecurity and diet-related disease and obesity for marginalised populations to high levels of social vulnerability, geographical segregation, and structural inequalities (Agudelo-Suarez et al. 2016).

In Colombia, from the sixteenth century, colonisation led to Europeans settling in cities, which pushed racialised and marginalised Indigenous, Afro-Colombian, and mixed-race groups to claim land in rural areas (Lamberty 2014). Ongoing rural marginalisation further displaced campesinos in the conflict of a civil war between 1948 and 1958 fought in the countryside, known as *La Violencia* (The Violence) (Lamberty 2014). Then the impacts of the fifty-year civil war with the government military, extreme left-wing guerrilla groups, and extreme right-wing paramilitary groups all culminated in a humanitarian crisis of displacement. Approximately 5.7 million people, or over 15 percent of the population, were internally displaced in Colombia throughout this conflict, with a disproportionate representation of racialised and rural populations (Lamberty 2014). Of the displaced peoples, it is estimated that 81 percent were campesino populations, leading to fragmentation in rural populations, land and the place-based knowledge and practices of seed saving (Myriam Ocampo et al. 2017). In 2014, during the armed conflict 986 people were displaced in Cauca Valley (Maher and Thomson 2018).

In exploring possible future pathways of food system sustainability, Roa-Clavijo (2021) positions campesinos as central actors in the quality, quantity, and timely local food provision

necessary in a sustainable system. In practices of food provision, campesinos rely on local and traditional knowledge, reinforce marginalised identities, and reinvigorate local livelihoods (Roa-Clavijo 2021). Roa-Clavijo (2021) argues that there needs to be increased policy recognition of the role of the peasant in the Colombian seed system. Hernández-Vidal (2022b) looks explicitly at how campesinos are involved in seed struggles operate at the territorial level in Colombia. Hernández-Vidal also focuses on how racialised Indigenous communities in Colombia have re-territorialised seeds and land by establishing transgenic free territories in which traditional seeds and seed users can reconfigure sociohistorical biosocial relations (Hernández Vidal 2022a). The connection between seeds, people, and land is explored throughout this thesis as particular biosocial relations are reproduced through seed practices situated in place.

In 2020 the Ministry of Agriculture and Rural Development created a policy framework called "Together for the Countryside," which set out the policy programmes to try and compensate for rural inequities. It sought to subsidise the high costs of agricultural transportation, machinery, and purchasing inputs, including seeds and chemicals (OECD 2021). Law 2046 (2020) requires that at least 30 percent of public food procurement is from peasant agriculture. Further, the National Technical Committee for Local Public Food Purchases was created, containing definitions of short marketing circuits, fair trade, local food, and agroecology. The rights of campesinos were recognised in Resolution 464 (2017), which set strategic public policy guidelines for Peasant, Family and Community Agriculture aiming to guide the government to strengthen rural communities' social, economic, and political capacities with a territorial approach to improving the sustainability of the agri-food system. The Resolution requires explicitly that native seeds are recognised in the national seed system and that sustainability is guaranteed. Most recently in the Colombian political context has been the appointment of a leftist government of Gustavo Petro and Francia Márquez, known as *Pacto Historical* [Historical Pact]. Hernández Vidal and Ramírez (2022) point to the need to remain critically hopeful about this political turn. Criticism is necessary against the complex embedded power dynamics within the racialised, patriarchal, and capitalist hegemonic global systems (Hernández Vidal and Gualdrón Ramírez 2022). Hope is needed in denouncing neoliberal extractivism and progressivism and in seeing that there is a possibility to imagine an alternative future (Hernández Vidal and Gualdrón Ramírez 2022).

Beyond the literature particularly in terms of what is written in policies and legislation are important contrasts with what is happening on the ground. Within the Colombian agricultural development trajectory, I explore seed struggles through the discourses reproduced by actors involved at the international, national, and local levels. Mainly focusing on the rift in the national

policy focus in the prioritisation of technoscientific modernisation yet the purported need to support Indigenous, Afro-Colombian, and campesino small-scale producers who are known not to be benefiting under this current technoscientific regime. Within this context, actors in international institutions such as CIAT, national organisations such as private producer organisations, and government representatives are positioned in the technoscientific paradigm. In contrast, local and racialised seed actors are positioned in a resistance paradigm against hegemonic agricultural development.

2.4 The role of intersecting actors in the Colombian seed system

Many actors with divergent interests and knowledge are involved in Colombia's formal and informal seed systems that exemplify the fragmentation of the agriculture and seed policy. There are multinational corporations and research and technology organisations at the international level. One key international research and technology institution throughout this thesis is CIAT. This institution is focused on future food security through technological innovation and human capital development (CIAT 2023b). With the Future Seeds germplasm bank, CIAT is prominently involved in characterising and utilising collected germplasm materials (Schultze-Kraft, Peters, and Wenzl 2020). The research and development objectives at CIAT are to enhance crop resilience, profitability, and productivity for a food-secure future (CIAT 2023b).

At the national level, the government and private producer associations for specific crop sectors are key actors throughout this thesis. Silva Garzón and Gutiérrez Escobar (2019) also draw attention to how the Colombian state acts through the ICA (*Instituto Colombiano Agropecuario* [Colombian Agricultural Institute]) to regulate seeds and implement biosafety norms, which are inherently biased towards multinational corporations. The national producer associations work closely with the ICA to achieve the provision of public goods and services that benefit the private sector they jointly represent (Junguito Bonnet 2019). The associations are private but operate on a source of public income through the producer or parafiscal tax. These associations, also known as *gremios* (guilds), are heavily involved in the marketing and promotion of the respective crop sector, representation of the interests of members, and analysis of information relevant to the sector to be used in projects, strategies, and lobbying (Junguito Bonnet 2019). In Colombia, the guilds also have a reputation for significant contributions to scientific knowledge and technological innovation (Junguito Bonnet 2019). The guilds exist for many crop sectors, including the highly supported export sectors of coffee, palm, and sugarcane. Acosemillas (Asociación Colombiana de Semillas y Biotecnología [Colombian Association of Seeds and Biotechnology]) is a guild that represents the seed industry and acts in the areas of regulation and development of biotechnological seeds. I was

unable to interview someone from this institution. In this thesis, specific examples from two producer associations focused on food production are drawn upon: FEDEARROZ (Federación Nacional de Arroceros [National Rice Growers' Federation]) and FENALCE (Federación Nacional de Cultivadores de Cereales, Leguminosas y Soya [National Federation of Cereal, Leguminous and Soybean Growers]).

At a national scale, in the seed system there is also involvement from Non-Governmental Organisations (NGOs) and social groups. Colombia's most prominent seed NGOs are *Grupo Semillas* (Seed Group) of the Swissaid Foundation and the RSL, a coalition of NGOs and traditional communities. Both advocate for the rights of Indigenous, Afro-Colombian, and campesino seed savers. These NGOs and local actors in the seed system have been contesting what Gutierrez Escobar and Fitting (2016) call the "biohegemony" of Colombian agricultural policies. Throughout this thesis the NGO, FUNDAEC, (*Fundación para la Aplicación y Enseñanza de las Ciencias* [Foundation for the Application and Teaching of Science]), in Cauca Valley uses social development programmes through science education and agriculture to support disenfranchised Afro-Colombian rural communities. The values taught at FUNDAEC include building the capacity of people and knowledge through strengthening the family and community model of farming (FUNDAEC 2021). There are also Indigenous communities known as *resguardo*s actively resisting corporate seed enclosure and genetically modified seeds through campaigns and mobilising, six of which have declared transgenic free territories (Fitting 2017). Academics, NGOs, and campesino activists alike all play vital roles in maintaining traditional knowledge through space-making, criticising unequal power dynamics, and contesting uncontested truths in the agricultural system (Goyes 2018; Goyes and South 2016; Hernández Vidal 2022a).

This thesis will contribute to the existent literature by drawing attention to the pertinent consideration of small-scale seed savers in the Colombian seed system. The current focus on seed system sustainability is fragmented in literature and reality. There is a significant focus on technological development and scientific evidence of the benefits of technological developments that improve the genetic purity, climate resilience and biofortification of seeds (Beebe 2020). At the same time, there is some policy recognition of the rights of small-scale producers. Local actors have engaged in social mobilisation advocating for the benefits of a seed sovereignty approach. This thesis explores the seemingly disparate and disconnected scientific and local perspectives of seed system sustainability with thought to how informal and formal parallel systems can be linked and strengthened in an actionable way. This research contributes to understanding how power and discourses are reproduced through collective imaginings of future seed system sustainabilities.

CHAPTER 3: THEORETICAL FRAMEWORK

This chapter uses a Science and Technology Studies (STS) framework to explore how power and discourses are reproduced in the Colombian seed system. Formal actors such as scientists, seed breeders, and representatives of private associations delineate categorisations of seeds and by association reinforce categorisations of peoples that use those seeds. The hierarchical categorisation of seeds and seed practices is reminiscent of the colonial racialisation of peoples in Colombia. This is maintained through how scientific communication emphasises rationality, objectivity, and expertise in putting forward technological seeds as a silver bullet solution. The social construction of categories and the physical practice of reproducing improved seeds in breeding programmes creates a controllable technoscientific subject with material and epistemic implications for the different pathways of seed system sustainability.

3.1 Science and Technology Studies

The interdisciplinary theoretical framework of STS brings social context and complexity into how technological systems are understood (Pinch and Bijker 1984). The concept of social construction facilitates this understanding by questioning how scientific knowledge is created by people and practices situated in a social context (Berger and Luckman 1967). Also of concern is how that knowledge is communicated by scientists to the public. Scientific communities rely on a deficit model of doing and communicating science that assumes the public is homogenous and ignorant (Irwin and Wynne 1996). This model fits within a positivist paradigm in which the public will become more understanding and accepting of scientific findings as evidence is provided through a top-down, one-way, transfer of scientific knowledge (Wynne 1995). This deficit model creates a division between scientific knowledge production and communication with publics. Reductionist technoscience leaves no space for public participation. It is by maintaining objectivity and authority that science retains its economic value (Jasanoff 2017). But scientific knowledge is produced through consensus building shaped by the social context, including human agency, discourse, norms, and cultural practices. Therefore, an object ascribed meaning by a particular social group reflects that social group's norms, values, and sociohistorical context (Pinch and Bijker 1984). In making knowledge claims that can be held to account, it must be recognised that the interpreter will only ever have partial knowledge because it is subjective and "situated" (Haraway 1988, 581). Haraway (1988) points to the impossibility of objectivity in science. Knowledges and methods are situated and the stories that are told as a result reflect the location and social agendas of that context (Haraway 1988). When situated scientific knowledge is deployed unilaterally in communication and policymaking, this maintains the cultural authority of science and orders social

life around a technoscientific imaginary. In the Colombian seed system science and its communication as a more legitimate and authoritative solution than local practices is a dominant theme in the discourse between formal and informal seed actors. The economic value of science is deeply embedded in discourses of development and technoscientific modernity. These discourses are reproduced by formal actors in climate resilient and biofortification breeding programmes that seek to produce a homogenous seed as a silver bullet to hunger and climate change. Local actors working with traditional knowledge and seeds are largely involved in agricultural development programmes in Colombia after the 'real' science is done.

3.2 Boundary work

The work of those 'doing' science in emphasising or de-emphasising certain results to have certain effects is known as boundary work (Gieryn 1999). This refers to how the boundaries of science are drawn to demarcate what is scientific and non-scientific (Gieryn 1999). A distinction is made to assert expertise and authority in a particular scientific domain (Gieryn 1983). Within boundary work, scientists or those referring to their work, carefully select qualities and methods specific to that scientific domain to make uncontested claims of authoritative expertise (Gieryn 1999). The communication of complexity, risk and uncertainty projected by scientific knowledge communities works to reinforce and transform these boundaries between science and publics (Nowotny 2016). These boundaries of science, risk and uncertainty are (re)drawn in flexible, historically changing and often intentionally ambiguous ways (Wynne 1995). The boundaries reflect human agency and politics (Iles et al. 2017) In the context of the global food system, boundary work has been used by corporate and state actors with scientists funded by corporate and state development projects, to make the productvist capitalist agricultural system more legitimate and powerful than traditional agriculture (Iles et al. 2017). Boundary work assumes a positivist scientific framework in which science is an objective truth and uncertainty is minimised through advancing scientific understanding, leading to rational decisions formulated upon scientific evidence (Jasanoff and Wynne, 1998). Scientific knowledge is produced and reinstated by actors with comparatively more power than those subjugated in holding local, traditional, and Indigenous knowledge. In this context, the Foucauldian idea of power circulating through society helps show how repetition of discourse and practice reinforces a specific narrative that can become pervasive to the point of hegemony despite counterdiscourses (Foucault 1979).

International conventions such as UPOV and TRIPS, redraw boundaries between breeders and farmers and downplay risk and uncertainty in the scientisiation of seed systems (Aistara, 2012). Governments and research organisations also act as boundary organisations through mediating the

interests of political and scientific communities (Guston 2001). These institutions need to balance the scientisation of politics and the politicisation of science (Guston 2001). In the Colombian seed system, the government, national producer associations, and research centres such as CIAT can be considered boundary organisations that become sites of co-production for science, knowledge, values, and social order (Guston 2001). The boundary management that the actors working within these formal institutions undertake reaffirms legitimacy in the authority of technoscientific seeds.

3.3 Racialisation

A discourse of racial formation refers to how ideas of difference are materialised, becoming visible and tangible through societal conditions (Lopez 1997). Organising humanity into scientific categorisations based upon race produces a structured societal hierarchy (Storey 2012). Central to racialisation is the Foucauldian notion of disciplinary power that exists everywhere and is most pervasive in the subtle ways our worldviews and everyday behaviour are shaped by what is perceived as normal in society (Foucault 1979). Disciplinary power is repressive in how it shapes society to undertake self-surveillance to confine with societal norms (Foucault 1979). Importantly it is also productive in that it constructs subjects of control while shaping reality (Foucault 1979). In this context, the subjects are the racialised groups of peoples and seeds. Power is operated on peoples and seeds as subjects, producing a docile seed. The social construction of race has historically categorised and stigmatised populations of people and seeds, resulting in subjectfication.

In Colombia, racial differences in peoples were socially constructed through colonisation and the impacts of slavery that contrasted Indigenous culture with a non-Indigenous national culture (Ng'weno 2007). This racial categorisation perpetuated a dichotomy of civilised and uncivilised, allowing for separate legal treatment of populations (Ng'weno 2007). Afro-Colombians were racialised through legal recognition of ethnicity. Law 70 of 1993 recognised Black communities as possessing their own culture, a shared history with traditions, customs and an identity distinct from other ethnic groups (Government of Colombia, 1993). Indigenous and Afro-Colombian populations have been legally and socially constructed through subordination marked by distance from the colonists (Harris 2006). In the 1991 Constitution through explicit exclusion from Indigenous and Black communities, campesinos were classified as rural *Mestizxs* (mixed populations), inferring impurity (Eiss and Rapport 2018). Racial divisions give different levels of accessibility and legal rights to land, impacting who can work on and with seeds. In Colombia, campesinos have been largely left landless with no constitutional protection facilitating a collective right to the land they used to work. This has further dispossessed this community of seeds.

In the 1966 book, *The Racial Composition of the Population of Colombia,* a United States sociologist, T.Lynn Smith constructs a racial hierarchy to differentiate racial mixtures. Specifically stated is that these descriptions of racial differences are "thoughtful, unemotional attempts to appraise various aspects of the racial composition and distribution of the population [because this] deserve[s] serious attention" (T.L. Smith 1966, 219). Immediately racial thinking is used to separate whites in Colombia as a "race [that] is greatly improved [as a result of] avoiding any intercourse" with other races (T.L. Smith 1966, 217). Purity is implied to be a distinguishing characteristic of racial categories with a chart situating "Whites" above the 'other' racial groups of "Indians" then "Negroes." Relegating mixed populations as 'impure' groups situated lower in the rankings, with "*Mestizos*" (peoples of White and Indian descent) and finally the mixed population of darker presentation, "*Mulattoes*" (people of White and Black descent) (Figure 3.1). Patriarchal notions of governance are introduced through describing whites as "feudal masters of the land, of noble intelligence, of exclusive culture" (T.L. Smith 1966, 219-220). While Blacks are described as a group that "devotes himself to […] vandalism. [And being] incapable of agricultural work. He is […] unmoral […] and lying" (T.L. Smith 1966, 219). Notions of improved, pure, master, and well-behaved attain meaning only in being directly compared to a subject that must be worse, impure, governable, and criminal by association. These heavily value-laden terms were applied to differentiate between different racial groups of people. Fifty years later within the same hegemonic system of capitalism which exploits people and land, these ideas are also applied to seeds, whereby genetically mixed or creole seeds are deemed inferior to genetically pure seeds. This also indirectly reinforces control over the racialised peoples who use those seeds.

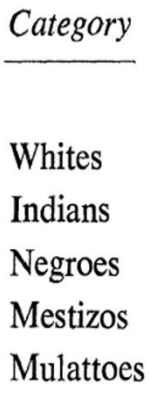

Figure 3.1 Racial categorisations of peoples in Colombia (Smith 1966, p.218).

3.4 Territorialisation

Territorialisation is an active strategy an individual or group employs to attain or maintain control over territory. Territorialising impacts place-based connections, histories, identities, and sense of belonging. De-territorialisation is a process of undoing connections to a place through a

reconceptualisation of belonging everywhere and nowhere (Storey 2012). Re-territorialisation is the reconfiguration of space, the politics of land, and belonging to place (Storey 2012). Re-territorialisation means rethinking the seed system from local spaces. It draws on food and seed sovereignty principles in building a bottom-up approach to socio-ecological sustainability, rethinking relationships between actors, land, seeds, and knowledge systems (Roa-Clavijo 2021). Territoriality helps explain how territories are produced and how politics, power and policy can facilitate the use of territory as a strategy for asserting power over others, including seeds (Storey 2012). Particularly important within a framework of territoriality are questions about who the actors are that employ power in constructing legislative, political, and scientific borders around land and seeds. Who originally owned the land that seeds were situated in? Who owns the land now and who will own the land on which banked seeds will be grown in the future? (Karafyllis 2020). At a global level, territory has been used to exert control in colonial and imperialist expressions of political power (Storey 2012). However territoriality also operates at a local level in any bounded space with internal or external contestation (Storey 2012).

As seeds are technologically modified, certified, and commodified, the meaning of caring for seeds is fundamentally changed (Aistara 2011). Discourses of care and interconnected socio-ecological sustainability are replaced by discourses of development and modernity that are reproduced under conditions of unequal power (Mohanty 1988). As Escobar (1997) highlights, discourses of development and technoscientific modernity socially produce space for scientific sustainability, which sidelines traditional sustainability and the actors that work with this knowledge, resulting in de-territorialisation. In removing seeds from a context of social exchange and meaning, producers are also disconnected from exchange networks and associated knowledge and histories (Aistara 2011). Therefore, as seeds and their producers are de-territorialised through *ex situ* conservation a hierarchically structured social life is co-produced with the technoscientific seed. Racialisation constructs the hierarchical categories that enable seeds and subjects to be produced and controlled in territories.

3.5 Sociotechnical imaginaries

The concept of sociotechnical imaginaries can be defined as "collectively held, institutionally stabilised, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order, attainable through, and supportive of, advances in science and technology" (Jasanoff 2015, 4). They can also be a collectively imagined resistance against undesirable futures (Jasanoff 2015). Sociotechnical imaginaries allow the exploration of how science and technologies shape and are shaped by social relations (Jasanoff

2015). This term allows different actors within the seed system to come into view with different imaginations for a sustainable future. The capacity in collective visions of technoscientific futures extends beyond sovereign power into the realm of disciplinary power, as actors within the seed system undertake self-surveillance of what seeds they are using and why and as the production of technoscientific seeds as docile subjects is mainstreamed (Foucault 1979). With increasing global competition, corporations and states have turned to science and technology to simultaneously solve social problems and achieve economic growth (Jasanoff 2017). There is an appeal in the innovation of science and technology due to the timely delivery of short-term outcomes that can justify funding. Big science is increasingly shaped around projects because of the standardised format of a process, structure, timeline, participants, and deliverables that have to be set out to receive funding and to assure stakeholders that progress will be made through bureucratised, performance-based, measures of accountability (Hackett et al. 2017).

On the current global development agenda, climate change and hunger are held up as targets for technoscientific strategies to be a silver bullet solution. Narratives around climate change and food insecurity draw on socially constructed discourses of scarcity and underdevelopment to justify development interventions (Nally 2016). Climate change and food insecurity also script societal futures and organise a future society that is collectively imagined to be able to face such complex challenges (Hulme 2011). Within this scripted food future, the seed is justified to be (re)produced in a way that systematically excludes sociocultural context and traditional knowledge systems, de-territorialising the seed. Specific nutrients and climate resilience characteristics are extracted in breeding programmes as seeds are taken out of context to make a homogenous controllable subject and dominant sociotechnical imginary. A sociotechnical imaginary of the modern seed is held up as the ultimate sustainable solution to feeding the population and facing climate change. Yet there is also contestation in the collective imagining of an alternative future premised upon traditional seeds, seed knowledge, re-territorialisation, and agroecological practices. The rifts between imaginaries are co-produced through discourses of modernity set against seed sovereignty as exemplified by categorised actors, seeds, and fragmented land.

The phenomena of boundary work, racialisation, territorialisation, and sociotechnical imaginaries allow the exploration of the diverse amd fragmented perspectives and discourses reproduced in this research in on the Colombian seed system. This thesis provides a context in which to explore the on-the-ground realities of fragmentation and scope for reconciliation and collaboration between disparate actors and their imagined futures.

CHAPTER 4: METHODOLOGY

4.1 Research paradigm

I undertook qualitative and inductive research to understand the subjectivities of seeds and sustainability within the Colombian seed system (Patton 2014). The methodological approach is constructionist as I analyse subjective realities to understand how sociocultural contexts shape collective meaning (Patton 2014). Before deciding to research seeds in Colombia, I asked myself what the benefits, risks, and limitations would be in undertaking cross-cultural research as a white educated woman with an intermediate level of Spanish in a country where I was an outsider to the political and sociocultural context. With this in mind I aimed to have a participatory and action-oriented research paradigm, prioritising a bottom-up process that addressed existing power dynamics and fostered local collective knowledge creation (Cornwall and Jewkes 1995). However, due to limited time, language, ongoing funding, and access to communities I drew on participatory techniques in lieu of meeting the totality of participatory research requirements. Before undertaking research concerned with improving outcomes for small-scale racialised producers it was important I consider how research itself is dominated by imperial and colonial power structures that disenfranchise racialised 'others' (L.T. Smith 2021). Despite the situatedness of my research in the western paradigm, this work draws attention to unequal power dynamics that need to be addressed in creating a collaborative and inclusive approach for seed system sustainability.

4.1.1 Positionality

Positionality is influenced by the researcher's worldview (ontological assumptions), as well as their perception of the nature of knowledge (epistemological assumptions) (Darwin Holmes 2020). It is important then that I considered how I was differently situated in each interaction I had along an insider/outsider continuum based on but not limited to factors such as race, ethnicity, education, gender, socio-economic status, and culture (Merriam et al. 2001). This involved recognising that my position was determined in relation to the participant or 'the other' and that despite being closely positioned towards an 'external-outsider' throughout my engagements, my position was relative to values and norms and could therefore shift as all understanding is subjectively formed based on power-relations (Merriam et al. 2001). To understand how different positionalities and power differentials impacted the research process, reflexivity was central to how I engaged in the research process. Reflexivity goes beyond reflection in that it is a state of mind (McGee 2012). This involved thinking about the research process with myself as the main research tool and also thinking about and communicating the potential biases I bring to the field through my own sociocultural and geographical situatedness (McGee 2012). There was also a consideration

of what was not said, what did not happen, and the informal interactions and conversations that were not recorded (Patton 2014). This served an epistemological purpose of increasing validity and quality in the research (McGee 2012).

I used three methods to engage in reflexivity. Firstly, I used experiential learning as a complementary process to conceptual knowledge-building (McGee 2012). Learning through experience requires being open to learn and to change with the research as a result of reflecting on one's own values, assumptions, and position within the research process (McGee 2012). To strengthen this learning, critical reflection should happen following the experience as the researcher unpacks how their understanding and behaviour may have impacted the research paradigm. This should involve a transformative shift in attitude (McGee 2012). To engage in the reflexivity mindset through experiential learning I had a field journal in which I took notes before, during, and after interviews. I recorded descriptions of the context and content of the interviews, participants' body language, external influences and interactions and added my own questions and thoughts. I will also send every participant a summary of my research findings and I made them aware of this during the interview. Finally, verbal collective reflexivity was used in open discussions about information interpretation, positionalities, trust, and ethical responsibility (Ozano and Khatri 2017). These discussions happened at various stages throughout my field research with my supervisor, interpreters, and participants. Importantly with my interpreters this also involved positioning them and considering the triple subjectivity resulting from the interaction between researcher and participant, researcher and interpreter, and interpreter and participant (Ozano and Khatri 2017). The interpreters acted as 'insiders' while I was an 'outsider' and helped me to bridge multiple gaps within the researcher-participant relationship.

4.2 Method

I researched across Bogotá, Cali, and the surrounding regions for over two months. I participated in four seed workshops organised by two representatives of the *Instituto Distrital de las Artes* [District Institute of the Arts] (IDARTES) and one representative of the National Indigenous Organisation of Colombia whom I later interviewed. The workshop participants were urban gardeners or members of campesino communities with rural ties and direct connections with local seed systems (Image 4.1). I undertook two field-days at CIAT learning about breeding programmes, hybridisation, and experimentation for climate resilience. During my time in Colombia, I also informally surveyed 11 seed shops across Bogotá, Cali, and Medellín to see how many varieties of

beans and maize were available. The main source of my data in this thesis is from interviews I conducted with 32 people working within the Colombian seed system.

Image 4.1 Group work at a seed workshop where participants painted seeds and arranged them into categories to produce knowledge about seed geographies and context (own photo).

4.3 Scope

The scope of this research is restricted to the seeds and associated saving and reproducing practices I encountered in Colombia. Eleven interviews were conducted on-site at CIAT where I was a visiting researcher for three weeks. Many of the institutional interview contacts I had were enabled through this formal research afiliation. While at CIAT, I also undertook interviews off-site, where I travelled with my supervisor from CIAT to other regions in Cauca Valley including Cali, Florida, Palmira, and Puerto Tejada. Being on-site at CIAT provided access to the recently built international germplasm bank, breeding programmes, research and development teams, and also insight into the national partnerships with Agrosavia (*Corporación Colombiana de Investigación Agropecuaria* [Colombian Corporation for Agricultural Research]), ICA, and the producer associations. The location of Bogotá was selected due to the number of research institutions and government offices based in the capital city. Selecting multiple sites for interviews was intentional in facilitating a multi-sited approach that provides increased nuance for analysing peoples and seeds across space and place (Falzon 2016).

I emailed the Sustainability Departments of Syngenta and Monsanto with an explanation of my research, asking to interview a representative on the Colombian context to extend the scope of this thesis to cover perspectives of transnational corporations, but I never received a response. I would have also liked to speak to a seed and biotechnology guild representative, Acosemillas. A more in-depth exploration of Indigenous perspectives is not included as a major component of the thesis due to my previously mentioned lack of time, language ability, and resources that could have allowed me to research within autonomous Indigenous communities.

4.4 Sampling

Participants were recruited through a sequential and emergence-driven purposive strategy (Patton 2014). Specifically, the sample was built during my fieldwork in Colombia through snowball sampling (Patton 2014). This process began by locating well-situated people in the seed system in Colombia and asking them who I should contact and then each consecutive participant was also asked if they could think of anyone that I should speak to whom they considered knowledgeable about seeds in Colombia. The original key informants were recruited through contacts I established with researchers of seed sovereignty in Bogotá and with my supervision team at CIAT in Cali. I also engaged in informal discussions with participants in the seed workshops and field days in which it became apparent who other key informants were. This sampling technique was well-suited as it generated insights and understanding from information-rich cases, while notably not resulting in empirical generalisations (Patton 2014).

The sample size in my qualitative analysis was emergent and flexible, which complemented the design and analysis (Mason 2010). I also carried out interviews until a point of saturation. This is not to say that my sample represents all the diverse stakeholders in the seed system in Colombia, or that the people I spoke with provided responses typical of a homogenous group. Rather, that I managed to ask the specific questions I had on Colombia's seed system to enough people from different areas that I reached an appropriate level of representation of certain interdisciplinary stakeholder groups in different geographical regions (Crouch 2003). The interviews were approximately an hour but sometimes would last two or three hours with invitations to go and see gardens, forests, seed banks, laboratories, and research centres. The quotes I use should show the material, cognitive, and sensory practices of seed saving within a situated and partial reality (Phillips 2016). These interviews and the workshops and field days provided enough material to make meaningful comparisons and develop and test explanations despite the time constraints (Mason 2010).

Despite wanting to reach a wide range of local actors, most participants were classified as formal actors working internationally or nationally. At the international scale, participants represented international research agricultural organisations including CIAT, CIMMYT (*Centro Internacional de Majoramiento de Maíz y Trigo* [International Maize and Wheat Improvement Centre]) and FLAR (*Fondo Latinoamericano de Reservas* [Latin American Reserve Fund]), which operate under the jurisdiction of the CGIAR Alliance and representatives of FIAN. While participants at the national level were representatives of public or private national institutions including Agrosavia, Cenicaña (*Centro de Investigación de la Caña de Azúcar de Colombia* [Colombian Sugar Industry Research Centre]), FEDEARROZ, FENALCE, FUNDAEC (*Fundación para la Aplicación y Enseñanza de las Ciencias* [Foundation for the Application and Teaching of Science]), Impulsemillas, Universidad Javeriana and the Ministry of Agriculture and Rural Developemnt. Those categorised as informal actors worked at the local scale and therefore oftentimes were representing communities rather than official entities. However, at the local scale there was also representatives from *Desde la Raíz* [From the Race], Grupo Semillas, the National Indigenous Organisation of Colombia, and *La Red de Semillas Libres de Colombia* (RSL) [the National Network of Free Seeds] situating them at the local level due to the preference to draw on traditional and contextualised knowledge rather than scientisied knowledge (Appendix A).

4.5 The interview

Before the interviews I would introduce myself to participants, detailing the universities I was working and the goal of writing a thesis. I also elaborated on my interest in the multiple perspectives around seeds, describing how I wanted to understand how they were used, saved, exchanged, and produced in Colombia to reach different sustainable outcomes. This increased transparency, trust, and equity, while I remained attentive to the unequal researcher-participant power dynamic, reflecting upon this along the way (Cornwall and Jewkes 1995; Arnstein 1969; Webler, Tuler, and Krueger 2001). I used two open-ended semi-structured interview guides that were similar but adapted for either gardeners and growers or actors involved in research, development, and breeding (Appendix A). The interview guide was formed before arriving in Colombia based on a preliminary literature review and an applied research pilot study that was undertaken through zoom-based interviews in which exploratory questions were asked to five participants in Colombia working in the seed system including researchers, practical professionals, and institutional contacts at CIAT. I also sought guidance from a previous masters student and amended questions from their interview protocol for a thesis on seeds and agroecology in Cuba (Dowding-Smith 2011). In the final interviews, different questions were emphasised orommitted dependent on the knowledge, preferences, and relevance to participant.

During interviews I created a space for participants to share stories that might not have directly fit within my interview protocol yet remained important to the process. I actively listened, asked follow-up questions, and used prompts when I wanted to know something specific. This led to an inductive and relational approach to interviewing in which I would listen to responses before analysing. Throughout the interviews I observed participant behaviour and contextual information, I took notes on the content and wrote down any Spanish term I wanted to cross-check later. I recorded the interviews and transcribed the conversations afterwards. For the Spanish interviews (29 of 32), I used HappyScribe transcription software, where I uploaded the audio. I then re-listened to every interview and edited the transcript manually. Then I used DeepL translation software to upload the transcript documents and download the English version.

4.6 Ethics

As well as my description of my positionality and research focus at the beginning of each interview every participant was given a participant information sheet. Participants understood that they would not be financially compensated for their participation (Appendix B). Then they either signed a consent form or provided verbal consent for participation in which I was granted permission to audiorecord the conversation and use quotes and ideas that I present in the discussion (Appendix B). Every consent form from participants, the Spanish and English transcripts, and documents provided by a participants were added to a Google Folder that only I could access which was labelled as "participant 1,2,3…." In a separate folder was the spreadsheet of participant details with identifying information including name and corresponding pseudonym, gender, age, organisation, education, and contact details. For consistency and to strengthen ethical responsibility, pseudonyms are used in this thesis to protect the identities of participants and no personal or incriminating information is included to minimise the potential risks for the participants. In line with the Central European University Ethical Policy on Research there was no coercion, deception, recruitment of vulnerable populations, or significant risks to the researcher or participants.

4.7 Procedure

On leaving the field and returning to Europe I had thirty-two interview transcripts, four transcripts from workshops, and notes from two field days defined as cases. I applied a qualitative discourse analysis of these transcripts using NVivo 12 software. The 38 transcripts were assessed in an inductive approach to coding. This process involved starting broadly with going through each transcript in open coding looking for units of meaning and then narrowing this down through a selection of specific stories (Figure 4.1). Then I refined the code content into categorical domains

in axial coding (Williams and Moser 2019). This led me to the final stage of selective coding, which involved conceptualising the stories and constructing meaning from the themes (Williams and Moser 2019). The final themes that emerged for telling the stories were: the seed, the use of the seed, and the (re)production of the seed.

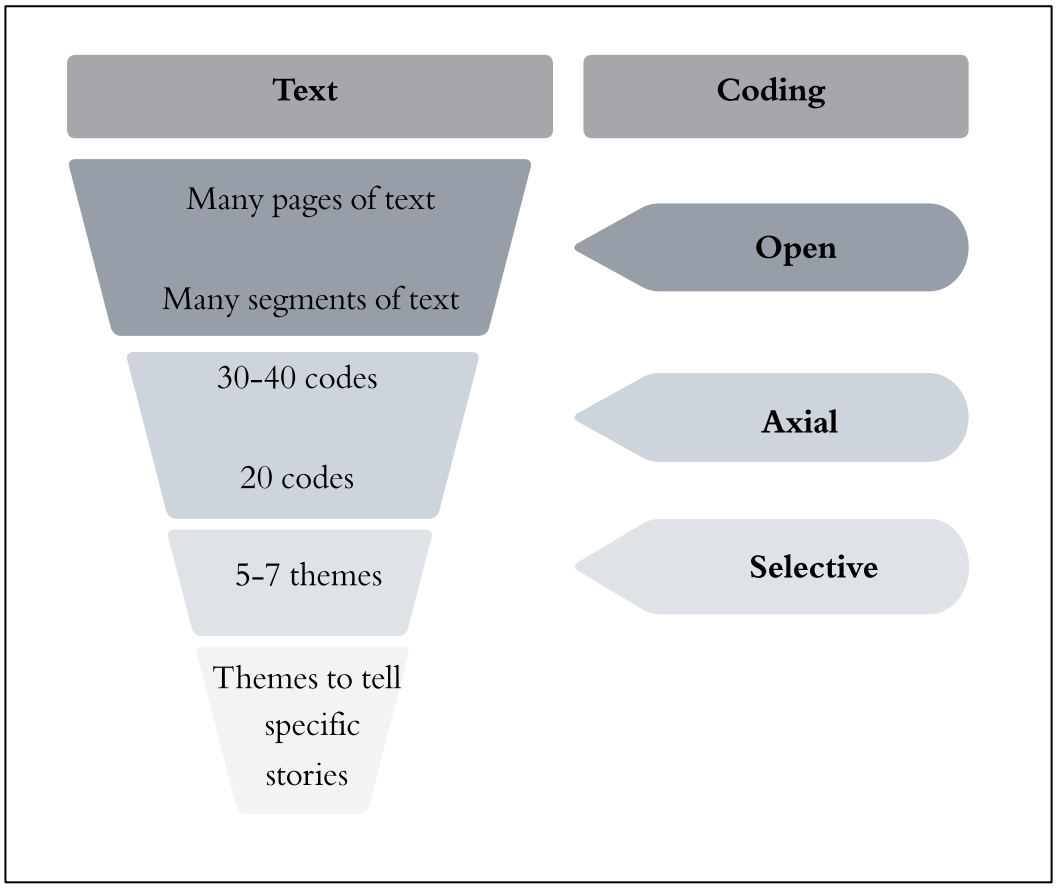

Figure 4.1 An overview of the open, axial, and selective coding processes (Adapted from Williams & Moser, 2019, p. 47).

4.8 Triangulation

Triangulation was used to strengthen the study design through combining methods to reveal different aspects of empirical realities (Patton 2014). A methodological triangulation was applied in combining semi-structured interviewing, participant observations, and document analysis. Interviewing aimed to understand people's perspectives about seeds and how they should be used and reproduced in a sustainable agri-food system. While the observations aimed to bring contextual factors to the analysis such as whether there were hierarchical, gendered, or (in)formal relations. Also, the observations provided an in-depth understanding of seed saving and production processes as I was shown these practices in the field. Participants gave me documents to provide additional information on a specific topic, law, or breeding process during the interviews so I could use these as part of my analysis.

Furthermore, the workshops I participated in in Bogotá brought a participatory and citizen science approach. Participants in these workshops were from campesino communities or had campesino family history but were involved in urban gardening projects and social seed saving organisations. The participants including myself led discussions, produced knowledge, and engaged in visual methodologies such as collage with images and text, painting seeds, and arranging seed varieties into categories (Image 2-3). The triangulation used in my methodology increases the validity and quality of the evidence, decreasing the likelihood of the study being influenced by biases or errors except for the inextricable influence of my own situated knowledge (Patton 2014). Even if the data from some interviews is not used directly in the analysis, it was an important part of the triangulation in understanding the overall system, actors, and processes in the Colombian seed system.

4.9 Limitations

The main limitation in my research was that I am not a native or fluent Spanish-speaker. This was mitigated first and foremost through having an interpreter present to help translate nuances in responses. I was also permitted by every participant to audio record the interviews and workshops, which allowed me to transcribe and relisten to every interview to check the details and make corrections. The types of questions I asked in the interviews also inherently limited the responses that I ended up with. Another limitation of this research is that it does not represent all the possible ranging local perspectives in the Colombian seed system. The snowball sampling method brings the possibility of researcher bias in selecting cases, which I mitigated through following up with every referral even if they did not immediately fit an anticipated informant category (Patton 2014). Furthermore, I could not access all local perspectives, particularly in-depth perspectives from Indigenous communities. This is because it takes time and a nuanced understanding of the local language to establish trust, networks, and foster relationships in outsider-insider decolonial research contexts (L.T. Smith 2021). However, within the scope of this thesis and chosen methodology, the sample was not supposed to be representative. As the research was conducted, I had the chance to interview a far wider range of participants than I originally anticipated, which allowed for an exploration of diverse perspectives with the known limitation that this could not be in-depth enough to lead to definitive conclusions about any specific community.[5]

[5] The use of participants' dialogue is used throughout this thesis not to attribute generalisations or blame to any individual actor or organisation. Rather, to paint a picture of the bigger picture of seed system sustainability in Colombia in terms of the different values, knowledge, and discourses around seeds.

CHAPTER 5: THE SEED AND RACIAL THINKING

"The food system is unjust and unsustainable, but it is not broken. It functions precisely as the capitalist food system has always worked, concentrating power in the hands of a privileged minority and passing off the social and environmental "externalities" disproportionately to racially stigmatized groups" (Holt-Giménez 2018, 2).

The current global food system has a racialised history that often goes unrecognised. But to function as it does today, the food system has systematically exploited people of colour by expropriating land, labour, and seeds. How people think about and use seeds is important in producing socially constructed categorisations. Categorisations map onto historically power-laden hierarchies of social relations and fragment communities and their knowledge systems. A long history of racial categorisation in Colombia began with European colonisation in the sixteenth century. The social construction of race was applied to people to categorise populations, shape imagined communities, and produce subjects of control (Anderson 2006; Foucault 1979). Racialisation of peoples is pertinent in conceptualising the understanding and governance of the seed system in Colombia. These categorical differences have been shifted from the original purpose of creating communities of governable peoples to creating divisions among seeds that make legible differences in governable subjects (Scott 1998; Foucault 1979). Race can be considered a condition of existence and a category for analysis through the territoriality of power (Gilmore 2002). Racial discourse is fragmenting the seed system, leading to genetic and cultural erosion and ultimately creating docile seeds (Foucault 1979). In the capitalist agricultural system, seeds can be seen as a genetic resource to be expropriated and exploited for increasing profit through productivity, which has critical implications for sustainability. Sociotechnical imaginaries are shaped through governing seeds, limiting how seeds can and are being used and how people conceptualise and use seeds to attain future sustainability.

Hartigan (2017) uses racial thinking to show how categorisations based on race fundamentally distort life forms within the social world (Hartigan 2017). For races of plants, life forms are continuously shaped through selection and breeding processes that produce different combinations of crosses (Hartigan 2017). Plants are selected and bred based on criteria of racial difference premised upon good, pure, and regulated hierarchies, set against notions of bad, impure and uncontrolled. This chapter uses racial thinking to understand the social constructions of the ideological binaries in seeds as native/ improved, non-certified/ certified, and non-transgenic/ transgenic. Although native, certified, and transgenic are not racial categories, they can be conceptualised as containing racial power and privilege. These labels are ideological concepts rather than phenotypic markers. They create socially constructed communities and, at the same time,

socially constructed seeds that are subjects of technoscience. Non-technoscientific seeds have different labels that hold different meanings[6]. These seeds play a huge role in the Latin American seed system, with approximately 70 to 80 percent of crops planted with native or creole seeds (Semillas and RSL 2015b). As Carmen Lucas, a native seed saver, said, "traditional, creole, or native, or whatever you want to call them seeds." Each label has different implications in producing a material reality in which the ideology of the traditional seed is systematically set apart from the conventionally improved, hybrid, and transgenic seeds along different axes.

Through the application of racial thinking in the Colombian seed system, I will first explore the boundary work undertaken by breeders of seeds and associated scientific perceptions of seeds as genetic resources that facilitate categorisations in selecting genetically pure varieties for modern breeding. This leads to a concurrent genetic and cultural erosion of traditional seeds and associated knowledge and practices. Then, I will look at how the category of traditional seed is also envisioned by some local scale and often racialised actors as embodiments of diversity, social relations, and place-based histories. Finally, I will examine how purification and standardisation ideologies embedded in understandings and practices for producing racialised seeds ultimately produce a docile and governable seed as a technoscientific subject. Throughout this chapter, I argue that to facilitate a just food system transformation that can adequately respond to the impacts of climate change and protect rural communities, local seeds and associated knowledge need to be more equitably valued. There needs to be a shift in vision and hegemonic structures of power to facilitate a more sustainable food system capable of responding to the effects of climate change and providing food for all.

5.1 Seeds as genetic resources

The phenomenon of traditional seed varieties being lost is known as genetic erosion. The concept broadly refers to replacing diversity with uniformity in modern plant breeding (Vellvé 2009). Throughout the modernisation of agriculture, biodiversity has historically been viewed as a genetic input or a resource to be tapped. This view was reflected in interviews with actors involved in breeding programmes, producer associations, and seed corporations. There is a nuance in perspectives, with no clear-cut dichotomy. However, through scientisation and boundary work undertaken by these scientists and formal actors in positions of relative authority, a dominant discourse arose in this research of native seeds as inferior to improved varieties. Coinciding with

[6] Native seeds are landrace varieties that have not changed significantly over time. Throughout this thesis, native and traditional seeds are used as interchangeable terms whereas creole seeds have been adapted by local communities.

these processes of modern breeding is a corresponding reduction in the diversity of seeds and a fragmentation in the diversity of cultural practices, traditional knowledge, and diets.

At CIAT, I interviewed Stuart Green, the head of the prestigious bean breeding programme. We sat in his office, and Stuart answered my question about the role of native seeds. He explained that "creole materials haven't been used in the process for a long time, but one way or the other, all the genes used at some point, they're from landraces. It's all there is." Modern breeding is a form of 'recycling uniformity' (Vellvé 2009, 16). Through using established breeding lines and selecting small segments of DNA and genetic material over years of breeding developments away from landraces, a funnel effect has occurred in narrowing down the genetic variability of modern cultivars (Vellvé 2009). The notion that all seeds have origins in landrace varieties yet that new and improved lines are more useful situates technoscientific knowledge as superior within the dominant productivist agricultural system. The uniformity in breeding programmes is co-produced through selecting categorically improved seeds while valuing scientific knowledge over and above traditional knowledge. Scientists in breeding programmes for climate-resilient and nutrient-dense seeds are undertaking boundary work. This demarcates which seeds and knowledge should be used to drive deliverables, specifically for solving climate change and global hunger. Stuart and others working for CIAT recognised that for their scientific work to be funded, there have to be clear performance-related outcomes, yet this also fundamentally prevents long-term continuity, participation, and accessibility of the research.

A week later, at CIAT, I interviewed Stuart's colleague Mateo Medina who had also worked in the bean breeding programme for over twenty years. In describing the importance of native seeds, he explained that "[native seeds] are very important because many native seeds have a natural adaptation in their ecosystem. So, these seeds generally resist phytosanitary problems quite well, but the problem is that these seeds have a very low yield. They do not yield enough. So, what these seeds are most useful for, is to make crosses, to be able to create new, improved varieties with resistance to pathogens, with resistance to drought and with the resistance that the adaptation of conventional varieties cannot give […]. So, the native or landrace varieties, let's say, are important to use." In this explanation, there is a more nuanced understanding of native seeds as a genetic input but also as a genetically distinct base of varieties that are adapted to different environmental contexts. Therefore, these native seeds are conceptualised within the breeding programme as providing a base for natural resistance to pests, diseases, and extreme conditions. Mateo described the limitations of conventional breeding lines in these programmes, saying, "Many improved lines are very good in one place, but in another, not so much because their ecosystem changes, so their

adaptation is not the same." However, what is happening remains unchanged. As modern plant breeding has diverged away from using landrace varieties, depending more and more on breeders' lines to establish conventional varieties with specific desirable traits, there is a decrease in genetic diversity (Aistara 2011). Seeds can be relationally constructed with improved varieties in a relative position of privilege through the distance maintained against the 'other' or traditional seed (Bridges 2011). As technoscientific seeds are both materially created and favoured as improved and controllable, there is a co-production and mutual constitution of Colombia's current hierarchical seed system and social relations (Iles et al. 2017).

5.2 Seeds as embodied diversity

The huge diversity of seeds in Colombia was widely recognised by participants including scientists, seed savers, and public and private executives. There was also a strong awareness that this diversity is being or is already lost. Carmen, a native seed saver, told me that growing up in Colombia she saw the disappearance of nature so that "when I go outside, instead of seeing beautiful landscape, I think, they didn't leave anything here. And its not only that there is less biodiversity but there are no connections left anywhere". This view of a loss was also reflected by representatives of producer associations, where a technological development officer said to me that "a main problem with native seeds is that most of these varieties have been disappearing, they have been lost." Many factors have played into the loss of biodiversity in Colombia, including the civil war and associated rural displacement through the conflicting violent exchanges between guerrilla, paramilitary and state armies, and the drug cartels. Throughout all of this, seeds have been categorised and selected for industrialisation and commercialisation, privileging the genetically improved seeds over native seeds, which are subjugated as inferior. As the global food system has shifted towards industrialisation and modernisation there has been a significant reduction in genetic diversity (FAO, 2019). The reduced variation in crops is problematic both in terms of human nutrition and environmental sustainability. There has been a steadily increasing dependence on three main cereal crop types globally since the 1960s, with maize, rice, and wheat being consumed by most people every day (FAOSTAT, 2018). This consolidation of staple crops produces fragmentation in agrobiodiversity through increasing the vulnerability and precarity of the global food system, making it less resilient to the impacts of climate change. In the seed system there is a clear need for an approach to protecting agricultural biodiversity that is removed from categorical segregation based on notions of privilege such as true of racialisation.

Image 5.2 Future Seeds international tropical seed bank at CIAT in Cali, Colombia (own image).

My colleague and I visited the new germplasm bank at CIAT, the *Semillas del Futuro* (Future Seeds). Diana was our guide, a young intern working on increasing the educational outreach at CIAT. As she walked us through these brand-new, open-air, high-tech, ecofriendly buildings, she asked us how many species of beans we could name. We were both stumped by this question coming up with approximately five names between us. Within the germplasm bank, the largest tropical seed bank in the world, there are 38,000 varieties of beans, 6,000 varieties of cassava, and 22,000 varieties of tropical forages as accessions from countries worldwide (Image 5.1). Diana told us that agriculture has been forming a bottleneck in the diversity of our diets. She said that people only know a handful of varieties, just like us, which is reflected in modern diets. She showed us the trajectory of maize as it was domesticated and improved over time and stated that when domestication started, there was a "huge diversity of genetic differences with different sizes, different colours, different patterns, and then we come to the modern ages, and we really just have a few varieties" (Image 5.2).

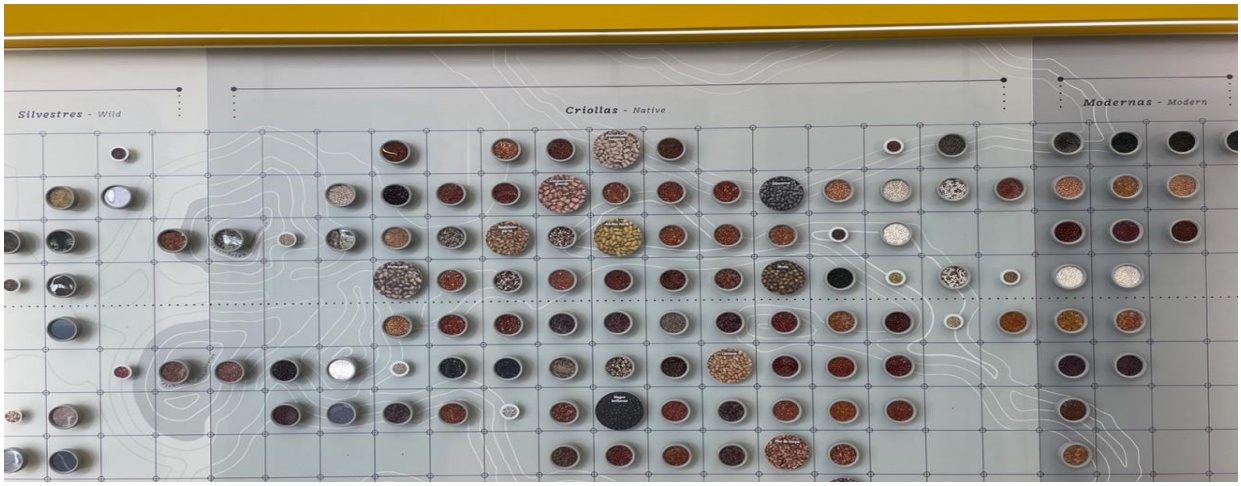

Image 5.1 A display of 'wild', 'native', and 'modern' seeds in the seed bank at CIAT (own image).

Later in the week, on-site at CIAT, Rafael Gallardo explained the bean breeding programme to me. He told me that even though Colombia has 56 different commercial varieties, only five are commonly known and consumed. He described how there is no point pushing for diverse bean varieties to reach Colombian markets when people have a cultural preference for specific qualities, namely larger red beans. While for example in Guatemala, in Central America, smaller black beans are more common because people are used to them and prefer them. Therefore, the cultural qualities of a place shape the focus of breeding programmes for releasing particular commercial varieties. Rafael's explanation shows how those situated cultural preferences for Andean and Mesoamerican varieties have led to decreased commercial variety diversity across regions. Whereas Diana's focus on the shift from the wild to native to modern varieties points to the exacerbated overall decrease in biodiversity that has occurred through the modernisation of agriculture. Karafyllis (2020) also refers to the bottleneck in agricultural diversity by stating that seed banks are a bottleneck that transform living plants into controllable instruments.

The view of traditional-, native-, and creole-categorised seeds as embodiments of biosocial relations and agrobiodiversity was evident in some of the local actors' seed stories. Agrobiodiversity refers to the sociocultural importance of native seeds and associated local diets. Biodiversity can represent the availability of a variety of seed types as well as the richness of sociocultural networks and knowledge systems associated with the seeds (Aistara 2011). Agrobiodiversity recognises the biological and sociocultural diversity within the histories and practices of people who grow, save and reproduce seeds (Aistara 2011). Within this understanding, biodiversity is tied to heritage, which is essential for conceptualising the intergenerational aspects of who is responsible for the seeds, knowledge, and world that is passed on (Vellvé 2009). The view of the biodiversity of seeds as innately connected to the associated traditional cultural practices and knowledge systems was held within communities of seed activists, campesinos and members of Indigenous and Afro-Colombian Councils that I spoke to. Biodiversity was conceptualised by the small-scale, often racialised rural actors with whom I spoke as inherently linked to the sociocultural history and diversity of peoples that save and use the seeds and the place.

In an office in Bogotá, I sat with representatives from Grupo Semillas. They said biodiversity is "closely tied to the blessings of Indigenous communities, Black communities, and peasant communities in Colombia." María Josefa, an anthropologist who researched traditional seed systems in Colombia with the RSL, told me that native seeds are important in relation to history, Indigenous identity, culture, nutrition, and the local economy. While Roberto Marin drew attention to the elements of seed diversity beyond biological composition by saying, "Seeds are in

a cultural, environmental, political, social system." Roberto said that the dependence on very few commercial varieties is a problem because it reflects "a cultural issue that goes through consciousness and cultural identity, which is why the diversity of the Indigenous, the Afro-Colombian, and the peasant is very important because this is also associated with ways of eating, managing the soil, and food, which is very important in facing the health and environmental crises." The commercialisation of agriculture is leading to a loss of the cultural knowledge, practices and history associated with landrace and native varieties. Roberto also said that "Colombia is a multi-ethnic and multi-cultural nation […] some say there are 85 or 100 different Indigenous peoples, it is true that there are 65 different languages, and that this cultural diversity has a lot to do with the biodiversity of wild and cultivated seeds." This sentiment of the connection between environment and society was also reflected in a statement made by Juan Manuel Dominguez, an Afro-Colombian Community Council member working on reclaimed land. Juan Manuel said of the trajectory of agriculture in Colombia, "As well as genetic erosion, there is soil erosion and a cultural erosion of the people that grow seeds." Agrobiodiversity should be protected by increasing recognition that biodiversity extends beyond the genetic diversity of available seeds, especially commercial types, to reach the categories of native seeds and peoples that use and grow these seeds (Aistara 2011).

A view of the loss of culture and traditional knowledge alongside the loss of traditional seeds was particularly evident in conversations with members of disenfranchised Afro-Colombian communities. Juan Manuel expressed a concern that as people had been pushed off the land, there was no one left to work the reclaimed land and to learn and pass on the local knowledge. He said, "People have been displaced, they have migrated to cities, and now as older generations pass on, they are taking with them their ancestral knowledge, and it is lost for the future generations." A friend of his and a person I interviewed, Alfredo, told me later that same day that most of the ancestral knowledge had already been lost. The National Indigenous Association of Colombia has reported that of 102 Indigenous populations, 62.7 percent are in danger of physical and cultural extinction, or in other words, cultural erosion (Hernández Vidal 2022a). This fragmentation of communities of peoples, seeds, and knowledge in Colombia has coincided with the concentration of land ownership in the hands of the elite. That land is primarily used for agro-industrial monocultural production (Zapata-Caldas 2021).

As agrobiodiversity is fragmented, it is easier for the pieces to be lost. The erosion of agrobiodiversity is evident in diets as modern foods are privileged over traditional foods in the industrial agricultural systems. In my final week in Colombia, in Bogotá at the office of Grupo Semillas, Roberto talked about how the agricultural system has homogenised supermarket chains

and standardised product availability. Roberto told me, "People prefer to buy a product that is more expensive if it's beautiful if it's well packaged […] It can be full of poisons, but if it is well packaged, it is bought." Big city markets favour more visually attractive and standardised products—again, pointing to the categorisation and prioritisation of more controlled and genetically pure populations. Roberto explained that in the cities in Colombia, you could only find white and yellow *arepas* (ground maize dough patties traditional to Colombian diets). You can no longer find purple, orange, pink, blue or black varieties that used to be common. The categorisation and promotion of industrial seeds over local, traditional, and native varieties mean people eat less diverse foods, from which they are increasingly disconnected. Sitting at a table on the garden's edge at her house in Cali, Carmen said, "I think people are so disconnected from where things come from." She goes on to describe the international influence of huge chain stores like PriceMart that lead to people in Colombia buying clementines from Spain simply because the price is lower than domestic products.

Image 5.3 Carmen in her garden of native tree seedlings in Cali, Colombia (own image).

Carmen showed me around her extensive native garden while she told me about an organic agriculture workshop she attended that made her realise the importance of growing local food (Image 5.3). Carmen said they were given a table of nutrients for a plate of organic vegetables compared to commercially grown vegetables, and she said that was when she realised that these bigger and better commercially grown vegetables are nutritionally empty. This disconnect between people and seeds was further evident in an informal assessment I did of 11 different seed shops around Bogotá, Cali, and Medellín. Firstly, it was not possible to buy native seeds in commercial agri-stores or supermarkets as these are not situated within the capitalist system. However, even

the commercial varieties were limited. In the agri-stores, there were approximately three varieties that I could buy for beans and maize. There was less variety in the more urban shops than in the shops on the outskirts of the cities. This links to the increasing homogenisation in diets. Within the capitalist agri-food system, food is categorised as a commodity with the value of feeding people to generate profit (Holt-Giménez 2017). As the consolidated range of global crops is processed, packaged, marketed, and priced to undercut the true social and environmental costs of local foods, the diversity of local food systems is being lost.

There was a particular recognition of a need to bring back diversity in colour and species of diets among racialised participants from Afro-Colombian and Indigenous communities in Cali and Bogotá. I met Enrique Gutierrez from FUNDAEC, which is an NGO that has worked with Afro-Colombian rural populations in Cauca Valley since the 1970s. Enrique and I sat on the edge of an urban garden in the middle of the FUNDAEC office and talked while looking at his coriander, spinach, carrots, and other vegetables growing in the sun. He told me that as part of their outreach, they realised they had to start making recipes and cooking meals with different fruits and vegetables that people have become disconnected from as a way of reintroducing colour and local agrobiodiversity into diets. He said, "We give it to people to try. It's delicious, then they think, I'm going to be able to do it myself." At the start of my research in Bogotá, I sat in a treehouse above an agroecological garden system at Universidad Distrital, talking with Alvaro Ortiz, a representative from the National Indigenous Organisation. He, too, painted a picture of this fragmentation of biodiversity. Alvaro said genetic erosion occurs by selecting specific traits to be expressed through breeding programmes. There is a fallacy of a size and colour hierarchy that has "completely fractured genetic diversity." As seeds have been systematically selected or not based on size, colour, and any other subjectively desirable characteristics within a racially constructed social world, the diversities of seeds and people are fragmented, and the intraspecific genetic diversity of native seeds is reduced. The very embedded nature of agrobiodiversity within creole and native seeds connects them to people and places.

5.3 Purification

Throughout the processes of formal seed saving and breeding, seeds are thought of as good and bad, better and worse, pure and impure. Latour (2012) highlights how purification is a key process of modernisation, and it leads to the separation of nature and culture despite the inextricable relationship between these domains. Through genealogical improvements in seed breeding, the boundary work undertaken by breeders attempts to remove the improved seed from its landrace origins and situated cultural context. The seed must be able to categorically achieve the

UPOV DUS criteria to attain purity (Aistara 2011). This sets the seed up to be scientised through boundary work undertaken by the scientists and researchers in breeding programmes and the state officials working in organisations that certify and register seeds, such as ICA. Boundary work privileges the productivist system, building and protecting the legitimacy of technoscientific knowledge and systems over traditional counterparts. This leads to the concretisation of constructs as the demands of funding agencies, governments, and the agri-food industry are materialised in the single object of the technoscientific seed (Feenberg 2017).

At CIAT, I saw the experimental field trials for improved maize varieties with Cristian Ramos, a technical researcher for CIMMYT. He explained that "native maize is a genetic source to which we need to resort to whenever there is a problem because that is where the genes for everything are." This is the exact sentiment of native seeds as a genetic input; however, the native seed classification is also associated with inferiority based on yield. He said, "Sometimes people see the native type with contempt because it doesn't yield what a better corn would." This idea of better or worse in terms of productivity justifies the work being done there. In explaining the importance of the conventional breeding and seed purification system within the National Seed Programme, an Agrosavia representative explained that "[native seeds] often come contaminated, with a bad behaviour, somehow they could have low quality in all aspects". This idea of cleaning to avoid contamination of seeds with weeds, pests, and diseases is no new concept for traditional and scientific seed savers alike. Juan Manuel, who plants in polycultures based on ancestral knowledge and moon cycles, "disinfects with specific cleaning chemicals, with chlorine" before sowing his seeds. But to be contaminated by bad behaviour implies the seed is unruly or uncontrollable, just as native peoples were historically conceptualised in colonial contexts (T.L. Smith 1966).

Roberto from Grupo Semillas told me that in people's minds, "native seed produce is polluted, it is dirty, it is ancestral." In the language surrounding purity, the native seed is seen in a dominant collectively held imagination as impure, with the need to be made clean and uniform through controlled scientised processes of standardisation. This was evident in a description of the National Seed Plan processes at Agrosavia. It was said that native and local seeds are taken into their research centres to be cleaned and improved before being given back to local populations. Carla Barera said, "[we undergo] a cleaning and scaling process where we can return their seed a little purer than what they had before. So we take that seed during the production cycle to clean it and leave it a little more homogenous to return it to them with this conventional improvement." The idea of cleaning seeds to achieve purity also came up in the rice breeding programmes as Manuela Rojas from CIAT explained to me that genetic inbreeding to achieve better climate, pest

and pathogen-resilient rice. She said, “We try to clean the seeds so that they are as pure as possible." While Alejandra Marquez, an agricultural engineer from FLAR, explained: "The farmer should always, at a certain point, reacquire the seed that has a desired genetic purity even if it is a variety (which is stable), which is a seed that when harvested, is genetically equal to the plant." Even when the stable seed has been achieved so that exact genetic replication is guaranteed, it is still necessary to purchase purity.

5.4 Registration and certification

Registration of seeds creates a legible hierarchy between categorisations (Scott 1998). Furthermore, to register seeds, specific standards must be met. Standards are inherently power-laden, controversial and an increasingly dominant source of social, political, and economic power relations (Wattnem 2016). Those who define and enforce standards have power (Busch 2000). In Colombia, the government organisation of the ICA determines which seeds are certified. However, the standards are set through the internationally set out requirements related to TRIPS and UPOV as conditional to the US-FTA. To certify a seed with the ICA is a costly process that inherently strips away this idea of seeds being a global common. There is a one-time registration fee to become a producer of certified seed, which is $2,214,234 COP or approximately $550 USD (ICA 2023). Then the fee for registration and supervision of multiplication fields is $6,172 COP per hectare (ICA 2023). For the seed to be processed and undergo quality analysis, the cost is between $27 and $50 COP per kilogram, according to the species (ICA 2023). There certified seeds are not equally accessible to producers with different purchasing power. It must also be considered what the purpose is of certifying seeds and regulating seed.

Seed is presented as in a binary of certified or uncertified, most noticeably by actors representing national producer associations that work primarily with certified seeds. A representative from the Ministry of Agriculture explained the difference in seeds to me. Xavier Guerrero said, "You have certified seed, and then you have uncertified seed". He tells me that "every ‘formal’ actor in the sector knows that certified seeds are better. Everyone, even the producers know that certified seeds are better". This begs the question of who the formal actors are and how this is decided. I pressed on with Xavier, questioning the benefits and potentials of certified seeds, interested in whether these certified seeds are seen as the answer to the unsustainable state of the current agri-food system. Xavier explained to me that "the traditional seed [for rice] is called *arroz criollo* [but] the thing is that it's pretty unregulated. Their yields are not that high. Whereas the thing with certified seed is that there is a whole process of research and not only genetic manipulation but also traditional sorting with different conventional varieties to get

the seeds." The research process behind the crossing and genetic manipulation of varieties validates them as superior to those crossed through farmer selection mechanisms that lean on traditional forms of knowledge and practices. Xavier told me that if Colombia only used certified seeds, the country could be more competitive because certified seeds give better yields and better-quality products that can be specifically adapted to the land parcel conditions, nutritional requirements, pest and disease resistance, and climate adaptation. Similarly, Alejandra from FLAR spoke to me about rice breeding and said that certified seeds are "good" seeds that lead to good production in this context. It is important to use good practices, but "the farmer has to start with good seed". Here again, a good seed is positioned against a bad one. The good, certified seed is the product of scientised standards, facilitating regulation and essentially controllability. With an overarching descriptor of the seed as good, this normative language ultimately takes the seed out of the growing context (Aistara 2011). Through this lens of viewing seed quality, the seed is seen as separate from the socio-ecological system in which it is reproduced. It is also separated from the producer and the contextual factors that might impact how well a seed grows in a particular place which undermines the work and local knowledge of associated seed producers (Aistara 2011).

5.5 Star seeds

In Colombia, it is much more common for certified hybrid seeds to be used in the maize and soy sectors than for other crops, such as beans and rice, which are harder to regulate in the current agricultural context. Victor Rojas, a Regional Coordinator at FENALCE, told me that for the unregulated sectors such as beans, wheat, barley, and oats, what they use in their programmes are "star" seeds, which are the best ones. These are reserved and reproduced in the production plant. The talk of star and non-star products makes me think of Dr Seuss' Star-Belly Sneetches.

> *"Now, the Star-Belly Sneetches Had bellies with stars. The Plain-Belly Sneetches Had none upon thars. Those stars weren't so big. They were really so small. You might think such a thing wouldn't matter at all. But, because they had stars, all the Star-Belly Sneetches Would brag, "We're the best kind of Sneetch on the beaches." With their snoots in the air, they would sniff, and they'd snort, "We'll have nothing to do with the Plain-Belly sort!" " (Dr Seuss 1961, 1-2).*

The history of people selecting the biggest, the most beautiful, and the best-tasting plants predates genetic science as a construct (Vellvé 2009). These practices have been implemented by scientists and non-scientists alike. However, it seems that the star seeds are only valued as star products when that star product is selected by someone within the productivist system, someone 'formal'. Like the Star-Bellied Sneetches, this comparative and categorical better-ness is socially constructed, entirely dependent on what is socially valued. Frequently certified and non-certified

seeds get mixed together, just like the star and no-star Sneetches. Specifically for the rice sector, it was explained to me by Xavier, who worked closely with FEDEARROZ, that it is no longer required for rice seeds to be certified because the certified and non-certified seeds all end up in the same storage containers. It is impossible to differentiate and regulate this sector. The corporate-certified seed is not always adapted to local environmental conditions in other sectors, such as maize and cotton. Therefore, large-scale farmers can mix conventional and corporate varieties to produce similar-looking seed that grows better, producing higher profit margins (Silva Garzón and Gutiérrez Escobar 2019). Small- and large-scale farmers in different crop sectors work with differently categorised seeds in parallel and overlapping growing contexts. Regulation that segregates seeds and constructs borders goes against the inherent transboundary interactional behaviour of seeds in nature.

5.6 Alienation of seeds from growers and growing context

In formal spaces, a distinction was made in interviews between "seeds", which must be certified, and "grains", which are farmer-saved seeds. This categorisation sets seeds up to be regulated and alienated from growers and growing contexts. In the unregulated bean sector in Colombia, Stuart reiterated the importance and legal implications of language in referring to seeds. "There is *grano* (grain) or *semilla* (seed), and if you call something semilla, that means it should be certified, or it should have some kind of legal structure to be able to use that word." Later, when I asked his colleague Mateo about the barriers to using certified and registered seeds in the bean sector, he told me that farmers continue to "sow grano, but grano is not semilla." Then he said of the dangers of informal seed reproduction, "They sow, harvest, garden, and select the most beautiful seed, the largest, and sow it again. But most likely, that seed is contaminated with fungi that are microscopic, that they cannot see. They see the seed, and it seems fine, so they sow it, but that seed may be contaminated, so its germination will be lower, or if it germinates, it begins to spread disease because it is not certified seed. It is a grain, it is a beautiful grain, but it is not a seed. So [for beans] 99.9 percent of our farmers are not sowing seed, they are sowing the grano of their own harvest", and then even he falls into the trap he just described of using the wrong term as he tells me, "All they sow is contaminated semilla." This distinction between seeds and grain is reflected in the international legislative context as farmer-saved seed has been relegated to "germinating grain", which cannot be traded among farmers under the 2004 EU Seed Marketing Regulation, and also cannot be classified as seed (Aistara 2011, 499).

Beyond differences in language, Mateo described the difference in yield potentials as a distinguishing characteristic between certified and non-certified seeds. Focusing solely on yield

potential in this unidimensional scale of value is problematic because it does not acknowledge the yield actually achieved, and it leaves out every other element that farmers might value (Stone and Glover 2016). Mateo told me that the Colombian yield potential for beans is only 1,100 kg/ hectare, while improved varieties from the breeding programme can yield more than 3,000 kg/ hectare. Similarly, for rice, Alejandra told me that yields are less when certified seeds are saved and resown. She said it is common in this instance for "a weed that looks just like rice but with a red pericarp, red rice, to contaminate the product because it comes with seed-borne pathogens [which means] you are going to sow bad things and that contaminates other plants." While in the description I got from FENALCE's technological research agent Gabriel, "the negative part of having varieties from native seeds [is that] the yields reach a certain ceiling, this is four or five tonnes maximum per hectare, whereas if I have a good hybrid, I can make it produce 10 or 12 tonnes of maize." In these descriptions of a problematised native seed, formal actors mediate a hierarchical relationship between seeds and between those who work with categorically different seeds (or grains).

Seed breeders, extension officers, and technological development agents attributed the setback to farmers not using certified seeds as certified seeds are too costly. In terms of beans, Stuart told me that "certified seed will cost at the very least twice as much and easily four times as much [as non-certified seed], so that is the biggest dis-motivation for using formally certified seed." Similarly, for rice, Xavier from the Ministry of Agriculture explained to me why farmers do not all use certified seed, which is because farmers do not "internalise the benefits of having certified seeds because they cost between 1.6 to 1.8 times more than informal seeds, but in the long run, they have worse yields because they have more disease and more weeds that have to be dealt with." Alejandra also working as a scientist in the rice sector, for FLAR, told me that for uncertified seeds "the truth is just cons. The only advantage is that the non-certified seed is cheaper". Beyond purchasing power, there are sociocultural factors that make native seeds preferable to certain producers that operate outside the productivist paradigm. Through discourses of scientisation, standardisation, and certification that remove seeds from the growing context, native seeds are alienated from their growers and contexts (Aistara 2011). This powerful separation of seeds from each other and from their socio-ecological context ultimately makes the seed more easily controlled.

5.7 Regulation

The regulatory environment for seeds is characterised by certification and IPR legislation that restricts informal seeds and the modalities, spaces, and knowledge associated with informal seed practices (Kloppenburg 2010). Set against the restrictive regulatory environment is a notion of a deviant farmer, which came up when talking with scientists in the breeding programmes and

producer associations. This produced the idea that farmers can also require regulation. In the rice sector, Xavier, the Ministry of Agriculture representative, told me that it is no longer mandatory for people to buy certified seeds because what was happening was that people would falsify their invoices to show that they had bought certified seeds when they had not. Another way small-scale farmers were deviant was buying the certified seed the first time but then saving it and producing it so they could "use it again and again and again and again [even though] every time it loses a bit of its quality." In the bean sector, with even less regulation, there are currently no certified seed producers in Colombia. However, this did not prevent the head of the bean breeding programme from speaking about how farmers can be deceptive. Stuart told me, "There is a contraband business where somebody goes to the market, buys seed, packages it up, it's never been inspected, never been certified, but they will call it seed [and] sometimes they will toss some fungicide on it to make it look a bit more legitimate, but it's not."

Gabriel Gimenez, a Research Associate for FENALCE, described the critical value of regulation and standards for seeds by comparing the quality control process of regulating seeds for human consumption to drug regulation. He said to me, picture this:

> *"Say I started making aspirin at home. I am going to sell aspirin and I am going to make this aspirin at home. And I do the whole process, I take out the acid and I start making and selling aspirin pastes. So, imagine the risk of someone at home doing this without any control, without any… without any verification of what they are doing, they start selling aspirin and people start taking aspirin without knowing what it has, without knowing if it works, if it has some toxic process. Yes, so the same goes for with the seeds. If I begin to produce seeds without demonstrating the quality of the process of those seeds, without being the owner of them then there could be problems".*

This is a powerful comparison to make. It favours corporate control over plant life and food above the idea of seeds as a global commons. Seeds selected without any control or verification are very unlikely to pose the hazardous risks to human and environmental health that chemicals in the pharmaceutical industry can.

There are levels of controllability within the constructed concept of certified seeds. Hybrid seeds are particularly controllable. A hybrid is created by crossing two inbred pure parental lines to produce the F1 hybrid result (Kloppenburg 1988). As explained to me by Gabriel from FENALCE, hybridisation is a necessary process that generates an eventually stable line with hybrid vigour: a "super-plant" is born from "pure plants called super parental lines". This creates new subjects to be controlled. Deviance regulation through controlling hybrid seeds is a dominant strategy in modern breeding. As Alejandra from FLAR explained, in the rice sector, hybrid seeds are now used to guarantee the use of certified seeds because they cannot be saved and reused, so this is the only

way to prevent farmers from using their own seeds. As Xavier had explained to me during an early interview in Bogotá, "With hybrid seeds, you don't have the problem of people pirating it because the hybrid seeds, once you get it, you can't use it again". Or rather, you can, but not with the same results. As it was explained to me by Manuela from the hybridisation programme at CIAT, crossing and reproducing hybrids splices the characteristics of the previous generations so that the offspring are not uniform and stable. After the F1 generation, Mendelian genetics comes into play, and as such, the performance of consecutive generations worsens, becoming increasingly unpredictable. As applied to seeds, the term 'pirated' is loaded with negativity. It relegates the informal producer to operating within an illegal system, which reflects the historical racialisation of people in Colombia as immoral and criminal. Xavier admitted that "hybrid seeds have a bad reputation" because it is problematic if one organisation has all the rights to all the seeds if hybrids were the only seeds used, making it "a bit of an ethical dilemma". While Gabriel from FENALCE expressed that native seeds are difficult to fit within the certification paradigm because no records are attached to them, and they do not belong to anyone. Native seeds also cannot fit within the regulatory environment because they are not genetically 'pure' enough. Therefore, the categorisations constructed in certification create a direct means to purchase preferred purity.

The regulation enabled through certification is taken to a new extreme in the described developments within the ICA that I am told about by Hector Vazquez from FEDEARROZ. He said that 'genetic fingerprint' technology is being developed to allow the "prevention of piracy and company appropriation of genetic material" simply by taking a plant sample. This is supposed to protect farmers and small-scale producers from seed companies selling them illegal seeds. What it will do though is massively increase the legibility of seed certification, increasing the police-ability of seeds and those who use, save, and reproduce illegal seeds. Ultimately, registration and certification requirements are part of a regulation apparatus. This legal and policy-based mechanism transforms illegible diversity into a legible hierarchy within different physically presenting groups of peoples and seeds (Scott 1998). Legibility arises through legal and policy-based support for improved commercial varieties of seeds. In contrast, native seeds are criminalised or subjugated to be allowed as a small-scale practice without generating economic value.

One take on the registration and certification standards was that they are slowing down the uptake of improved varieties. Stuart from the bean breeding programme said to me, "If you want to produce seed of an improved variety, that is where the formal system kicks in, and [the seed] should be certified with all the regulations of the government. This is a huge limitation on disseminating seed of improved varieties." I think about the formal system kicking in and wonder

if we are not so deeply embedded within the hegemonic capitalist industrial system that it is hard to know where the boundaries end for this system. However, Stuart said and then paused for a while, thinking about the implications, "There are ambiguities in the system." There are limited resources for regulating certification, so there is room for movement outside the governability of the certified seed regime. He recognised a "two-track system for local varieties being distributed without certification and then the certified seed system." He told me that this binary of certified and non-certified is limited, and he suggested that more allowances should be made to disseminate improved varieties to match the lenience for local varieties. Others might argue that in Colombia, the seed system is already inherently lenient towards improved seed. Roberto told me, "Colombia is a state that has worked in favour of certified and transgenic seeds. That is the norm, making it seem that working with native seeds is outdated and illegal." Therefore, Colombia's state and international research institutions are seen here as a coalition of actors exerting power through boundary work. The result is the co-production of a hierarchically structured, technoscientific and socially ordered reality in which native seeds and peoples that use those seeds can be regulated.

There was a recognition in formal research and technological extension spaces that farmers are advocating for the freedom to use seeds and reproduce local seeds. Alejandra from FLAR told me this is fine if farmers save and reproduce their own seed only for self-consumption. However, certain limitations should be applied to this so that seeds on the market for consumers are regulated "because there is a great technical responsibility there." This idea is interestingly also recognised by a native seed activist who stated she could "see the necessity for commercial [certified] crops because you don't want to propagate the illnesses and diseases that will affect the food produced in crops." Roberto from Grupo Semilas told me that certified seeds had not solved the problem of hunger, but rather they have left the rural communities that produce food more food insecure, particularly after the period of government intervention through technological packages ended. He told me that the policies in the agricultural sector had prioritised exports of non-essential food crops like coffee, avocadoes, sugarcane, and flowers, while the plants that people rely on for food have been entirely left out. The neoliberal policy environment of Colombia is an important factor here as the prioritisation of trade liberalisation since the 1990s led to the introduction of biosafety standards, PBR, and seed certification while also prioritising the production and export of the aforementioned non-food crops. These policies help the state, scientists, and private actors to control certified seeds, which also co-produces a control regime over the people that use uncertified seeds informally.

5.8 The docile seed

Seeds have co-evolved with human societies for thousands of years through domestication processes. Different varieties have been selected in various geographical regions to suit particular needs, cultural preferences, and customs (Vellvé 2009). Within the agro-industrial productivist system, varieties are not selected equally. Power is exercised through neoliberal governmentality as the state and private agro-industrial institutions systematically organise a technoscientific system in which scientific seeds and knowledge are prioritised over traditional seeds and knowledge (Foucault 1979). Boundary thinking shapes the seeds and discourse surrounding the seed.

On the one hand, I am told by breeders, researchers, and extension officers alike, that certified seeds are better and of a higher quality because they must pass quality tests to earn the qualification. On the other hand, these tests can be understood as processes of scientisation that produce a certified seed as a docile and governable subject (Jasanoff 2017). This occurs through the productive operation of power on seeds (Foucault 1979). While seeds need us, and we need them for survival, there is a power imbalance within the co-evolution of seeds and peoples in this modern and industrialised agri-food system that is being reinforced through the regulation and control of seeds in policy, legislation, and practice. At the same time, the marginalised campesinos that use, save, and grow local 'impure' seeds are subjected to increasingly stringent governance due to this control over certified 'pure' seeds. The consequences are that the role of being a campesino is seen as undignified and the people as uneducated, holding inferior traditional knowledge about the seed systems and sustainability that is not factored into dominant food system strategies.

The most extreme level of seed control could be genetic manipulation and transgenesis. As it was explained to me by Gabriel from FENALCE, "Transgenesis is a management tool, quite simply." It allows total control over the seed. Just as racialised peoples are made to be subject to social control, seeds through transgenesis are made governable to the extent that they become the IPR of the developer. Seeds remain enclosed by IPRs until a certain time lapses. After this point, they are released to be utilised by other entities under the condition that no amendments are made to what was initially approved. Gabriel told me, "FENALCE have incorporated transgenes into conventional breeding [after the patent lapsed], so it already had good hybrids, and then it added materials with three transgenes that currently exist in corn". He said that "[transgenics] are not for having higher yield or avoiding subproblems with weeds, pests and diseases, they make it easier to manage things." He understood the contention around the topic when I asked if and how the national producer association uses genetically modified seeds. He went on to say that people are too quick to judge, saying, "Transgenics are bad, transgenics give cancer, transgenics, I don't know,

give Alzheimer's [when] maybe in 10 years it will turn out that this is true, but currently there is no study to show that consuming transgenics for humans produces disease or is less nutritious. It is assumed to be the same for humans and animals." He told me, "There is a collective thought that they are bad because there are people who are very radical with the issue of native seeds [and they think] transgenics are displacing the native seeds and that they are forbidding you to sow native seeds so that they can sow transgenics, but no the reality is not that." Gabriel said transgenics should be a tool that one can choose to use or not. It is also his opinion as a technological researcher and developer that "transgenics are not necessary because if one manages a conventional plant properly, it will have good results." Hartigan (2017) points out that racial thinking makes the discursive differences between transgenic and native seeds irreconcilable despite only minor variations in the DNA of the species.

Victor of FENALCE told me that commercial, large-scale farmers understand the benefits of transgenic varieties because of the positive economic impacts that these varieties yield. They are often businessmen with high levels of education, unlike smaller farmers, and so they know that if they follow best practices with transgenics, then this will be economically beneficial. This brings in the inextricably connected material and epistemic realities of racialised seeds with formal education and scientific knowledge selected through certified seeds' development and (re)production. While on the other end of this, Carmen's argument is a complete resistance to transgenic seeds rather than for lack of purchasing power. This was evident in the campesino perspective and is the official position of Grupo Semillas. Roberto expressed the critical nature of the transgenic issue in saying that even though the new President is of the left, the Minister of Culture expressed that Colombia must respect trade agreements, specifically those with patents on seeds and the use of transgenics. Therefore he believes that there will likely be a ruling that will change legislation to approve the widespread use of transgenics, possibly even this year. Looping back to this notion of diversity and sustainability, Roberto stated, "Transgenic contamination is a threat to our country's biodiversity."

Through categorising seeds as native, conventional, hybrid, certified, and transgenic, further broken down into good, bad, pure and impure, a racial ideology is mapped onto seeds and the physical and social Colombian landscape. This mapping of seeds and peoples was particularly evident during my seed workshops at El Planetario in Bogotá. This is because traditional seeds were associated with racially marginalised seed system actors who hold fluid situated knowledge of cultural histories and socioenvironmental contexts, and this knowledge needs to be shared in discourse and practice to keep the diversity alive (Nazarea 1998). In the first workshop, 11 primarily Indigenous and campesino participants were tasked with arranging an array of photos of rural

scenes and paragraphs of text into a collage (Image 5.4). Pedro, the group facilitator and artist, told us that "the danger attached to this reification is to classify, because when we classify images and documents and catalogue them [we need to question] how to classify them without paralysing them." Pedro described the danger of freezing seed stories and histories in photos, as in a gene bank. But he said, "There are all the opportunities to unfreeze, to circulate, to exchange, and to build diverse knowledge. We can think of the archive as a dangerous thing, but others can speak of archives as possibilities for constant creation and recreation by seeking continuities." In the same way that art archives can maintain conversations and create knowledge-building networks, seeds can be archives of biodiversity, culture, history, and knowledge. Nazarea (1998) points to the centrality of cultural memory embedded in place-based knowledge and food. By communities engaging in the re-vitalisation of memory through sharing local knowledge and reproducing local seeds, small-scale farmers can resist the agroindustrial homogenisation of diets, conserving agrobiodiversity through maintaining connections to the past.

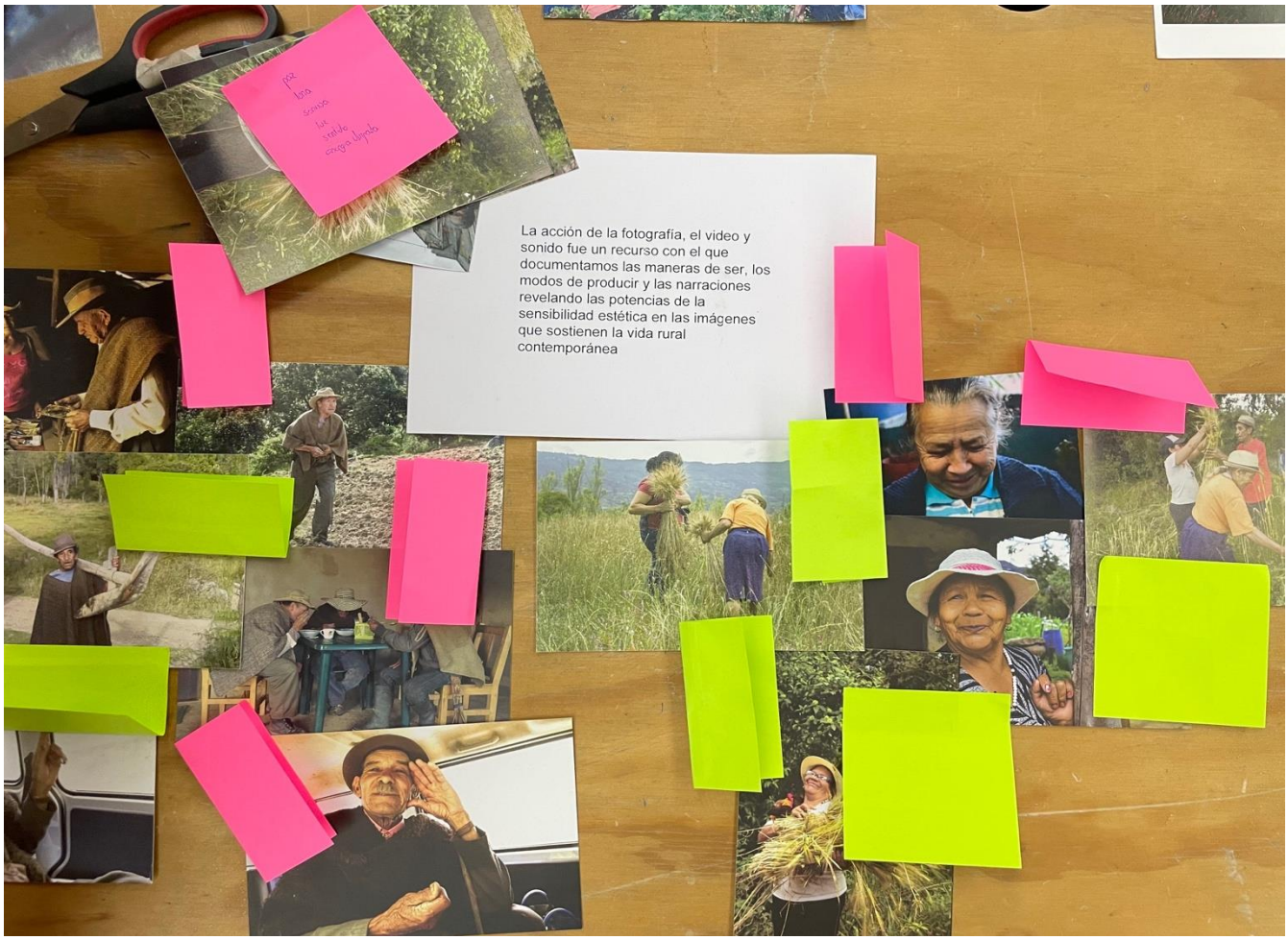

Image 5.4 Picture and text collage of racialized campesinos mapped onto landscapes by participants in the first seed workshop, El Planetario, Bogotá (own photo).

CHAPTER 6: USE OF THE SEED AND TERRITORIALITY

> *Seed saving involves "a complex set of practices including the planting, tending, harvesting, storing, eating, and replanting of seeds (and other planting materials), as well as the attendant processes of exchanging and knowledge-building. [...] Seed saving is a set of practices that raises vital ethico-political questions: who has access to seed and for what purposes; whose knowledge is valued and how?; who/what participates in arranging seed relations and how? (Phillips 2016, 3-4).*

Racial thinking and attributing classifications based on stereotypical characteristics often go hand in hand with attempts at socio-spatial segregation that can produce racialised places (Storey 2012). These racialised places can be produced and occupied by seeds saved by actors with specific knowledge sets under specific conditions. People who work with seeds can actively contribute to the exertion of control in enclosing the seed through germplasm conservation; they can be complicit in these processes or resist this control. All *in situ* seed saving is situated in places requiring some degree of land and territorial autonomy (Hernández Vidal 2022b). The territory concept is critical to understanding how seed governance and resistance are situated in place (Hernández Vidal 2022b). Therefore, territoriality should be a unit of analysis because it is inherently tied to creating identities and the organisation and reorganising biosocial life and place, which are embodied and embedded in seed processes (Hernández Vidal 2018). Seeds have been de-territorialised globally through establishing transnational seed banks, yet importantly seeds have also been de-territorialised locally. This was particularly evident while researching at CIAT, located near Cali in Cauca Valley. This area is planted in a substantial sugar cane monoculture. In this chapter, I will look at how people use seeds in Colombia and how different knowledge systems are fragmented through the de-territorialisation of seeds and embedded within territorialisation and re-territorialisation practices. Then I will argue that the hegemonic discourse of capitalism is reproduced through the globalised technoscientific modernity of seed banking undertaken in formal spaces. In contrast, alternative discourses of seed sovereignty and a holistic approach to seed system sustainability produce a differently imagined future for local seed-saving actors.

Seed saving will be considered part of territorialisation, de-territorialisation, and re-territorialisation, always inextricably connected to the land. As borders are constructed formally or informally, space and place are fragmented, which may also be contested (Storey 2012). As seeds and land have been enclosed by policies, legislation, and seed banks, both physical and figurative borders, have been put up around the docile seed. Formal and informal actors are constituted hierarchically through institutional affiliations and boundary work in scientific seed-saving practices and communication that seek to reaffirm prestige and authority. Indigenous traditional knowledge is subjugated in these processes to be seen as less formalised, legitimate, and ultimately inferior, as

are the people holding the knowledge and the seeds themselves (L.T. Smith 2021). Understanding knowledge as socially constructed allows the view that this dichotomy between scientific knowledge and traditional Indigenous knowledge is arbitrary (Agrawal 1995). When I was in Bogotá talking with María Josefa about her ethnography research on the seed-saving practices in the RSL, she said, "Obviously, they [RSL] don't only use traditional knowledge, they also use scientific knowledge in the seed house to conserve the seeds. Stuff like the level of humidity or acidity or whatever. It's like what they call *diálogo de saberes* (dialogue of knowledge). Have you heard that? It's like a dialogue of knowledges, so it's like you put into dialogue the scientific knowledge and the traditional knowledge." This presentation of traditional and scientific knowledge in a dichotomy is too common. However, there is recognition in this dialogue description of exchange and overlap with more nuance than there may seem. Through my conversations with different seed savers holding situated knowledge, three critical areas will be highlighted concerning territorial thinking and seed saving: those involved in seed saving, where seeds are saved, and how this has operated at a territorial level in the Cauca Valley in Colombia.

6.1 Seed saving actors

Seed saving is a practice that can be undertaken in fields and gardens, but it can also include the scientised work of technicians, breeders, and technoscientific researchers. There is a multitude of 'informal' actors, including Indigenous, Black, campesino mestizx, and less racialised but still marginalised rural people. At the same time, 'formal' actors are involved in collecting, categorising, and saving seeds in a scientific space that focuses more on genetic resource accumulation for development and progress.

6.1.1 Introducing the informal seed savers

The local informal seed savers practised *in situ* seed saving in this research, while this is not always the case (make footnote). It is essential to define who the informal seed savers are in this study and what makes them be seen as informal. In the Colombian context, the informal seed savers are most frequently racialised Indigenous, Black, or campesino mestizx populations. For these communities, there is often an associated connectedness to place that is inextricably linked to seed-saving practices. As seed saver Eliel Castillo explained, "To be a seed guardian or a seed custodian, you have to be from an Indigenous, Black or campesino community. You have to have a sense of belonging to the land as well as working that land and with the ancestral seeds". This important connection to land extends between the physical and spiritual realms through cosmologies (Rotarangi & Russell, 2009). The land is conceptualised as tying the past, present and future through the interconnectedness of environment-society relationships (Descola 2005; Ka'ai

et al. 2003). The environment itself can be conceptualised as an ancestor, and those that inhabit the land are, therefore, inextricably related to the landscape (Ka'ai et al., 2003). A sense of belonging to the land and working that land with a view of connectedness rather than extractivism or productivity situates traditional seed savers on the margins of the agro-industrial food system. Eliel continued saying seed guardians "live with [the seeds], they also take care of them, protect them, exchange them and exchange experiences with other custodians, also while protecting the community and seeds in terms of the right to food security and food sovereignty." In this, it is clear that the environment and seeds are not commodifiable while enhancing food sovereignty brings access to land into central consideration to improve local control over local food systems (Devon et al. 2021; Wittman 2011).

Eliel also told me that to be a seed guardian or custodian means having unique management processes and ancestral knowledge that allow a feeling of the seeds and telling of their stories back to 100 or 200 years. Some protocols are incompatible with the technoscientific paradigm within Indigenous communities where seeds are cared for. When I was in Bogotá with a representative of the National Indigenous Organisation of Colombia, Alvaro Ortiz, he told me about the three central guides for any research or process with knowledge-building as an Indigenous practice. These are *cosmogonía* (cosmogony), *cosmovisión* (worldview), and *cosmovivencia* (living and coexisting with the cosmos). Traditional Indigenous seed savers see themselves as part of and connected to their environment. Therefore, to engage in environmental resource use for sustenance-based practices, it is necessary to ask permission from and give thanks to ancestral gods. As Eliel explained to me in the Colombian context, if he takes his seed to a seed guardian, "they pray to the seed and speak to it, they immerse themselves in the seed and say these seeds are brought by this person in good shape, and now that you are arriving here in this territory, you will grow. It is a spiritual protocol." He also explained that if government programmes are involved, they lack recognition of this spiritual protocol. It can be seen that national and international development programmes lack recognition of situated knowledge and practices; therefore, the transfer of scientific knowledge through agricultural extension displaces local knowledge, customs, and seeds. Whereas Indigenous and traditional knowledge is embedded within a holistic concept of sustainability expressed through spiritual seed-saving practices that show a view of society and nature as part of one inextricably connected socio-ecological system.

Jaime Hernandez told me about the seeds they work with at Desde la Raíz. He said that the seeds they have are native seeds which they get access to within seed exchanges and specialised events with campesinos, Indigenous and Black communities. Jaime said, "The conservation of

these native seeds goes beyond the planting of seed and the eating of it. It's a political position because it goes against this way that capitalism takes the things and basically destroys the territories, destroys the mountains because it tries to standardise the processes." The racialised seed savers can be seen here as undertaking a conscious practice of resistance to capitalist agricultural control via the re-territorialisation of the space and land expropriated in seed enclosure. Importantly for racialised Indigenous and Afro-Colombian seed savers, conserving seeds and their histories is also a resistance that involves reclaiming and reconnecting to land territorialised through histories of colonisation and slavery. In Bogotá, during a seed workshop with urban gardeners and campesinos, one participant said that "the human being is a being of resilience, men and women, they will always look for a way to harvest. When there is no land, there is no ground that can be planted in the cities, our people will look to the walls, accumulate seeds to give food sovereignty, then find a stick to hang pockets, and there they will start to grow coriander, radishes, anything, this is what politically tells us that there is a possibility to continue, that there is a possibility to continue searching and feeding." This resilience can be seen as the re-territorialisation of seeds.

It is also possible for seed savers to fall outside of the immediately apparent racial thinking paradigm. Carmen and Sonia, both self-proclaimed native seed savers, make it clear that anyone can and should be able to access seeds in public places and territories. This could look like small private gardens, public green spaces, and forests, but both expressed to me that everyone has some connectivity to spaces of nature and, therefore, seeds. In the last week in Colombia, I walked with Sonia through a native forest in Cali that she had planted and watched grow from seeds. This was a dedicated practice of re-territorialisation that she undertook to reclaim green space and a place for connectivity between native species and the people that occupy urban landscapes. Sonia told me that although Colombia is the most biodiverse country in the world, people eat, know and talk about so few species. Sonia asked me, "How can we talk about the fruits that my grandma used to eat when kids these days don't know them? How can we recover what we don't have anymore?" Sonia also said to me that her main message to kids and people, in general, is to be a seed collector because it will mean we can keep the species alive that we have today. She said, "I love seeds, I collect native seeds, and I spread them like a bird." In everyday practices of seed saving, sharing, and caring for a native forest as it is regrown, re-territorialisation is being embodied as a form of resistance to agrobiodiversity loss and seed enclosure. Similarly, Carmen said that she collects seeds from the middle of motorways in the grass strip between lanes, she collects them outside restaurants in the car parks, and she walks around the local golf course, which has native trees that her and a colleague planted around the edges. "You can find seed everywhere at any time of year in Colombia". She said we have to learn how to collect and save seeds by looking at nature. So we

can all be seed savers, at least in some spaces. Suppose people in their everyday lives make this effort to occupy space. In that case, the increased participation of informal actors in seed saving can challenge the hierarchical scale of access to seed that the formal system of seed saving maintains. Carmen said during our talk, "One of the things that need to change a lot is that we need to make seeds more accessible to people. I find that so many seeds are kind of hogged like this is my seed, this is my genetic super breed. We are now at a point [in time] where we need to share seeds."

The sharing of seeds in informal community networks seems to have a non-monetary value. In seed-saving practices, a discourse of exchange is evident in association with native and local seeds. Alvaro explained that seed exchange is called *trueque* (barter) or an exchange of goods or services. This idea of exchange tends to be one of reciprocity, hospitality, and gifting, which is less about money changing hands and, thus, more about existing outside the context of capitalism. Mario Diez, whose family have a commercial avocado and coffee farm, told me about how they access the commercial and non-commercial seeds in his region. The commercial seeds must be bought, he told me, because the scale is simply too big, but for other plants, he said, "it's not for money, no no no no, if I have a very good one [seed], I give it to you so that you can grow it. It's like a very free exchange." Similarly, Sebastián Reyes, in his small community on the outskirts of Bogotá, said it has always been about helping each other in a trade system that operates on a small scale. He explained that maybe you need a fencepost, and your neighbour has one, so you give him some seeds, and he will give you the fencepost. He said, "People always used to carry around seeds as a thank you, and you would give seeds from the garden, and people will know you can also feed your family with that." This gifting is a way of maintaining social relations and recognising the right to self-determination through the decision to accept and grow the seed. In seed, exchange are associated processes of trust, relationship and knowledge-building that address power dynamics. Eliel also describes the place-based community exchange of seeds and knowledge from the Seed Guardian group. He said that as a seed saver, one is often left without seed. This is because to keep seeds alive, you are constantly giving them to people you know cultivate them, and all this giving means you are often left without any so that, ultimately, the seed (and knowledge and cultural practice) is never lost. In this view, seeds must be (re)used and (re)sown to maintain life and keep the associated knowledge alive across communities.

Seed savers can be thought of as hosts of seeds and, ultimately, the deciders of whether or not the knowledge, resources, and power of those that seek access to seeds are accepted in that space. If the intention of those wanting access to the seed is not compatible with the worldview of

the seed saver, then access is limited. This is true for traditional informal seed savers and institutional formal seed savers. When informal actors and their *in situ* seed-saving practices are relegated as inferior to *ex situ* practices, technoscientific boundary work is being undertaken by scientific experts, this de-territorialises seeds through the projected authority of scientific knowledge and investments and simultaneous exclusion of the deemed non-scientific approach people, and related sociocultural space (Jasanoff 2015).

6.1.2 Introducing the formal seed savers

The formal case for seed saving in Colombia is portrayed through the perspectives of institutional, corporate, and producer association representatives. Firstly, CIAT was a key institution I worked with throughout my research. I also spoke with formal actors from national corporations and the producer associations, which provided a nuance of how formal actors from public-private organisations engage in boundary-making in seed-saving spaces. Once the seed is classified through certification and regulation and made to be a docile subject, the formal actors dictate its accessibility. Formal actors in seed saving can subjugate the informal seed savers through boundary work and decreasing accessibility to enclosed and scientised seeds.

On-site at CIAT, I talked with Alejandra, who works in the rice research sector of the Latin American reserve fund institution FLAR. I asked if farmers could access the seed bank, and she told me that FLAR is public-private, so people cannot just access the seeds in her work bank. The objective of FLAR is to deliver outcomes for the partners, and the partners are the ones that have access to the seeds. The governance comes from the donors, and control is made possible through the financial support of technoscientific seed development. However, Alejandra said that after the material turns ten, they have to hand it over to CIAT, who dispose of the seeds under specific criteria. The seed becomes public in some ways because the patent expires. Although she admitted, "only a little bit of seed is delivered [to the public] because it is very expensive to deliver more so the person can multiply from there, but it is not for trading purposes." Limited public access to gene banks is a phenomenon that is true globally. However, access to at least a certain number of seeds from specified varieties should be possible. Alejandra compared her work bank of rice seeds at FLAR to the seeds of the future seed bank at CIAT. She said it is different because anyone can access the CIAT seed bank. She also said the government and many private companies help to sustain the huge expense of maintaining all those seeds. Therefore, access to the seeds is granted (and regulated) by the state and corporate actors. This idea of anyone being able to access the seeds in CIAT's seed bank as allowed by the financial donors was put into question when I spoke with Carmen, a native seed saver. She said, "Technically, anyone can access [CIAT's seed bank], and you

just need to go onto the website, write a letter and say what you want and why you want it, but most people don't know this, and then they think ok you have to write a letter and they think ok how can we justify why we want these ten seeds?" There needs to be more scientific communication surrounding initiatives for public seed access from institutions such as CIAT, and there is also a need for more equitable access facilitated through these online and complex formal processes. Seeds could be made more accessible by minimising complexity and community educational outreach.

Actors involved in institutionalised seed saving enact processes that are less participatory, inclusive, and more selective and elite. Hector told me about the seed bank they have at the national rice guild, FEDEARROZ. The seed bank is monitored by an authorised person who inserts and removes seeds through "proper coding, and they [the seeds] are all in the databases, so there is a traceability of material". On the one hand, this increases legibility, and on the other, this systematised process uses public money for private seed control, making seeds inaccessible to the public. Cristian spoke to me about the CIMMYT seed bank in Colombia. He said that it is smaller than the central bank in Mexico and primarily holds the improved varieties. In contrast, the Mexican bank holds over 28,500 accessions, including, he said, "almost all, if not all, of the native materials of Colombia." This bank is not accessible to the public, he told me. While also, all of the native seeds with inherent ties to the land in Colombia have been de-territorialised through translocation to Mexico. Gabriel told me that FENALCE does not have a seed bank. Instead, they have seeds maintained for experiments and breeding, which are the parents of the hybrid seeds. He told me that when they (internal actors) need the parents, they take them from where they are stored in Tumba and multiply them, and then return them to be stored. When Alejandra talked to me about her work bank of seeds at FLAR, she said it is small because it only holds the lines they consider to be of 'useful variability', which relate to 6,500 accessions, rather than all of the diversity of rice, which she says is held at the international rice seed bank in the Philippines in the International Rice Research Institute (IRRI) where there are closer to 110,000 accessions. Gene banks can be seen as a means for the useful de-territorialising of seeds.

Other seed banks in Colombia are described to me by the formal actors with access. Xavier, the representative from the Ministry of Agriculture that worked directly with FEDEARROZ, told me this producer association has the largest germplasm bank for rice in Colombia. Hector later told me that FEDEARROZ has two germplasm banks in the experimental centres with approximately 9,000 accessions. During an interview with the native seed saver, Carmen, I also had the chance to speak to her partner David who works as a commercial producer of seeds for growing

chilli peppers to supply the raw material to companies such as Tobasco. He told me about a relevant national seed bank operated by Agrosavia, a public entity. In this germplasm bank, I am told, there have been 310 accessions of chillis since the 1970s. However, he said, "Of the 310 accessions, only 280 have successfully been grown out. So over 30 have already been lost of the original accessions because of being kept in a cupboard." David told me that he has filled in the application to be given the permitted number of seeds for trialling the growing out of different varieties. However, he said, "It's been impossible to get Agrosavia to release any seed to us, even though it is a public seed bank, funded by public money, and technically the law said I could ask for 20 seeds from the capital. But when I asked, they said you have to be part of a registered approved group with connections to two universities. So, my access to it is zero." He asked, "What's the point in this bank? It's not preserved for people in 20 years' time. It should be able to be used by humanity now. [Agrosavia] are seed hoarding for their own research. They have this idea that the business community has made themselves rich by using resources in a way that no one else has access to, so they think this is the way to the future for them. If they don't share with anyone, then eventually this will provide money to them too." This criticism brings nuance as it comes from a corporate actor and is targeted at corruption in the public system. Nevertheless, restricted accessibility through the accumulation of seeds and biodiversity remains applicable for corporate and formal actors, showing the impenetrability of the hegemonic capitalist system. Disciplinary power produces socially constructed subjects of control through seed banking, shaping a reality that excludes specific categorisations of seeds, people, and knowledge (Foucault 1979). As seeds are banked, and access is prevented, seeds are remade from co-evolved, culturally and genetically mixed socio-ecological objects to commodifiable, genetically pure, globally homogenous, and legally protected subjects (Aistara 2012).

In excluding certain actors from accessing seeds and contributing knowledge, seeds are de-territorialised despite the inherent situatedness of these seeds. To an extent, the criticism of limited access was also recognised by Victor as the head of FENALCE, who commented on the national seed storage at Agrosavia. He believes that the strengthening of germplasm banks is a very important measure, in terms of "strengthening the banks in technology, but also in the capacity to get the greatest number of species of seed varieties that exist in Colombian fields, and also to have a facility to permanently share them with the farmers." He told me that "from an official point of view, that would be ideal but that for the moment, these conditions do not exist to exchange seeds within research entities with farmers in a fluid manner." The conditions of seed banks are essentially actively being maintained to prevent this collaborative participation. Victor continued by saying, "this [fluidity] would precisely guarantee the conservation of the genetic material" and

he recognised that there is a need for nurseries of seeds at the community level that are supported by the state. Alejandra explained to me a set-back of *ex situ* seed saving is that "the seeds lose their viability very quickly, so in other words, you have to maintain the banks." So, we see management difficulties with having seeds kept external from their natural contexts where they are kept dormant and prevented from being used. Much work goes into maintaining banks and the associated technoscientific seed system.

Alvaro, a representative of the National Indigenous Organisation, questioned the idea of seed enclosure and banks as we sat in the treehouse above the agroecological gardens. He asked me if, "In seed banks, you are going to preserve the diversity of the world?" Then answered, "No, that's with the farmers on their land. So we say no, there is no alternative. The only alternative is in the fields, with the autonomous territories. But those seeds of ours come from our territories. So, *they* are carrying out piracy. They are carrying out robbery [and] the seeds are like a common good of humanity, which should be exempt from any individual usufruct." Bringing back into the centre this idea of seeds as part of a socio-ecological system that should be accessible as a global common. In Bogotá, during the seed workshop, the faces of the informal seed savers are captured in the photos we collage with. One woman from our group described our collage to the others. She said, "We asked ourselves the question, what is the role of the peasant woman, and what is the role of the peasant man? In our creation, you can also see a bit of this patriarchal, capitalist culture that exists in which we move, so we question what is the importance or what is the role of each of these characters that are part of rural life?" She described the lack of youth in our collage and questions, "what is the future of agriculture if there are no young people in the countryside?" One young man interrupted to say, "it's about *tejidos* (tissue or fabric)." I had to ask him to explain what this meant, and he said that it is a complex tissue with '*vínculos* (links)' between people, seeds, animals, and landscapes and that this is a good word to use in place of a network which implies institutional connections. Then the woman in our group continued, saying, "It is through these links that exchanges and experiences of ancestral knowledge take place, which sadly, if we do not continue to multiply, will be lost." The *tejidos* of human and non-human actors in seed systems bring a complex interplay of knowledge systems, sociocultural histories, and connections to the land. The territorialisation of seeds directly undermines this perspective of interconnectedness between humans and nature. Meanwhile, these informal actors and their associated traditional knowledge are systematically excluded from dominant formal spaces of ex situ seed saving. Through re-territorialisation of land and seed, there can be increased participation and visibility of local and marginalised efforts to care for seeds to feed people and to maintain agro-biodiversity and resilience in the context of the climate crisis.

6.2 Seed saving places

Seeds are described by those I interview as being saved and used across various spaces, including gardens, communities, seed houses, seed backpacks, in vitro, and seed banks.

6.2.1 In situ

Image 6.1 An arrangement of native and non-native seeds and the seed backpack at a seed workshop led by Alvaro Ortiz in Bogotá (own photo).

Those who worked with seeds on a small scale were wary of the term seed bank. When expressing the desire for a systematised means of storing seeds at FUNDAEC, Enrique told me they want to have a small seed bank, but they also "know everything that implies." Alvaro from the National Indigenous Organisation said they refrain from discussing seed banks. He told me about a seed reservoir. I asked if that differs from a seed bank, and he said, "It's not a bank because there is no profit from the fruits." He said that there is a hidden discourse in the germplasm bank model because the existence of the world cannot be preserved in a warehouse. Instead, "We talk, for example, about reservoirs, seed houses or seed backpacks, which is one of my initiatives. Why don't we question the system of the bank and say no, it's different? It is in the territories. It is the free seed. It is the seed in the backpack. There are other ways to preserve the seeds traditionally, for example, in *totumas* (squash)." Alvaro had also arrived at the seed workshop days earlier in Bogotá with a backpack filled with various seed varieties (Image 6.1). The same practice of preserving seeds

in *totumas* was shown to me in Juan Manuel's Afro-Colombian community on the reclaimed land. This brings an interesting overlap with place-based Indigenous versus traditional knowledge of seed practices. Juan Manuel told me the *totuma* is hollowed out, and they put the seeds in ashes with oil from a plant called *higuerilla* (castor bean or '*Ricinus Communis'*) which is strong enough to repel insects and protect the seeds. He says they do sometimes use jars but never plastics. It is more likely to be a wooden box. I also asked Roberto from Grupo Semillas if they had a seed bank. He quickly responded, "No, no, we do not promote banks. Our approach is based on the fact that the best way to preserve seeds is in the orchards of the cultivated fields. Only *in situ*, not *in vitro*." The colleagues sitting around the table in the office in Bogotá discussed their group's perspective. They told me, "Banks should be in communities, not in CIAT, not in the ICA, and not in Agrosavia." Roberto went on to explain, "There are seed networks at the territorial level [as well as at the national level], and they also have their community seed houses, that is here in this nation or many parts of the world they are called seed banks, but we as an organisation and as networks at the national level, well we chose not to call them banks because that is a very commercial term. For us, they have been more like family houses in community seed beds where the seed is kept, and that has also greatly strengthened the organisational work of the seed network and conservation work."

6.2.2 In communities

Seeds also seem to be saved by being disseminated within communities. A colleague of Juan Manuel, who also works on the reclaimed land, told me he "saves seeds as something to socialise with colleagues and with the farmers." When I spoke with Paula from the RSL, she told me they are focused on trying to make visible the work that people are doing at the territorial level regarding the conservation of seeds. She told me seed saving is a community effort and that they are most interested in promoting networks of producers or seed guardians. This community solidarity in seed communities links to practices of decolonisation which centre on relationship-building, connections, and maintaining collectivism rather than focusing on any individual or isolated effort (Pihama et al. 2014). As marginalised communities of Indigenous and Afro-Colombian seed savers have been pushed off the land, historical trauma is realised as situated in a context of ongoing, unresolved, and disenfranchised oppression that persists intergenerationally, impacting these peoples (Pihama et al. 2014). A collective resistance to the sociotechnical imaginary is formed through re-territorialisation of the seed, reclaiming and reusing the seeds and land. Paula told me that even if there are community seed houses, it is about something more than the work of the one person who has this seed house. It is about the producers who have distributed the seed so it can evolve and survive and not just stay in one place. She reaffirmed that "seeds are in communities, they are in the territories, people keep seeds in their gardens, not in banks or houses".

Seeds are situated and place-based; therefore, contesting their de-territorialisation through seed banking is a form of re-territorialisation that re-centres traditional place-based knowledge collectively held by networks of traditional seed savers. For Paula and the RSL, they privilege the idea that "seeds are in contact with the soil, with the water, with the culture, because it is also a way for them to evolve." Furthermore, she told me that the knowledge that should be used in seed saving practices should be local and context specific. She said, "Knowledge about seeds is not generic because, for example, with storage and conservation, it depends a lot on the region."

6.2.3 Ex situ

Seeds in seed banks are stored as genetic resources to be conserved for the future (Hartigan 2017). Seed banks save seeds as agricultural, epistemic, technical, cultural-heritage, and legal objects instead of saving living and growing plant life (Karafyllis 2020). Both in situ and ex situ practices of seed saving are conservation strategies, yet place, agency, and people change the materiality of the seed and the knowledge surrounding it. Seed banks operate to preserve history and conserve for the future through technological intervention to the growth of the plants, which creates a 'biofact' (Karafyllis 2020). A biofact is a natural and artificial object that still grows but through technological means (Karafyllis 2020). Biofacts are created through technoscientific actors' seed banking to produce material and epistemic realities that consolidate the dominant agro-industrial sociotechnical imaginary. As a seed is kept in a bank under controlled conditions, it is prevented from growing through latency, and when it is rejuvenated through being grown out, it is controlled and restored. The seeds being kept in banks are supposedly for all of humanity. But the inequitable access as well as the transnational movements of seeds from Global South origins to Global North vaults, particularly evident in the case of Norway[7], begs the question of which actors have access to banked seeds. On a micro-level, seed banks increase the socio-economic inequities between seed savers and breeders and on a macro-level, they increase the inequities between the Global North and South (Phillips 2016).

[7] In 2008, the Svalbard Global Seed Vault was established in Norway. It holds over 930,000 varieties of seeds to be saved for use by humans in a future global state of emergency.

On an international scale, the CIAT seed bank has integrated its genetic records into a global web portal for 68haracterize meta-data. Online, seeds are frozen in digital archives accessible through permanent URLs (Karafyllis 2020). Seeds have become digital objects, serving a scientific purpose and are part of the agro-industrial sociotechnical imaginary. These national and international seed banks are collecting seeds, taking germplasm samples as accessions, registering "passport data", and cataloguing it in inventories into data and codes (Karafyllis 2020, 147). Seed banks are premised on conserving a metaphysical notion of a common heritage (Karafyllis 2020). While technological processes for storing biofacts unify heterogeneous cultural identities and agrobiodiversity, transforming spatial-temporal concepts of the past, present and future (Karafyllis 2020). Ultimately seed banks and their usage are part of the shaping of sociotechnical imaginaries that excludes the seed-saving activities, knowledge, and access of marginalised actors while working towards a productivist, technoscientific, food secure (for some) future.

Image 6.2 The rice work bank at FLAR (left) and the selected seeds from the breeding programme in packages (right) (own images)

When talking with seed breeders, technological research, and extension officers, I noticed that the term seed bank was much more readily used and accepted. These actors described to me the conditions of control within seed banks. Cristian described the humidity sensors for grain conservation, climate forecasting and hermetic technologies to prevent deterioration in post-harvest management. In Alejandra's rice work bank, she said the temperature is at a constant 12C° with 48 percent humidity and that it is vital to have these minimum conditions to preserve seeds (Image 6.2). She said they need to change and regenerate them because the germination levels fall,

but they try to maintain them. All of this work to conserve 'pure' varieties of seeds in seed banks directly contrasts the practices of artificial and natural selection or breeding and evolutionary dynamics (Hartigan 2017). The conditions are highly controlled and 69haracterize to prolong the dormancy of cleaned seeds, conserving the past and preserving them in a state of purity for the future (Karafyllis 2020). The management of spatial conditions occupied by seeds and the relations and state of seed populations makes plant life a subject of human 69haracterize (Hartigan 2017). Hector from FEDEARROZ elaborated on the controlled practices needed to maintain seed banks with a recognised need for managed growth cycles. He said," Every so often, a renewal is made. All that material is planted. Obviously, though, because it is so much, this is done periodically." To keep the seeds alive, they must be planted. This makes sense. Yet the perspective of protecting genetic purity through periodic planting runs contrary to traditional and historical practices of plant breeding, conserving, and growing (Hartigan 2017).

Outside of the bank, in an institutional 69haracterized programme for rice at CIAT, I was shown the highly controlled conditions for seed reproduction. Manuela took me and my colleague to the greenhouses to show us the process. The humidity and temperature are controlled, and there is an automated irrigation system so that a hose is activated instantly when the water goes down. A cell phone also controls this, and some cameras monitor the greenhouses. These processes embody the de-territorialisation of seeds through technoscientific control by scientists and breeders in formal spaces. In the Cenicaña sugar cane research centre in Palmira, I am told that there is no need for a seed bank for asexual varieties because they have an advantage in that they can just clone the mother by taking the *yemas* (stalks). This practice of vegetative reproduction of planting stalks or root pieces to reproduce clones rather than crosses has been 69haracter by farmers for millennia. The breeders at Cenicaña, Fernando Cruz and Julián Gallego, also use this asexual reproduction of stalks to fulfil a commercial objective of "increasing the volume, the amount [of a final marketable product]". The efficiency of reproduction is enabled by cloning the mother plant by taking a stalk extraction machine and running it along each cane to punch out the stems, which are soaked in hot water for 69haracterized and then transferred into semi-commercial seed beds before being planted out in the fields (Image 6.3). But they told me they use an *in vitro* germplasm bank for sexual seeds, saving plantlife in glass test tubes under controlled conditions. Here I am introduced to this idea of managing the sexuality of the seed. Modern plant breeders use sexual reproduction to create new and improved categories of seed, creating a scientific subject. The sexuality of seeds is 69haracterized in breeding and banking as it can also undermine the genetic purity of varieties, affecting how plant life and genetic material can be stored in banks (Karafyllis 2020). Therefore sexuality must be regulated and rigidly controlled in seed banks, putting the sexuality of plant life

in reserve, and preventing the germination, crossing and selfing of species (Hartigan 2017). This reproduces the technoscientific discourses of development and modernity, which co-produces a docile seed and regulates the socio-ecological system around the seed, excluding certain types of seeds, people, and knowledge in shaping a dominant imagining of a particular sustainability within the future seed system.

Image 6.3 The machine to extract the yemas (stalks) of sugarcane (left) and the asexual reproduction of stalks in seed beds (right) (own photos).

6.3 Seed de-territorialisation and re-territorialisation

> *"Seed banks make material politics of infrastructure for, on the one hand, actors in biotechnology and bioinformatics and, on the other hand, actors in agricultural politics that separate seeds from lands. Hence a question omitted by all parties concerned is: Who owns the land on which the preserved plant genetic resources will grow in order to actually be options in the future, not for the future? (Karafyllis 2020, 154).*

The classification and systematic preference for one seed over another are deeply embedded in the history of agricultural domestication. As peoples have settled in and migrated between places over time, seeds have been territorialised in particular geographical locations, reflecting the choices made to save and reproduce them. Alvaro from the National Indigenous Organisation spoke to me about the internal migration of populations in Colombia as people have been displaced through the enforcement of the productivist agricultural development project. He said, "There has been a violent displacement of communities from their land to be used for agricultural production. We have a long history. We are close to life experiences of eviction from our territories due to the development of agro-industrial project models." This displacement of peoples from territories is attributed to violent conflict and coercive policies. In the seed workshop where we made the collages, one participant drew attention to the role that both armed and

unarmed conflict have had in displacing peoples from territories: "It seems super important to me how not only armed conflicts, but also unarmed conflicts in the territories, of course, have influenced the ways in which those territories are inhabited and uninhabited, and are uncovered and revolted. There is a process that, yes, today, there is a good example in the way in which people begin to consider their territory, whether to sow in that territory or not, and those who dealt with the violence and the structure of weapons obviously have influenced our history which is not a minor matter." This workshop was 71haracter by the representative that I interviewed from the National Indigenous Organisation. During the workshop, we spent a lot of the discussion on how reconnection to land is a form of re-territorialisation and resistance. One woman said, "There has always been an amnesia in this country in 71haracteriz the histories of peasants. So, when there is no respect for the foundations of agriculture, well, what it generates is abandonment. The only thing we lack is land." This land has been de-territorialised and fragmented by conflicting interests and desired control of the state, drug cartels, guerrillas, and paramilitary groups.

While I was still in Bogotá at the beginning of my research, I interviewed María Josefa, a professor and researcher of seeds, in her apartment, and she spoke to me about the history of social unrest related to social movements in agriculture in Colombia. She said, "The civil war has been so terrible for farmers in the sense that they have their lands taken away. They have been displaced to the cities." She carried on saying, "We basically need to make peace with everyone […] so that all of these displaced people, displaced farmers who came from the country, whoever they are, if they want to go back and become farmers again, then they should have their lands back and be able to farm and to live with dignity and not amid the war. And not being forcefully recruited for this variety of [paramilitary and guerrilla] groups."

However, this opinion contrasts with another sentiment that people no longer wish to work in agriculture. The rural setting and work of campesinos have been made to seem undignified, unappealing, dirty, and for a lower class of society. Juan Manuel, his colleague Lucas Zapata, and another Afro-Colombian community advocate, Ever, expressed concern about the youth's lack of interest in being in the countryside. While Carmen told me she thinks that about 90 percent of people that have been pushed off the land are no longer interested in working in agriculture or in growing their own food, so there is a disconnect between the reported current efforts of the government in buying land to return to disenfranchised communities when "part of the problem I think is that it is very un-prestigious in their [youth] minds to work in the countryside." The systematic boundary work and technoscientific control of the docile seeds, land and people have

shaped a deeply embedded consciousness in society that growing food in rural spaces is not valuable or valued work.

Sitting in the treehouse above the university gardens with Alvaro, he picked up a jar of seeds and unscrewed the lid, tipping them out into my hands and others in a circle. He told me, "This maize is from a place in Cauca Valley where everything was 72haracteriz by sugarcane production." When I arrived there a week later, I saw exactly what he meant by this. Leaving the airport just outside of Palmira in the 30-minute drive to the outskirts of Cali, everything I could see out of my window was sugarcane. When I spoke to Emilio Montero a couple of weeks later, in the native forest of the bahá'í community, he told me, "The north of Cauca is a region that for many years was 72haracterized precisely by food production, agricultural production and livestock production as well, food production. Then for many years, there has been a process of expansion of sugar cane cultivation, which has expanded throughout the valley and has left the peasants with very little land to produce other foodstuffs. Most of the land with sugarcane is not owned by the peasants. Most of it is owned by the sugar mills." Alfredo Morales, the father of my supervisor at CIAT, lives in Puerto Tejada, a town on the outskirts of Cali that was historically massively involved in traditional agricultural production and trade. Now it is surrounded by sugar cane plantations. It used to be dominated by traditional fincas, where Alfredo grew up with his cousins. Alfredo explained that "the sugar mills own a lot of the land." Within the metropolitan area of Cali, of the total area suitable for transitory crops, sugar cane covers 57 percent of the area (Zapata-Caldas 2021). Alfredo said, "What they [the industry] do is that they rent the land to the mills, so the mills take care of everything and, at the end of the harvest, transfer the money to their account. So the other thing is that they make agreements with the owners and establish contracts for the planting of sugar cane in which the person must plant the land with sugar cane for, say, five to ten years and then sell the cane to the mill".

Alfredo mentioned how people got pushed off the land in Cauca Valley with violent displacement by groups such as paramilitary and guerrilla but also focussed on the de-territorialisation undertaken by the sugar cane corporations. What people did was they either migrated to cities or out of Cauca Valley and went and claimed land elsewhere, resituating themselves in a space. "There were tracts of land, and people could say, well, I'm going to clean from here to here, and this is mine. Some went there to do that, and they built their farms there a little differently because the climate was different and everything, but they did it." This is reminiscent of the same racialised Black populations being displaced from Africa to Latin America during the slave trade. As Jaime Hernandez explained to me during my first interview in Bogotá at

the Universidad Nacional, “Europeans brought here Black people. They had to reconnect with the territory, mostly situated in Cauca Valley. They had to learn how to use these new plants. They learn to cultivate these new plants because they came from a different continent." Then these same populations are displaced from territories they learned to reconnect with over generations. Now, Alfredo is the only one left with any land from his family, as the rest were forced to sell due to the impossible loan fees required by the National Agrarian Bank. Then the soils on their land were made unfertile through corporate intervention with chemicals. Alfredo told me about the onset of the sugar cane industry intervention for land grabbing in his community. "I even remember the first time I heard and saw a helicopter, that is, we lived there on a farm, and there were mountains and farms around us, and then at noon once, coming home from school, we heard it, like something that was coming and wanted to raze the house. It was a helicopter that was fumigating. Fumigating what? The farms to dry them out so that crops wouldn’t grow.”

Alfredo said, "200 years ago, this country belonged to an elite and that elite has always wanted those of us below to work for them." His son, my colleague, explained that the elite still owns the country and have continuously created mechanisms to get more land from poor people, particularly land in good agricultural conditions. Alfredo continued, "They then wanted to take away this land that was being worked by the poor, through those mechanisms, using government entities, using bad credit, and starting to spread the issue of sugarcane." Enrique echoes this sentiment at FUNDAEC. He said that although he only moved to Cauca Valley from the North Coast of Colombia in the 1990s, he knows that "many people have lost their land for many reasons. For example, in north of Cauca, if you look, 86 percent of the land is in sugarcane monoculture production, and that was not the case before.” He said, “They say that in the 70s or before that, people had traditional fincas where they produced everything. Then the Green Revolution began, and all that extensive cultivation and some people wanted to sell consciously, others did not want to sell, and they had to sell due to pressures, and that happened a lot." Fernando and Julián at Cenicaña told me, “We currently have 240,000 hectares and that the area unit would be 2,000,400 square meters.” When I was with Alfredo, he showed me a picture of a small parcel of land amongst a mass monoculture of sugar cane. "I have that little piece there. And in a certain way, that is why I resist so much, because it represents a lot, in what we are saying, the resistance to the change of the land. Although it was a farm, now it is no longer a farm, but it is there and it is in the middle of all that cane, cane that is now on my cousin’s land, as they were the ones who sold, and next to it all is the sugar cane mills. But that little piece there is representing the resistance. It is representing the efforts that my grandmother made, who was the owner of the land. That's why I always make that resistance to not [sell] the little bit remaining. At some point, it has to change. It has to".

When I returned to Bogotá before leaving Colombia, I went to Grupo Semillas office. Roberto and his colleagues told me, "Colombia has among the worst land distribution in the world. There is corruption, and it has also been maintained by force." We talked about the marginalisation of Afro-Colombian populations in Cauca Valley, and Roberto told me that "Black communities are doubly affected. The cane industry took their land. Now, since they took the land there from the people who had diverse agriculture because there are very fertile lands, very very fertile, they took the land, but they are also taking huge amounts of ultra-processed food, and these exaggerated amounts of sugar to the schools and these local populations have been left without land, but now they also have very high rates of diabetes, obesity, diseases associated with food. So they are doubly affected by sugar."

Image 6.4 The traditional finca agricultural system with the community house, gardens, chicken coop, pig pen, and a polytunnel for native seedlings at Los Tulipanes (Photo credit: Alfredo Morales).

With territoriality and the exertion of control over the place, there is also contestation and resistance. Juan Manuel and Lucas are members of an Afro-Colombian Community Council that have reclaimed a farm called Los Tulipanes. Currently, they have 104 hectares, 44 of which are being re-territorialised by planting native seeds. The other 60 remain territorialised by the sugar cane industry as part of a contract with the mills. Juan Manuel explained the re-territorialisation and social mobilisation of the Afro-Colombian community council network in Cauca Valley.

> *"In 2015, there was a municipal office in Popayan and we, the Black communities, went and took over, in a peaceful takeover, we took over the office in Popayan for five days. From that, and later a negotiation was made with the government, the Minister of Agriculture, some officials from the high government, and they made, let's say some agreements, which were to buy land from the community councils to rescue agricultural production and food security, yes, to recover ancestry, as in a territory to have autonomy. That was not fulfilled, the government complied and later with the Indigenous people, like three or four years ago*

more or less, we blocked the Pan-American highway that comes from Popayan for two days and there was another table there and then the agreement was achieved again to negotiate what had already been agreed with the government, which was to allocate money to buy land, farms from community councils. In the last conversation, 27 billion pesos were allocated to buy land from the community councils. At this moment, in the region of these municipalities in northern Cauca, we have 42 community councils, we are constituted in an association called CON, the Association of Community Councils of Northern Cauca. Of those 42 community grants, to date, seven have already been given to us."

Juan Manuel's vision for the reclaimed land is to restore the previous Afro-Colombian traditional finca agricultural system, replanting native seeds, reinstating diversity, and sustainable local economies through polyculture practices (Image 6.4). This vision is being transformed into reality on Los Tulipanes as community solidarity is strengthened in the re-territorialisation of seeds and knowledge that is co-producing the physical traditional finca place and an alternative future imaginary of a sustainable seed system (Image 6.5).

Image 6.5 An interview in the polyculture system planted by Juan Manuel on reclaimed Afro-Colombian land at Los Tulipanes (Photo credit: Alfredo Morales).

As seeds are saved *ex situ*, scientific knowledge is prioritised in breeding, research, and development programmes to create a genetically pure and controllable subject for the seed bank. This de-territorialisation fragments the epistemic and material landscape of the seed system by relegating traditional seeds, knowledge, and seed users as inferior. Invisibilised by the mainstream technoscientific discourse of agricultural development but prevalent throughout the Colombian rural territories are marginalised seed savers that use local knowledge and native and creole seeds on reclaimed land in efforts to re-territorialise the seed system. Within the hierarchically constituted social relations of the seed system are contesting imaginings for a future sustainable system.

CHAPTER 7: (RE)PRODUCTION OF THE SEED

With climate change and hunger held up as targets of development strategies by governments, corporations, and international research organisations, seeds are (re)produced to be technoscientific solutions by the actors. Using theoretical concepts from STS is especially relevant in analysing the relationship between agricultural technology and social life in Colombia. Notably, sociotechnical imaginaries allow the exploration of how science and technology co-produce a dominant collective imagination of the future while also allowing discrepant societal responses to new and emerging technologies based on collective imaginings of alternative futures (Jasanoff 2015). Climate change and food insecurity are scripting societal futures by organising a future society that can face these complex challenges (Hulme 2011). There are mythologies of climate change and food insecurity relating to scarcity, lack of development, access to the free market, and technology as a solution (Nally 2016). These mythologies are socially construed and essentially "lend legitimacy to domination" (Nally 2016, 5). The modelling of climate change, levels of hunger, and rates of diet-related diseases all contribute to the public reporting of mythologies and the shaping of "practices of anticipation" that change the anticipation, planning, and realisation of futures (Hastrup 2013). The anticipation is of a new problem, yet the solutions are the same as existing approaches focusing on scaling up and out of markets and technologies (Clapp, Newell, and Brent 2017).

Jasanoff (2015) recognises the importance of the complex dialectic of time in reproducing imaginaries, with the past shaping the future and the future reshaping the past. In the global food system, discourses of development have historically been deployed to further the objectives of capitalism in concentrating the power of industry and governments through exploiting people, land, and seeds. In place of the Green Revolution, a Gene Revolution is being put forward as a new technological silver bullet focusing on small-holder farmers and sustainability through productive and genetic technologies that decrease the necessary inputs by technological efficiency (Holt-Giménez 2017). This involves rolling out biofortified and climate-resilient seeds as a technological solution to hunger and climate change. But this Gene Revolution has the same structural roots as its predecessor. The scientific knowledge used in these technical programmes assumes an authority of truth, becoming hegemonic and excluding alternative knowledges (Foucault 1979). The sociotechnical imaginary is shaped by hegemonic power structures within a hierarchically structured social life (Jasanoff and Kim 2013). Therefore, the dominant collective view in these imaginaries prevails in that the world should operate in line with the promises of neoliberalism's modernity and development. A capitalist system cannot solve climate change and

social inequities or restructure the food system to be sustainable (Holt-Giménez 2017). The results of the Green Revolution in displacing seeds, knowledge, and practices of small-scale farmers to make space for large-scale monocultures should be considered. At the same time, the novel promises of a Gene Revolution suggest that big data, precision agriculture, and genetic engineering can solve the unsustainability of the global food system.

In Colombia, at a national scale, the dominant imaginary holds onto technological transfer and trade liberalisation strategies as means to progress towards a developed future state. This will be explored through the national producer associations' technological transfer programmes and the national agricultural focuses in research and development. In a global context, no country is self-sufficient with genetic varieties of seeds (Frison, López, and Esquinas-Alcazar 2012). However, a common concern among participants, campesinos and institutional representatives alike, was that Colombia's food system is no longer self-sufficient, despite the country being highly agrobiodiverse with the environmental conditions, seeds, and rural populations that could support increased local food production.

Jasanoff (2015) describes how the imagination operates at an intersubjective level that connects people with shared ideologies, values and desires about how the world should or should not operate. While seeds and farmers are made more precarious on the frontlines of facing climate change, alternative imaginaries also contest the dominant view and position the native seed and associated traditional systems as central in visualising a future in which we can feed the population while facing climate change. New and emerging technologies arise based on conscious and explicit decision-making and funding provided by state and private actors, and this often goes together with the decision to downplay risk and uncertainty in one-way scientific communication undertaken by experts to the public. Imaginaries reconfigure actors' sense of the possible spaces of action and the rightness of action at scales ranging from international, national, and territorial to local (Jasanoff 2015).

Here I explore how seed (re)production co-produces epistemic and material realities through reshaping relations and collective imaginaries at global, national, and local scales in the Colombian seed system. This is particularly relevant in discussing how discourses and power are reproduced through different collective ideas of sustainability and climate adaptability. In the examples given in this chapter, at a global level, work by experts in international research organisations is significant in the conditioning and constraining of technoscientific seeds. At the national level, state and private actors form coalitions that make and unmake sociotechnical

imaginaries through technological transfer and dependencies associated with seeds. At the local level, collective imaginings in Cauca Valley contest the hegemonic agro-industrial approaches to seed reproduction through holistic visions of a sustainable transformation in which community solidarity comes before economic profit.

7.1 International scale

Image 7.1 The front cover of a biofortification pamphlet (left) and detailed description of a new biofortified bean and the increased levels of iron and zinc (right) (own pictures).

While at CIAT, I attended a presentation on the research, development, and outreach programme for biofortified and climate-smart seeds. In front of me on the table was an array of biofortified products, including maize, rice, beans, and the associated pamphlets that highlighted the increased levels of micronutrients in the specified variety. Frijol BIO102 possesses 60 percent more iron and 50 percent more zinc than normal (Image 7.1). The presenter proudly went over the statistics for the dissemination of biofortified seeds in Colombia, listing four different varieties that have been the focus: 'Maiz Blanco BIOMZn01, 'Frijol arbustivo' BIO101, 'Frijol voluble' BIO102, and 'Arroz Fedearroz' BioZn035. The steps for obtaining these biofortified seeds are shown in the next slide: 1. Define the crops; 2. Select the best material; 3. Conventional breeding; 4. Use of biotechnological tools; 5. Produce a biofortified crop; 6. Tests of acceptability; 7. Delivery post-harvest; 8. Processed products. The equation displayed on the slide reads:

"Seeds with high agronomic performance (e.g. drought tolerance) + seeds with high nutritional quality = biofortified seeds" (CIAT 2023a).

These biofortified seeds have been delivered as seed packages to more than 50,000 rural families since 2016, while more than 120,000 Colombian households have consumed biofortified foods, and over 100,000 kilograms of biofortified seeds have been delivered (CIAT 2023a). The focus of the biofortification programme is highlighted to me during this presentation as increasing the strength of production through agronomics aspects, quality and processing, and markets and commercialisation. Then in the final slide of the presentation, it is shown that the programme has "other interests", including the farmer, rural families, and urban consumers.

These biofortified seeds are synonymous with technology. This is a form of reductionist science (Hite and Broad 2014). It breaks down the seed into parts to be studied individually through nutrition and climate science. This reconfigures the seed within a manageable technoscientific process that ignores the interactions and complexities between components. Although mentioned as part of the rural aid packages for small-scale farmers, access to these fortified and resilient seeds remains a critical limitation. Small-holder farmers lack purchasing power, which was recognised by those I interviewed at CIAT, including those working in the biofortification breeding programmes. They also need a voice in decision-making about decisions relating directly to their own livelihood. Meanwhile, there is no evidence that a sociotechnical imaginary of technological seeds is collectively desired by the small-holder farmers for whom these seeds are reproduced. All the while, boundary work is being undertaken by scientists in advocating for nutritionism as a solution. Stuart, the leader of the bean breeding programme and face of the biofortification developments at CIAT, described how the focus on biofortification in breeding programmes had transformed the purpose of seed reproduction "to serve human nutrition". This marks a shift from serving caloric deficiencies in human populations to serving nutrient deficiencies. Nutritionism is what Holt-Gimenez terms a "science of insufficiency", while the Green Revolution was premised upon a "science of scarcity" (2017, 189). Global agriculture has moved towards understanding food through its nutrient composition (Hayes-Conroy, 2013). By focusing on nutrient components in food rather than the whole complex food, the importance of other components of eating, such as the cultural, historical, and social contexts that come with sharing food and knowledge, is undermined (Guthman 2014). Furthermore, Yates-Doerr (2012) suggests that nutritionism neglects the context of nutrition, excluding the assumptions made in forming a social consensus about this term. It also creates a moral subject that suggests the individual is responsible for their own health, diet, and associated well-being (Yates-Doerr 2012).

To counter this, there needs to be recognition of the relationships connecting dietary practices, bodies and daily life that recognises the historical tendencies of humans to seek combinations of taste, textures and culturally appropriate foods instead of this sole focus on the reductionist components of vitamins and minerals.

During a tour of the biofortification laboratory on-site at CIAT, I am shown biofortified supplement alternatives to whole foods, such as powdered biofortified rice, beans and maize that can be made into soups and drinks. Paula Rodriguez, a biotechnician in the lab, pointed to some pasta with shared components of beans and wheat (Image 7.2). I asked if the cultural aspect of food is lost in this work on biofortification. She said that that industry drives this demand for non-grain products designed for urban populations. Paula said there is work done with Indigenous communities that recognises the cultural component of foods by working with the raw materials available in that locality. So, if the community works with beans, they suggest, without forcing, a transition to biofortified beans. Biofortification as technology permeates the global food system in what started as maize and rice but has shifted to include 'poor-man' crops such as beans, sorghum, and cassava (Holt-Giménez 2017).

Image 7.2 Biofortified maize, rice, and beans in powder form as well as processed products such as pasta with different components of biofortified crops (own image).

There needs to be more clarity between international scientific development and local agricultural realities. This was noticeable in an explanation from one of the bean breeders at CIAT about how they lose a lot of their work each year due to the absence of farmers' input in the process. Rafael said, "I don't know [if farmers even want biofortified varieties] because we don't work with the value chains. There is no value chain for beans in Colombia, so it is difficult to quantify. The power in the value chain in Colombia is the intermediary, not the farmer, not the consumer, not the producer. This is the group that has the power of beans because this person goes to the farmer and pays less than the real cost for the material, and then it combines high and low quality and then says to the market what the price is for a kg of beans. I don't know how to quantify which ones people like and why." He told me that less than five percent of the improved climate-resilient and nutritional bean seeds are commercialised after they make over 400 new crosses a year. "This is a big huge problem," he said, "if twe send 100 lines to the farmer and the consumer says I dislike, it is a problem for us because we don't know which will be the preference of the consumer." These international initiatives are receiving huge amounts of funding in the name of solving issues of climate change and hunger by focusing on small-scale farmers, but the small-scale farmers and consumers need seats at the table.

In promoting biofortification, these scientific experts actively engage in boundary work of what can be seen as the discourse of 'benevolent technology' in the dominant sociotechnical imaginary (Holt-Giménez 2017). There is an assumption that science is needed to explain the hidden reality of hunger and seeds. This scientific research and development of benevolent technologies in the global agricultural system are supported by multinational agricultural corporations, international research organisations, and governments that use scientific knowledge and market-oriented strategies to integrate small-scale farmers and their practices into the global industrialised system (Holt-Giménez 2017). This connection is aptly described to me at CIAT during one of my interviews with a representative from CIMMYT. "We do research for developments always based on performance; mainly, they have to be materials that perform with the characteristics that the donor requires. The one who puts up the money is always the one who says what he needs." The one putting the money forward for the work carried out on the Biofortified Crops Programme of CIAT is HarvestPlus and Agrosavia. HarvestPlus is another entity within the CGIAR, and the prominent donors are the Bill and Melinda Gates Foundation, the UK government, the US government's Feed the Future initiative, the European Commission, and the Government of Canada (CIAT, 2023).

Stuart told me about the biofortification programme, "I think every one of our international partners found it to be extremely motivating to understand the potential impact of their work." It is the potential impact of this work and the motivation for it that is troubling to me. The international partners are largely the same as in the Green Revolution of the 1960s. These Global North institutions hold the money and power and are operating in a post-colonial system to perpetuate inequality through using technology to work in a top-down way to solve Global South problems and improve an underdeveloped less technological state. There is a lack of recognition of local knowledge in research and technology organisations that aim to integrate science and innovation in generating technoscientific knowledge (Hernández-Socha and Zuluaga-Jiménez 2022). Research and technology organisations are funded to produce research that increases efficiency for industry through technological and innovative problem-solving as funded by the state or private sector (Hernández-Socha and Zuluaga-Jiménez 2022). There is an incompatibility between capitalist technoscientific solutions to food insecurity and a sustainable global food system.

These solutions are leading to the worsening of problems they are posited to fix by replacing small-scale and subsistence agriculture with large monocultures of commercial crops and biofuels (Nally 2016). To understand the efforts of research and technology organisations in agricultural development, I interviewed representatives from international and national organisations, including CIAT, which is privately financed, Cenicaña which is privately financed and linked to a national producers' association, and Agrosavia, which is publicly financed. These international organisations and corporations are increasingly acting upon imagined understandings of how the world is and should be by shaping societies' understandings of what is good and bad, allowing the propagation of technological solutions that can generate profit through productivity across geopolitical boundaries (Jasanoff 2015). As Sandra explained to me about the biofortification programme at CIAT, "[there are] three micronutrients used, which are a lot of work and validation by nutritionists, were decided that these were the ones that are going to have the greatest impact on the vulnerable population, because they are the greatest deficiencies that exist at the level of the world: iron, zinc and vitamin A." She went on to show me the x-ray equipment used to determine mineral levels in parts per million at the granular level for 25 to 30 samples every minute. Then we went into the next room of the laboratory with a CX ray machine from 2020. We met a colleague named Alfredo, who was taking root samples to determine carotenes, beta-carotenes, acidity, and dry matter through infrared technologies. This tour went on for almost an hour while nutrients were put forward as the good, the solutions to problems of poverty, hunger, and this concept of antinutrients, which were explained to me as determinants of obesity. However,

it was admitted that the public does not seek these new technological seeds. It requires effective marketing and commercialisation strategies to shape what consumers will buy because shoppers are oftentimes not basing their decisions on micronutrients and antinutrients. Here the idea comes up again that the consumer is responsible for their own diet and health, while the food insecure are being subjugated under the pretence of doing good (Nally 2016).

Biofortified seeds and nutrient-deficient populations are co-produced through the industrial concentration and local disconnect in the global food system. In the interplay of past and future imaginings for a food-secure global population, approaches to hunger worldwide have coincided with an increase in diet-related chronic diseases and nutrient deficiencies. Roberto from Grupo Semillas criticised how the "approaches to food security and hunger in Colombia have led to an increase in non-communicable diseases including obesity and diabetes. The different observatories show, for example, that Colombia has very high rates of hunger and malnutrition. It is precisely because it attacks hunger with those conventional traditional forms of delivering food without looking at the origin, without looking at the quality, not using traditional seeds and relying heavily on in agro-industrial production that produces poor quality food, the use of foods that have nothing to do with culture. Too much oil, too much processed flour, too much sugar consumption, the juices, the fizzy drinks…." The list goes on. This same sentiment was evident in the statements by Patricia Lopez from FIAN, an international global human rights organisation focused on establishing equitable access to a healthy and nutritious diet. She said that in approaches to tackling food security, technologies are being used to increase agricultural productivity for exports of commodities that are ultimately not foods. She stated that the impacts of this industrialised technoscientific approach to the food system are leading to the industrialisation of diets, decreased health of populations, and decreased cultural diversity and agrobiodiversity.

Just as the Green Revolution achieved an overall production in food, biofortification and climate-resilient seed reproduction has generated benefits in increasing the nutritional constituents and resilient traits of seeds (under certain conditions). A study undertaken by the CIAT researchers I spoke with showed that a rural population that consumed a high-iron fortified bean variety had increased iron status in the population, which led to increased cognitive ability, brain functioning and work efficiency (Beebe 2020). But there are severe implications in contributing to the reproduction of a collective imagination in which deficiencies are dealt with through technoscientific solutions without addressing why people are deficient in the first place. In these international efforts to tackle climate change and hunger, seeds have been adapted from high-yield varieties to drought-tolerant and high-temperature resilient varieties to higher zinc and iron content

varieties. The co-production of the technoscientific seed and sociotechnical imaginary is disembedding seed in Colombia from its geographical, historical, sociocultural, agroecological, economic, and public health contexts (Stone and Glover 2016). In the dominant sociotechnical imaginary, hierarchies are constituted between categorisations of seeds, people, knowledge, and ways of dealing with nutrition and climate variation, and this is inextricably linked to institutional and ideological ideas of development and modernity. The de-territorialisation of seed plays out in the global agricultural context of placelessness, driving a rift between the homogenous technoscientific solutions and heterogenous local realities.

Roberto from Grupo Semillas said there needs to be an increased effort towards "understanding local processes and establishing a dialogue bridge between this ultra-specialised scientific knowledge and traditional knowledge." This was in response to my asking how the Grupo Semillas organisation felt about the work of CIAT. He elaborated, "I think CIAT is taking a long time to propose strategies against climate change in a country like Colombia. I mean, why the saved seeds? Why drought-tolerant seeds in a seed bank if they can't be used to solve local problems?" Roberto spoke about how climate change is scripting societal imaginaries by stating that "climate change on its own is not the issue because much of climate variability cannot be attributed 100 percent to climate change, this variability is deriving from the model of producing, from the model of appropriation of the assets under development." As Alvaro from the National Indigenous Organisation said to me "seeds that are resilient to climate change are traditional seeds." Therefore, an alternative imaginary collectively held by native seed savers is conceptualised in native seeds being pertinent to challenging and unravelling the hegemonic power structure in which the technoscientific biofortified and climate-resilient seed is (re)produced.

7.2 National level

Central to the national scale of sociotechnical imaginaries for seed reproduction in Colombia is the idea of up- and out-scaling technologies to be transferred for maximum impact (Green 2021). The national producer associations are key actors involved in co-producing a national sociotechnical imaginary of seeds and social order. The private producer associations in Colombia produce and use scientific knowledge, technological development and lobbying as strategies to influence policymaking and generate economic results for the producers of the respective crop sector through productivity. Therefore, the guilds can be seen as sites of co-production for knowledge and social order. A coalition is present within these sites between the private sector and the state, which plays a pivotal role in making and unmaking global sociotechnical imaginaries (Jasanoff 2015).

Xavier from the Ministry of Agriculture explains the complex interrelations between the public and private spheres in these sites. He was the rice technical secretariat and worked together with FEDEARROZ. He told me that in the rice sector, the parafiscal fund is known as Fondo Nacional de Arroz and is specifically dedicated to increasing the competitiveness of the rice sector through productivity measures. Xavier's role is to present technical concepts proposed by the guild about projects they want to undertake at the national scale, and with this information, decision-makers make a call on whether the project will go ahead. Xavier told me there is a development committee for activities that will be carried out, and the commission has to approve it." The rice sector is also supported by the state, Xavier said to me, and this support tends to come in the form of price stabilisation. As a result, FEDEARROZ established a company and a fund management line within the association so that they could independently support rice development in Colombia regardless of political decisions. The FEDEARROZ company buys seed from the fund management line, replicates it, and then sells a specific variety, going through the process of making it commercially available and certified within the regulations of Colombia's Agricultural Institution (ICA). Xavier told me, "It's completely private. The government only gets involved in approving the research projects." However, even though they are private entities, the guilds play a critical role in negotiations regarding the agricultural sector with the state, particularly in defining the stabilisation of macroeconomic and trade policies (Junguito Bonnet 2019).

Hector, who works at FEDEARROZ in the technical transfer area, later described to me in more depth what the purpose of seed reproduction is within the guild. He said, "FEDEARROZ has different work fronts. The purely union front is to defend the general interest of the rice growers before the state or other institutions. So, ensure that marketing issues, price, imports, all these issues are not harmful to Colombian farmers." He later said, "here it is the farmers themselves that finance it. They pay something called the promotion fee, so each farmer is deducted 0.5 percent from the value of their production and that money goes to the National Rice Fund where we can work on research and technology transfer." He also described the other branches of FEDEARROZ. "It also has a commercial area that is responsible for marketing white rice, inputs, and seeds. And it has the technical area, which is where I am part of. So, we have research in all genetics and agronomy issues, and we transfer that technology, we extend it to farmers and different actors in the sector, agronomists, technicians, students, machine operators." He talked about how the research area focuses on genetics and agronomy to generate and produce varieties of rice "as well as knowledge, new technologies, and better management practices." This technological extension programme and the associated genetic focus on seeds used are embedded

into the national civic engagement strategies, systematically prioritising a scientific and technological approach over local approaches that draw on traditional knowledge.

A similar sentiment is echoed in the description of the cereal and legume guild, FENALCE. Gabriel said of FENALCE, "It is private, but it manages public resources." He gives me an example of how the fund management works, "for maize, it is 0.75 percent of what is sold goes into the parafiscal fund. Maize is what sells the most. That fund is the one that has the most money. It is around 3000 million [pesos] more or less a year". He also explained that "the objectives are to support producers in topics like commerce, markets, investigation, research, and the federation uses most of its budget in research and technology transfer". He specified that "80 to 90 percent of farmers work with maize. It is the strongest crop that FENALCE manages in terms of budget and in terms of dedication of FENALCE staff time." This is what the bean breeder at CIAT, Mateo had said to me about FENALCE when speaking on the prioritisation of maize at the detriment of underrepresentation for beans in Colombia's producer associations. Gabriel also mentioned that the philosophy of FENALCE is to provide farmers with a choice of seed for their production method, offering transgenic and conventional seeds. He said they no longer work with conventional farmers' varieties because they are attempting to increase productivity.

(Re)produced technoscientific seeds as solutions are prioritised in Colombia because of the history of technological interventions and the assumptions and anticipated future of climate change. One example of this in Colombia is the Mass Adoption of Technology programme (AMTEC). This programme was designed and implemented by FEDEARROZ (Ramírez and Bedoya 2019). The objective of this programme is to increase productivity and profitability by improving product quality while focusing on sustainable agricultural practices (Cuestas and Cortés 2019). Xavier, the representative from the Ministry of Agriculture, told me about the AMTEC programme and its integrated technology. He said to me that the idea is "they have a system that integrated everything. They have certified seeds and preparation of the land and the use of fertilisers, and they are even diving into bio fertilisers and plague control" When I asked what kind of technologies they use, he said, "We're only just starting to dive into genetic markers and CRISPR and all of those technologies. We're only starting to use them now, it is not widespread", But he continued, "[AMTEC] have the whole system in place so that they can start implementing different technologies to improve yields and productivity and competitivity because this also can reduce costs. They can reduce costs a lot by using integrated technology." Then he told me, "The problem is that they don't have as many people as they would like. They can only cover around 25,000 hectares when in rice Colombia is producing around 500,000 hectares."

One noticeable issue is that technology transfer is insufficient to ensure that technologies are used. This is for many reasons, including but not limited to the fact that programmes of technological transfer are often project-based, and therefore the funding is limited to a results-based timeline. Also, recently in Colombia, there has been a lack of state funding directed towards agricultural support programmes. While it is also paramount to consider that people might not always want to use technologies instead of engaged human practices, and there is a lack of efficient citizen engagement and scientific communication. For beans that receive significantly less regulation and financial support from its corresponding guild, FENALCE, there is insufficient financing to transfer certified seeds to farmers, specifically for biofortified bean varieties. Mateo told me that there is very little in stock, so this technological transfer cannot be effectively provided to many farmers. Whether or not the farmers want agricultural support in the form of a technological transfer of biofortified seed is not a question. The producer associations provide subsidies for certain formal and certified varieties while regulating and restricting the influence of informal seed systems. These private national associations can be seen to moderate the relationships between peoples and seeds in Colombia, together with ICA. The role of the ICA as a public entity is the regulation and control of production, import and export of genetically improved seeds (Lázaro-Palacio and Aranda-Camacho 2019). The ICA also supervises seed commercialisation and planting and maintains a registry of agronomic evaluation and research units in national plant breeding (Lázaro-Palacio and Aranda-Camacho 2019). Alejandra described this regulation over seeds' private development and reproduction: "The ICA oversees the entire process here and [sometimes it could] be more flexible, because sometimes, some things really don't make sense."

A social order of formal seeds and seed users subjugating informal seeds and seed users is maintained in the reproduction of technological seeds and the dominant sociotechnical imaginary propagated by the productivist objectives of these producer associations. This is evident in the need for more connection between technological solutions and the small-scale farmers they are purported to be developed for. Enrique, the representative of FUNDAEC in Cali, said to me that what Colombia is lacking is "contextualised technology, like technology that is connected to the needs and contexts and seeds here, to prepare the terrain in a simple way with a cost that most people can afford." While in contrast, a view that came up with Hector when describing the AMTEC initiative is that "it's easy to access technology. I think there is the availability of technology in Colombia. If someone wants to make their applications with a drone, now they do it with a drone without a problem." He said, "What we are still working to improve is adoption so that people use it." With the innovations in technology in Colombia, there is an imagined future

society that could face the challenges of climate change and hunger by using drones and robots to be more efficient, precise, and cost-effective in fields. This is evident in the field trials at CIAT as they use Robert, a robot cart, to go through bean rows and take pictures at every angle to assess parameters such as the number of pods per plant. A drone is also being used to apply pesticides on the rice used for the hybridisation programme. Manuela and a field extension worker, Miguel, explained that by using a drone, they "have reduced the amount of water that has to be applied from 200L to 11.6L per hectare." This technology is positioned as a solution to a future in which scientific understandings point to climate as a primary determinant (Hulme 2011). However, technology is created by people, for people, and it has the potential to exacerbate or alleviate social inequities depending on if the power dynamics between the practitioners and recipients are appropriately addressed (Green 2021). In this instance, the difference in power is maintained through the use of technology as an exclusive tool or black box that makes agricultural production seem so complex that only the inputs and outputs can be focused on (Latour 1987). In this process, seeds become subjects of selective and strategic development and aid programmes that further concentrate power in the hands of philanthropists and practitioners, bestowing technological solutions upon technologically deprived seed producers.

As expressed by representatives of national institutions, sustainability in the dominant Colombian imaginary is largely associated with economic and environmental aspects without deeper recognition of the social domain. There was a gap in recognising how social order is maintained by small-scale producers being subjugated through agro-industrial development. Cenicaña is exemplary of another actor involved in shaping the dominant technified imaginary of sustainability at the nation-state level through reproducing seeds (or stems) to mass clone uniformity and increase productivity. Fernando and Julián described the sustainability of the sugar industry in Colombia, repeating my question to me and answering, "Is [caña] sustainable now? Yes, yes, yes, it is sustainable. Right now, it is sustainable. Actually, if it had not been sustainable, at this moment, there would not have been almost 240,000 hectares planted with sugarcane, then it is a sustainable system." Later my supervisor at CIAT explained to me his doctoral research that analysed the socio-ecological system of Cauca Valley. Sugarcane in Cauca Valley is evidently unsustainable when social equity and environmental sustainability are considered alongside economic prosperity. This is because the capacity to provide ecosystem services is reduced when productive land is dominated by a monoculture such as sugar cane (Zapata-Caldas, 2021). At the same time, Afro-Colombian communities have been displaced and marginalised through the commercialisation of agriculture in the region (Zapata-Caldas 2021). While it also points to the fragmentation that sugar cane monocultures cause in landscapes and populations through

disproportionate use of water basins, land tenure, and the creation of sociocultural externalities (Zapata-Caldas 2021). Fernando and Julián continued to explain to me that "There are even people who have between two and five hectares, even people who may have more than 300 hectares, that is, for both small and large [-scale producers], sugarcane is sustainable, for the production of sugar, and ethanol, as they also use it for the part that is energy." When I asked about what happened to the workers when the sugar industry transitioned to mechanisation they told me "there was a need for more cane to be cut, we had to look for alternatives and mechanical construction began to be implemented. It has its limitations, as in other crops, when the environmental conditions are not ideal, which are with a lot of humidity. The harvesters, the machines as such, cannot enter the lots because they cause damage. [But] basically it was like a combined thing where on the one hand they needed more work and people didn't want to do it, and on the other hand there was an advancement in technology. Now over 80 percent of the harvesting is done with machines." He told me that ultimately at Cenicaña, they "always work for the environment and, in general, the industry", explaining how the two go hand-in-hand as good cultivation techniques and agronomic technologies are needed to plant and grow successfully on a large-scale. This view fragments understandings of environmental, social, and economic sustainability because, ultimately, the industrial model for agriculture that centres on capitalism is incompatible with socio-ecological sustainability as the environment is instead seen as a resource through an extractivist and imperialist lens.

A national imaginary of being part of a globalised technoscientific economic network is co-producing a reality in which Colombia is not self-sufficient in terms of food provision despite having the resources to be. In the neoliberal age, food security is often not synonymous with self-sufficiency. As part of the free trade paradigm, producing enough food to trade rather than consume is the goal (Harrigan 2003). Structural dependencies are systematically created between multinational agricultural corporations, international agricultural aid organisations, and nations in globalising the food chain. Cristian from CIMMYT pointed out to me that it has not been a priority to focus on shortening the food chain to the local level in economic and agricultural policies in Colombia. Cristian asked me, "What would happen if we were not able to get maize from the United States or Argentina, for example? And I think we would have a food crisis, the biggest we can see. But we have the capacity to produce maize and we can do it. So, that is the biggest challenge, to be able to produce maize to supply a large part of the imports. It is what I think that this is the challenge we have." This is elaborated upon by Gabriel a week later when he talks about Colombia's national precarity based on the US prices of crops. He explains the price stabilisation policies that the state has put in place to try and ensure domestic farmers' maize cultivation. He

explained to me that in Colombia, white maize is primarily for humans while yellow maize is primarily for the industry in making processed products and to be consumed as animal feed. He said this means that by far, the majority of maize consumed in Colombia is yellow maize, and "the price of yellow maize is managed in the United States, on the Chicago Stock Exchange. When maize prices are low there, then the marketers here also lower the price. So, many times people are sowing with the luck of looking to see what price it comes out at. When my maize comes out, at what price is it in the United States? White does not have that influence [but for yellow maize] if the price goes down there, it starts to arrive here right away, because it's cheaper to bring it over, then the local price also falls. That affects us quite a bit. There are some tools that the government has provided and that, in general, have been promoted a lot, which is, for example, the issue of price coverage. I buy insurance that corn is going to be at a million a tonne, for example, the issue of price hedges." In Colombia, free trade ideology is promoted over and above agricultural protectionism that attempts to mitigate market fluctuations and maintain certain levels of domestic production, reflecting the globally dominant discourses of neoliberalism (Moon 2011). Colombia is a net food importer, while the agricultural export industry is dominated by those heavily supported industries mentioned earlier for fuels and cash crops, including petroleum, coal, cotton, coffee, and sugar (OEC 2023). This exposes the un-free reality of global trade and the impacts this has as an inequitable power dynamic between multinational corporations, the state, and small-holder or subsistence farmers render profits and food provision for some, not all, while problems of climate change and food insecurity are compounded (Moon 2011).

The Instituto de Mercadeo Agropecuario (IDEMA) is the national agricultural marketing institute that is responsible for intervention prices and price stabilisation for the imports, exports, purchase, sale, storage, and management of food products (FEDESARROLLO 1976). Price policies in Colombia can be effective instruments for stimulating production; however, historically, these support prices have not been used to purchase nationally produced goods in line with the Food and Nutrition Plan or the philosophy of the Integrated Rural Development Plan (FEDESARROLLO 1976). IDEMA has used international price benchmarks to establish minimum guaranteed prices for purchasing staple crops from domestic producers (OECD 2021). Mateo also described the lack of national support that beans get and said, "If it were a government priority, we wouldn't buy a grain, we would produce everything, but, unfortunately, we buy beans from abroad. And that is very bad, that makes me very angry." While even for maize, the top priority crop for FENALCE, accruing vast amounts of national policy support, Victor spoke about what it would take for Colombia to become self-sufficient in maize. "There is a need for actions and activities to improve the system. One is called Maize Plan, and that is a big part of the

government's role. It needs to be that politics align to assist people. The programme here is big. We need more access to land. With IDEMA, the government would send products afterwards. The other is working with CIAT on big data to create a development plan, and also they are doing a lot of things because they know climate change is a challenge. In order to have one million hectares, to be self-sufficient in Colombia, we will need approximately 12-15 billion pesos." I ask if this is to acquire the land needed to be self-sufficient in maize, and he clarifies that it is not even for the land. This is just for the resources and transformation of the land once the one million hectares are acquired. Therefore, the dominant collective imagining of Colombia's seed system is embedded within the ideals of globalisation and neoliberalism that have co-produced an agricultural reality and future imagining of sustainability. Within this national sociotechnical imaginary, local and conventional seed varieties are being systematically replaced by genetically pure hybrid or transgenic varieties, which have decidedly better commercial potential, and this is a national priority in focusing on exports, particularly noticeable for the commercial food crop sectors of maize, rice, and sugar. As modernised agricultural technologies are scaled for improving productivity in specific crop sectors, the land is territorialised, seeds are de-territorialised, and recognition of the needs and knowledge of small-scale farmers is excluded.

7.3 Local level

Alternative imaginaries held by some actors at the local level resist the seamless progression of sociotechnical imaginaries becoming future realities (Jasanoff 2015). In contrast to the dominant sociotechnical imaginaries, there is also a view of a future seed system that can enhance food sovereignty through organic, agroecological, and permacultural practices. This view and the associated practices are largely related to small-holder actors working at the local scale in Colombia's seed system. A socio-ecological approach to imagining a sustainable food system extends the focus of food security from the health of the individual to the health of communities, the environment, and all the elements of the food system. This contestation brings in the inherently dynamic and flexible components of how collective imaginations can be made and unmade (Jasanoff 2015). In the office of Grupo Semillas in Bogotá, Roberto described to me how native seed reproduction and the associated knowledge and conditions for producing food without agrochemicals require "that families start to see the importance of their traditional foods, so they don't have to go shopping outside. It is close to the food sovereignty approach because we assume that to have enough of our own good quality food, we must have enough healthy seeds that can produce nutritious food with less expenditure in production." In addition to shifting the view of food security to food sovereignty, this alternative imaginary also undoes some of the racialised stigmatisation attached to native seeds, traditional seed knowledge, and people that hold that

knowledge. There is also a marked shift away from a view of climate change through technoscientific models of measured carbon emissions to viewing the health of the ecosystem in non-quantifiable and non-monetary terms. Paula from the RSL questioned the role of carbon as the new scapegoat of the climate and socio-ecological crisis. She told me, "Carbon is a terrifying point in this country and worldwide. We have jumped from oil to commodities and now carbon, decarbonisation." In this instance, what good is a technoscientific climate resilient and biofortified seed for people when, as Jaime said to me in my very first interview in the agroecological gardens of Universidad Nacional, "we do not see seeds as instruments of production, we see agriculture as a way of life."

Seed (re)production can also centre on sociocultural and historical contexts. In the seed workshop I attended in Bogotá, the facilitator, Trixi, described how "people, territory, and seeds are changing all the time." She said, "In this universe, seeds are the vectors of production and reproduction that articulate culture, nature, nutrition, food circulation, sustainability of the territory and are entities that reflect genetic codes and the cycles such as nourishing, healing, growing, caring, and understanding activity from life to death" or in linking past and future imaginations. This thinking sees seeds as sites of (re)production for material and epistemic realities. When Alvaro talked about sites for native seed reproduction, he told me that important knowledge is generated through having a cultural space where "we can make metaphors of the matter, that is, we can make it poetic. We make community through the food that we grow." As we sat in a treehouse above the Universidad Distrital gardens on the edge of the urban city landscape, he went on to describe the name of the closest mountain, which through an Indigenous worldview is a woman and a place of fertility, where the children of the mountain come from and the place where maize cultivation was born." He said the methodology and pedagogy of the meeting space at the university is known as a word circle, it happens around a fireplace where dialoguing between disciplines occurs, as he calls it "a dialogue of non-hegemonic knowledge and an ecology of knowledge" (Image 7.3). He said having this social space is key, "we gather to cook, to prepare medicine, to sing, to dance, to weave, to cultivate, and to transform the soil." This came back to the idea that "any [technological] alternative in the creation of new agri-food systems, more sustainable… or give it the name you want to give it, must start from keeping in mind that the peoples who carry out those sustainable practices have a cosmogony, a way of seeing the cosmos and there is a worldview that is being lived, there is a habitat there." Seed (re)production can be localised and collectively imagined in these localities as being inherently socially and environmentally sustainable by considering the connectedness and situatedness of socioenvironmental contexts.

Image 7.3 The sociocultural word circle dialogue space at Universidad Distrital, Bogotá (own image).

A localised imaginary for a sustainable food system is collectively held and exemplified by non-profit organisation FUNDAEC members. Alfredo was part of the first education class in the north of Cauca, and he explained to me how FUNDAEC was conceptualised as an educational organisation that connects scientific thinking with spiritual perceptions and traditional knowledge to enhance community solidarity and create opportunities for those residing in the countryside, re-establishing hope. Dr Farzam Arbab of the Bahá'í religious faith came to Colombia and founded this organisation in Cauca Valley. His vision was to enhance ecological sustainability through fostering social sustainability with values of cooperation and reciprocity in lived realities of rural disenfranchised Afro-Colombian communities. This connection taught at FUNDAEC between social and epistemic realities resonated with Alfredo so much that he later became Bahá'í himself and raised a Bahá'í family, including his son and my colleague at CIAT.

This collective spiritual view of human-environment relationships was also evident in my visit to the Bahá'í native forest in Cauca Valley, which also holds a house of worship (Image 7.4). I spoke with Emilio, the administrative director, who told me, "The idea of the forest is to modify or transform relationships [because], at the moment, the principles that predominate in relationships are economic interests, money, competition. But a project like this one focuses on generating relationships based on collaboration, mutual help, respect for others. A collective project can also help to collectively solve the basic problems and needs of a population because the other view is to expect each person to solve it alone. But the project itself, in general, is looking for collective solutions to social problems."

Image 7.4 The Cauca Valley Bahá'í house of worship and site for a co-produced community native forest that will help to transform relationships (own image).

Enrique, a director at FUNDAEC and friends with Alfredo said to me, "Since its creation, FUNDAEC has been very concerned about the relationship between intervention and production, how this harmonious relationship between human beings and nature should be, and how natural resources should be cared for and protected. And on the other hand, the emphasis of its creation has always been to produce food on a small scale, but clean food, healthy food, taking care that it comes from organic origin for the most part, that it does not intervene so much with the environment through the use of agrochemicals within it." He explained the focus on urban agriculture in community outreach programmes because there is a lack of knowledge about gardening, growing and seeds in urban populations. He said, "we found that there were people who had never planted anything in their lives [so we have been educating them] not just through theory but practical workshops [and] in this whole process, people begin to find meaning in it." Through this local seed (re)production strategy, there is a reshaping of relations and collective imaginaries premised upon the value of local, traditional, and contextualised knowledge that should be shared within and between communities to connect people with seeds and food.

I spoke with Alfredo at his home in an agricultural town within Cauca Valley, and he explained to me the reshaped relations between people, land and seeds in that area. As an

industrialised monocultural system manifested in sugar cane production replaced the traditional finca small-scale agricultural economies, de-territorialisation was undertaken to delegitimise local knowledge and exacerbate racial stigmatisation. Alfredo told me, "Here, for example, *Puerto* (Port) *Tejada*, do you know why it is called Puerto Tejada? Because here came the river that you see when we passed, it was mighty, so boats entered and traded between Puerto Tejada and many of these northern towns and Cali. It was done through the river. It was mighty. When all this sugarcane arrives, then the river begins to decrease its flow because the forest is cut. There is no forest anymore. There are no trees anymore. The traditional fincas disappeared." Roberto also spoke of the traditional finca from his office in Bogotá. He said the traditional fincas in Cauca Valley did have sugar cane but in a polyculture as part of a combined system of other crops. "People previously had sugarcane on their farms, of course, but they had bananas, cassava, fruits, animals, and they had a different diet and a dignified way of life. Not now, now it's just lots of impoverished people in towns and all of it full of cane. They are a small town here, another here, and all full of cane." The traditional finca agricultural system is a site of an alternative imaginary that sees interrelations between living components, cultural and agrobiodiversity, and displaced Afro-Colombian communities. The traditional finca is an important space for practices that (re)produce social, cultural, conservation, and production components of traditional agriculture (Guaza Mina 2018). Juan Manuel also spoke about how the traditional finca concept is incompatible with capitalism, a concept very few outsiders can even understand anymore. He said, "If you start the process and after six months you do not have four or five million from the production, people from outside will say you are wasting your time. But the processes, I tell them, what we are doing, is not to buy a car or a motorcycle or a helicopter, it is to connect us and recreate ourselves, to educate us and to live sustainably."

Alfredo showed me a video in which he, Juan Manuel, and other community members discuss the successful efforts of FUNDAEC in revitalising the traditional finca and strengthening an alternative collective future imaginary. Today there is an association of traditional farm producers with more than 1200 families in the north of Cauca (FUNDAEC 2021). The programme has renovated old farms that were in soybeans and sugar cane, and in the last ten years, about 350 hectares of traditional fincas have been reinstated (FUNDAEC 2021). This view of a sustainable future is well summarised by Alfredo when he said, "If money is always in the centre, then maybe the traditional knowledge will disappear. But if the sustainable system, way of life or livelihood, is the one that people are more conscious about and try to foster, so maybe it can continue. We will have to change our way of seeing things and thinking more about serving others, not for our own benefit. [A national history of violence and suffering] has to serve us something, and that history

is written and will remain written. So we will have to look there to say no, we cannot repeat that." Juan Manuel spoke about the Tulipane farm that the Community Council have reclaimed and their vision to create an agroecological educational centre that engages youth in permacultural seed practices. He told me, "What we want is to build a new generation of people who feel ownership of the earth. They have to find a different way to produce food."

At the local level, these actors call for reordering power dynamics surrounding seeds, people, practices, and land. This re-territorialisation of the seed produces an alternative imaginary in which science and technology are not central drivers of productivist change but a means of connecting people, seeds, and place-based needs in targeted agroecological innovations for food provision and climate adaptation. When biofortified seeds are prioritised over native seeds, local ways of doing and knowing are relegated as inferior through de-territorialising, disembedding, and breaking down the seed into constituent components. Boundary work undertaken in international and national agricultural research agendas delineates seeds as genetic resources that should be placed into germplasm banks for imagined future scenarios. The complex sociocultural histories and local knowledge embedded within the seeds are displaced in controlling seeds as docile subjects, reflecting how racialised peoples have historically been displaced in rural Colombia. The dominant sociotechnical and alternative imaginaries within the seed system can only be brought into better dialogue by first addressing the racialisation of seeds and people and the fragmentation of territories in reproducing these socially constructed categorisations.

CHAPTER 8: CONCLUSION

Throughout this thesis I have explored seed practices in Colombia and highlighted how science, technology and social relations are co-produced through the ways that seeds are used to improve the sustainability of agricultural systems. To do this, I put forward the following research questions: How do people think about, use, and (re)produce seeds in Colombia? How are different knowledge systems embedded and fragmented in relation to seeds in Colombia? How are discourses and power reproduced through the governance of seeds and the imaginings of future sustainabilities for the Colombian seed system?

In Chapter 1, I introduced the contestations surrounding seeds in a global and national context, referring to sociocultural, ecological, economic, and legal debates that play out in power struggles at local, national, and international scales. The Colombian seed system was set as the problem context with mainstream productivist development and contesting alternative local agroecological practices producing a dilemma of differently conceptualised sustainable future seed systems. In Chapter 2, I explored the literature on the politics, legislation, and development trajectories within the Colombian agricultural and seed system. Specifically, I looked at the role of different actors and policies. I drew on interdisciplinary academic contributions in the areas of seed standardization, patenting, and regulation, in parallel to the areas of rural social mobilisation, seed saving, and seed sovereignty. In Chapter 3 I set out a theoretical framework for this thesis within Science and Technology Studies (STS), using the interrelated concepts of boundary work, racialisation, territorialisation, and sociotechnical imaginaries. In Chapter 4, I described the methodology and ethics of this inductive, reflexive, qualitative research in which I undertook 32 interviews, participated in four seed workshops and two field days across study sites in Colombia.

In Chapter 5, I showed how people think about seeds through categorical differences that can be understood through applying racial thinking. Certain genetically 'pure' seeds are selected and reproduced in modern breeding based on socially constructed ideas of racial difference in which an improved seed is one that can be certified, regulated, and controlled. The use and (re)production of the improved seeds was problematised as a form of recycling of uniformity (Vellvé 2009). This was shown to be contributing to a massive reduction in the genetic and cultural diversity of Colombia. The answer to the reduced biodiversity and threat of climate change can be framed by the 'real science' that is undertaken in breeding programmes where improved seeds can be manipulated into a homogenous solution to be globally applied. Scientific knowledge is used in these seed practices to assert authority and protect prestige as international and national institutions draw on technoscientific researchers' and breeders' input. This is the undertaking of boundary

work, which relegates certain seeds as more legitimate and deserving of funding, while the local racialised seeds and seed savers are systematically excluded. The racialisation of peoples and seeds in Colombia was also tied to disciplinary power in the creation of categorisations that make controllable subjects. The result is a fragmentation in the seed system in which different ways of doing and knowing are separated and made incompatible.

In Chapter 6, I used the concept of territoriality to explore how specific practices of seed saving relate to knowledge systems and discourses. The territorialisation of land and seeds in Colombia has been contingent upon historical racialisation and displacement occurring throughout colonisation, civil wars, and neoliberal agricultural development. Territorialisation of the seed system was shown to have fragmented identities and agrobiodiversity. I also explored how as seeds are de-territorialised in *ex situ* seed saving, local traditional knowledge and users of that knowledge are relegated as inferior to the rational objectivity of western scientific evidence. It was demonstrated that formal and informal actors alike recognise science needs to retain an economic value for projects to be funded and scaled up and out. This explained the protection of the prestige and authority of scientific knowledge and practices within modern breeding, hybridisation, and industrial production programmes that excludes local input. Embedded in the practices of *ex situ* seed saving are discourses of development and technoscientific modernity. Positioned against these hegemonic discourses of neoliberalism are alternative discourses of food and seed sovereignty that were shown to be produced through agroecological practices of re-territorialisation by local actors at the community level via *in situ* seed saving. This had implications for co-producing contesting sociotechnical and alternative imaginaries for sustainability in the seed system.

In Chapter 7, I looked specifically at the (re)production of seeds, discourses, and power dynamics across international, national, and local scales in Colombia. This chapter tied together the three research questions and the theoretical concepts showing how people use and (re)produce certain seeds, drawing on situated knowledge systems that reinforce discourses and co-produce realities in which contested seed practices fragment the sustainability of the seed system. At the international scale, scientific experts in research organisations undertake boundary work that condition and constrain racialised seeds, producing a technoscientific improved class of seed. Technoscientific seeds are de-territorialised and disembedded from geographical, historical, sociocultural, agroecological, economic, and public health contexts. These seeds are manipulated, banked, grown out under controlled conditions, and multiplied. The aim is to release the silver bullet technoscientific seed into a globalised (placeless) world for homogenous (cultureless) populations in an attempt to solve the complex problems of climate change and world hunger with

a simple solution. At the national level, state and private producer association actors have formed coalitions that reproduce the sociotechnical imaginary through technological transfers, subsidies, and support for export-based industrialised (often non-food) crops, creating international trade dependencies. At the local level, in Cauca Valley a contesting collective imaginary was seen as explicitly resisting the agricultural industrialisation manifest in the territorialisation of sugar cane. A holistic vision of sustainable transformation was held by the Afro-Colombian Community Council members who undertook agroecology and organic farming practices in recreating the traditional finca system and re-territorialising traditional seeds and knowledge. This vision was also held by local communities involved with the education and practical outreach programmes of Grupo Semillas, FUNDAEC, and the RSL. In the alternative imaginary for a sustainable seed system, social equity and community solidarity are prioritised in the production of local-scale economies that can provide diverse and healthy diets to local populations. This model of agriculture and food provision is incompatible with the productivity and profit of modern industrialised agriculture.

This thesis contributes theoretically to the STS discipline through connecting the concepts of racialisation, boundary work, territorialisation, and sociotechnical imaginaries. These interrelated concepts help to explain the current state of social inequity, agrobiodiversity loss, and economic precarity in the fragmented Colombian seed system. Empirically, this thesis also contributes to the literature on the Colombian agricultural and seed systems by exposing the disciplinary power dynamics enforced through modern breeding as technoscientific seeds are reproduced as controllable subjects and control over racialised communities is reinforced. In Colombia, the historic rifts between racialised peoples and seeds are reproduced through the sociotechnical imaginary of modern agricultural development. It is not just science and technologies that need to be reordered (Jasanoff 2017). This research contributes to the extensive literature in STS that addresses the pressing need to reconsider how our social world is ordered in a way that enables the status of 'expert' to be applied to scientists, giving credibility to scientific knowledge claims, while systematically excluding others (Collins, Evans, and Weinel 2017). As experts do and communicate science unilaterally, a socially constructed hierarchy of superiority orders social life, reinforcing the hegemony of technoscientific modernity. In this research, claims made by scientific experts about the benefits of hybrid, certified, and biofortified seeds sidelined small-scale seed producers' knowledge and values as they were considered as an afterthought; after the 'real' science had been done.

Although there is a significant empirical base for seed struggles globally and in Colombia (Aistara 2011; Goyes 2018; Gutiérrez Escobar and Fitting 2016; Hernández Vidal 2022b; Kloppenburg 1988), future research should turn more to how to action participatory processes for improving public access and involvement in negotiations of seed policy, research and development (Almekinders and Louwaars 2008). Consideration of how local and traditional knowledge can be valued and centred in conversations on seed system sustainability currently dominated by scientific knowledge is required. Participatory research was beyond the scope of this research, but it would be beneficial to use participatory and decolonial processes to explore future pathways for seed system sustainability and potential (in)comptabilities with technoscientific solutions. The findings in this area will have important implications beyond seeds in the agricultural system, especially as recent developments of other adaptive technologies such as Climate Smart Agriculture are deployed in Colombia and globally (Green 2021).

To conclude, this thesis shows how historical categorisations of race construct legible hierarchies in people and seeds, exacerbated through territorialisation where marginalised populations have been displaced from the land and disembedded from sociocultural context. The fragmented and racialised seeds, communities, and knowledge systems are firstly made legible and then made into controllable subjects in which characteristics of purity are protected at the expense of agrobiodiversity. Throughout the reproduction of modern technoscientific seeds, the boundary work undertaken by scientists and policymakers reinstates a sociotechnical imaginary of seed system sustainability. On the other side of this socially constructed 'non-science' boundary are local actors that are re-territorialising native seeds and producing alternative imaginings of holistic sustainability that decentre economic profit and put forward a seed sovereign path to feeding people and facing the impacts of climate change. As the farmer Mario Diez said to me in an early interview in Bogotá, "The seed is the metaphor of existence," therefore it is of utmost importance in future trajectories to consider how to enhance existence for all human and non-human actors. This requires we address the histories of oppression that condition and constrain seed system sustainability, enabling a more equitable and resilient future food system for all.

Appendix A

Table 1. A table of the 32 interviewees (pseudonyms) and corresponding demographic data with international, national, and local scale categorisations of role in the Colombian seed system.

		Interviewee	**Gender**	**Age range**	**Organisation**	**Role**	Total (n)
FORMAL	INTERNATIONAL	Mateo Medina	Male	60-70	CIAT	Agricultural engineer (bean breeding)	9
		Manuela Rojas	Female	30-40		Agricultural engineer (rice breeding)	
		Rafael Gallardo	Male	50-60		Agricultural engineer (bean breeding)	
		Stuart Green	Male	>70		Agricultural engineer (Coordinator of breeding programme)	
		Ismael Diez	Male	30-40		Agricultural engineer (rice research)	
		Paula Rodriguez	Female	40-50		Research Associate	
		Cristian Ramos	Male	40-50	CIMMYT	Research Associate	
		Alejandra Marquez	Female	50-60	FLAR	Agricultural engineer (rice breeding)	
		Patricia Lopez	Female	30-40	FIAN	Research & Advocacy	
	NATIONAL	Hector Ramirez & Carla Cabrera	Male & Female	50-60	Agrosavia	Research Associates	10
		Emilio Montero	Male	30-40	Baha'i bosque	Administration	
		Fernando Cruz & Julián Gallego	Male & Male	20-30 & 60-70	Cenicaña	Agricultural engineers	

		Hector Vazquez	Male	50-60	FEDEARROZ	Technical Extension Officer	
		Victor Rojas	Male	60-70	FENALCE	Regional Coordinator	
		Gabriel Gimenez	Male	50-60		Research Associate	
		Enrique Gutierrez	Male	50-60	FUNDAEC	Regional Director	
		Ana Rojas	Female	40-50	Impulsemillas	Development & Product Director	
		María Josefa Cortes	Female	50-60	Javeriana Universidad	Professor	
		Xavier Guerrero	Male	20-30	Ministry of Agriculture	Technical Secretary with FEDEARROZ	
INFORMAL	LOCAL	Lucas Zapata	Male	60-70	Community Council		13
		Juan Manuel Dominguez	Male	60-70	Community Council		
		Sonia Caballero	Female	60-70	DAGMA		
		Jaime Hernandez	Male	20-30	Desde la raíz		
		Mario Diez	Male	20-30	Finca		
		Sebastián Reyes	Male	30-40	Finca		
		Alfredo Morales	Male	60-70	Finca		
		Carmen Lucas	Female	50-60	Fundación Manigua Dispensa Botanica		
		Roberto Marin	Male	50-60	Grupo Semillas		
		Samuel Vidal	Male	60-70	Grupo Semillas		

		Eliel Castillo	Male	50-60	Guardianes de Semillas		
		Alvaro Ortiz	Male	30-40	National Indigenous Organisation of Colombia		
		Paula Reyes	Female	20-30	Red de Semillas Libres		
Total (n)							32

Appendix B

Dear Sir/Madam

My name is Rose Fitzgerald. I am a student undertaking a Master of Environmental Science, Management and Policy at Central European University, conducting research with the Universidad de los Andes. My supervisors are Guntra Aistara and Maria Fernanda Mideros Bastidas. I am interested in exploring seeds, seed practices, and the sustainability of agricultural systems in Colombia.

The purpose of this study is to explore how seeds are used, the problems surrounding seeds in the current agricultural system, what kind of factors have influenced the issue, what the future looks like for seed practices and the agricultural system in Colombia.

I would like to invite you to take part in an interview. If you choose to participate the interview would take approximately one hour. With your permission, I would like to audio record the interview so that I can go back over what we talk about later, especially to try to understand the translations. This data will be stored on my computer, only I will have access to it, and the audio files will be deleted after my researching ends in June this year.

The conversation will be confidential and anonymous unless otherwise agreed. I will not include your name or anything else that could identify you, I will use pseudonyms. Your participation is voluntary. You can stop being in the study at any time. You do not have to answer any questions if you do not want to. You will not get any direct benefits if you choose to join the research study. Taking part in the research study will not cost you anything and you will not be paid for being in this research study.

The risks for this research study are no more than what happens in everyday life. If any of the questions asked make you feel uncomfortable, do not feel obliged to answer. Please let me know if this is the case, and we will move on from the topic or stop the interview with the option to continue at a later time.

The insights gained from this research will be used to write a master's thesis and a summary report of the findings will be written and can be made available to you after June this year.

If at any time you have questions about this research study, feel free to contact me or my supervisors through the contact details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact my supervisors.

Yours sincerely,
Rose Fitzgerald Phone: +64 21 294 2058
Email: rose.fitzgerald@mespom.eu

Supervisors:
Guntra Aistara, Central European University
Email: AistaraG@ceu.edu Phone: +43 660 368 4072
Maria Fernanda Mideros Bastidas, Universidad de los Andes
Email: mf.mideros35@uniandes.edu.co

Estimado Sr./Sra.

Me llamo Rose Fitzgerald. Soy estudiante del Máster en Ciencias, Gestión y Política Medioambientales de la Universidad Centroeuropea y colaboro en la investigación con la Universidad de los Andes. Mis supervisoras son Guntra Aistara y Maria Fernanda Mideros Bastidas. Me interesa explorar las semillas, las prácticas con semillas y la sostenibilidad de los sistemas agrícolas en Colombia.

El propósito de este estudio es explorar cómo se utilizan las semillas, los problemas que rodean a las semillas en el sistema agrícola actual, qué tipo de factores han influido en el tema, cómo se ve el futuro para las prácticas de semillas y el sistema agrícola en Colombia.

Me gustaría invitarle a participar en una entrevista. Si decide participar, la entrevista duraría aproximadamente una hora. Con su permiso, me gustaría grabar la entrevista para poder repasar lo que hablemos más adelante, sobre todo para intentar entender las traducciones. Estos datos se guardarán en mi ordenador, sólo yo tendré acceso a ellos, y los archivos de audio se borrarán cuando termine mi investigación en junio de este año.

La conversación será confidencial y anónima a menos que se acuerde lo contrario. No incluiré su nombre ni nada que pueda identificarle, utilizaré seudónimos. Su participación es voluntaria. Puede dejar de participar en el estudio en cualquier momento. No tiene que responder a ninguna pregunta si no lo desea. No obtendrá ningún beneficio directo si decide participar en el estudio de investigación. Participar en el estudio de investigación no le costará nada y no se le pagará por estar en este estudio de investigación.

Los riesgos de este estudio de investigación no son más que los de la vida cotidiana. Si alguna de las preguntas formuladas le hace sentirse incómodo, no se sienta obligado a contestar. Por favor, hágamelo saber en ese caso, y pasaremos del tema o interrumpiremos la entrevista con la opción de continuarla en otro momento.

Los resultados de esta investigación se utilizarán para escribir una tesis de máster y se redactará un informe resumido de las conclusiones, que podrá estar a su disposición después de junio de este año.

Si en algún momento tiene preguntas sobre este estudio de investigación, no dude en ponerse en contacto conmigo o con mis supervisores a través de los datos de contacto que figuran a continuación. Si tiene alguna duda o queja sobre los procedimientos éticos de este estudio de investigación, puede ponerse en contacto con mis supervisores.

Atentamente,
Rose Fitzgerald Teléfono +64 21 294 2058
Correo electrónico: rose.fitzgerald@mespom.eu

Supervisores:
Guntra Aistara, Universidad Centroeuropea
Correo electrónico AistaraG@ceu.edu Teléfono: +43 660 368 4072
Maria Fernanda Mideros Bastidas, Universidad de los Andes
Correo electrónico: mf.mideros35@uniandes.edu.co

CONSENT FOR INTERVIEW

Exploring seeds, seed practices, and sustainability of agricultural systems in Colombia.

Name and position:

_____

- The participant wants their identity to remain anonymous.

  YES NO

- This research has been explained and the participant has been given an opportunity to ask questions for clarification. The participant agrees that they understand what this study is about.

  YES NO

- The participant understands that their participation in this study is voluntary.

  YES NO

- The participant gives their consent to participate in this study.

  YES NO

- The participant agrees that this discussion may be audio recorded.

  YES NO

- The participant agrees that quotations from the interview may be reported in a research report and thesis set of statements, without mentioning names, unless otherwise specified.

  YES NO

Name:

Signature:

Date: ___ / ___ / ___

CONSENTIMIENTO PARA LA ENTREVISTA

Explorando las semillas, las prácticas con semillas y la sostenibilidad de los sistemas agrícolas en Colombia.

Nombre y cargo:

- El participante desea que su identidad permanezca en el anonimato.

  SÍ NO

- Se ha explicado esta investigación y se ha dado al participante la oportunidad de hacer preguntas aclaratorias. El participante acepta que entiende de qué trata este estudio.

  SÍ NO

- El participante entiende que su participación en este estudio es voluntaria.

  SÍ NO

- El participante da su consentimiento para participar en este estudio.

  SÍ NO

- El participante acepta que esta conversación pueda ser grabado.

  SÍ NO

- El participante acepta que las citas de la entrevista se incluyan en un informe de investigación y en un conjunto de declaraciones de tesis, sin mencionar nombres, a menos que se especifique lo contrario.

  SÍ NO

Nombre:

Firma:

Fecha: ___ / ___ / ___

Interview questions for gardeners and growers – preguntas para entrevistar a los agricultores

Number – número

Background & agricultural system – antecedents y sistema de agricultura

- Can you tell me about the type of farming or gardening that you do?
  ¿Puede hablarme del tipo de agricultura que practica?

- How long have you been doing farming?
  ¿Cuánto tiempo lleva cultivando?

- How did you learn to cultivate?
  ¿Cómo aprendió a cultivar la tierra?

- What do you grow or how many different products do you grow?
  ¿Qué cultiva o cuántos productos diferentes cultiva?

- How do you decide where to plant different crops, that is, do you grow each crop separately or do you grow them together?
  ¿Cómo decide dónde plantar los diferentes cultivos, es decir, cultiva cada cultivo por separado o los cultiva juntos?

- How do you manage issues like weeds and pests?
  ¿Cómo se gestiona problemas como las malas hierbas y las plagas?

- What do you do with your produce?
  ¿Qué hace con sus productos?

- Do you farm full-time (is this your only source of income) or do you do farm part-time with other sources of income?
  ¿Agricula a tiempo complete (es su única Fuente de ingresos) o lo hace a tiempo parcial con otras fuentes de ingresos (es la agricultura una actividad no remunerada para usted)?

- Do you use any technology or mechanization in your farming, for what purposes and how important is it?
  ¿Utiliza alguna tecnología o mecanización en su explotación, con qué fines y qué importancia tiene?

We have been talking about your farming. Now I want to ask more specifically about seeds.
Hemos hablado de su agricultura. Ahora quiero preguntarle más concretamente sobre las semillas.

Seed system – sistema de semillas

- Where do you get your seeds from? [Which seeds do you buy and why?] [Do you exchange seeds with anyone and why?]
  ¿De dónde obtiene sus semillas? [Qué semillas compra y por qué?] [¿Intercambia semillas con alguien y por qué?]

- What seeds do you save and reproduce yourself, and how do you decide this?
  ¿Qué semillas guarda y reproduce usted mismo, y cómo decide esto?

- Have you received any seeds from government or aid organizations? If so please tell me if you know who they are and what conditions must be met to get the funding.
  ¿Ha recibido semillas del gobierno o de organizaciones de ayuda? Si es así, por favor dígame si sabe quiénes son y qué condiciones deben cumplirse para obtener la financiación.

- Where and how did you learn about seeds?
  ¿Dónde y cómo conoció las semillas?

- How do you get information on seeds? [Are there education programmes or outreach initiatives?]
  ¿Cómo se obtiene información sobre las semillas? [¿Existen programas educativos o iniciativs de divulgación]?

- Do you share your knowledge about seeds? If so, please tell me how you share this knowledge and with whom.
  ¿Comparte sus conocimientos sobre semillas? En caso afirmativo, por favor dígame cómo comparte estos conocimientos y con quién.

- What is the seed production process like [on your farm] [in your garden]? (saving, exchanging, distribution, breeding, selling)
  ¿Cómo es el proceso de producción de semillas [en su campo][en su huerto]? (guardar, intercambiar, distribuir, criar, vender)

- Do you have to follow any regulations or laws to reproduce seeds or share them with others? Do seeds have to be registered or certified? If so, what kinds of seeds and does this cost anything?
  ¿Hay que cumplir alguna normative o ley para reproducer semillas or compartirlas con otros? ¿Hay que registrar o certificar las semillas? En caso afirmativo, ¿Qué tipo de semillas y tiene algún coste?

- Do you have a community seed bank or other ways to share seeds with others? If so, please can you tell me about these.
  ¿Tiene un banco de semillas comunitario o otras formas de compartir semillas con los demás? En caso afirmativo, por favor puede hablarme sobre estos.

- Can you tell me about the markets or shops that you or people in the community use to buy or sell seeds?
  ¿Puede hablarme de los mercardos o tiendas que usted o la gente de la comunidad utilizan para comprar o vender semillas?

- Have you collaborated with the gene bank? Why or why not?
  ¿Ha colaborado con el banco de genes? Por qué o por qué no?

We have been talking about the seed system. Now I want to finish with some questions about changes, challenges and the future.
Hemos hablado del Sistema de semillas. Ahora quiero terminar con algunas preguntas sobre los cambios, los retos, y el future.

Changes, challenges, and the future – cambios, retos, y futuro

- What are the biggest challenges you face as a farmer involved in seed production?
  ¿Cuáles son los mayores retos a los que se enfrenta como agricultor dedicado a la producción de semillas?

- What are the biggest changes you have noticed in the seed system in the past ten years?
  ¿Cuáles son los mayores cambios que ha observado en el Sistema de semillas en los últimos diez años?

- Were you or farmers you know involved in the protests and social movements after seed legislation changed in Colombia, restricting the saving, and exchanging of non-registered and non-certified seeds?
  ¿Usted o los agricultores que conoce participaron en las protestas y movimientos sociales que she produjeron tras el cambio de la legislación sobre semillas en Colombia, que restringía la conservación y el intercambio de semillas no registradas y no certificadas?

- What could be done to help improve the local seed system and your farming?
  ¿Qué se podría hacer para ayudar a mejorar el Sistema local de semillas y su agricultura?
  - What types of seeds and seed practices should be used to improve the local seed system?
    ¿Qué tipos de semillas y practices semilleras deben utilizarse para mejorar el Sistema local de semillas?

- How, if at all, do you consider the issue of climate change in relation to your farming?
  ¿Cómo considera, si es que lo considera, la cuestión del cambio climático en relación con su agricultura?

Final questions – preguntas finales

- Is there anyone that you could recommend I speak to about the seed system and practices in Colombia?
  ¿Podría recomendarme que hable con alguien que considere especialmente entendido en semillas en Colombia?

- Finally, is there anything else you would like to share with me that you might think is important?
  Por ultimo, ¿hay algo más quiera compartir conmigo y que considere importante?

Demographics - demografia

Gender – género

Age group – grupo de edad

Organization – organización

Position – posición

Education – educación

Interview questions for researchers/ organizations – Preguntas de la entrevista para investigadores/organizaciones

Number – número

Background – antecedents

- Can you tell me about the work and the objectives of your [organisation] [research] [project]?
  ¿Puede hablarme del trabajo y los objetivos de su [organización] [investigación] [proyecto]?

- If you can, please explain a bit about the history of your [organisation] [research][project].
  Si puede, explíquenos un poco la historia de su [organización] [investigación] [proyecto].

- Please describe what your role is within this [organisation] [research][project]
  Por favor, describa cuál es su función en esta [organización] [investigación] [proyecto].

- How long have you worked here?
  ¿Cuánto tiempo lleva trabajando aquí?

- What aspects of the seed system are you involved in?
  ¿En qué aspectos del sistema de semillas participa?

- Do you work directly with farmers? How?
  ¿Trabaja directamente con los agricultores? ¿Cómo?
    - How would you evaluate your cooperation with them?
      ¿Cómo evaluaría su cooperación con ellos?

We have been talking about your research more generally. Now I want to ask more specifically about seeds.
Hemos hablado de su investigación en general. Ahora quiero preguntarle más concretamente sobre las semillas.

Seed system – sistema de semillas

- What is the seed production process like in your [organisation][group][project]?
  ¿Cómo es el proceso de producción de semillas en su [organización] [grupo] [proyecto]?
    - Is this similar or different to the seed production process in the rest of Colombia? (saving, exchanging, distribution, breeding, selling)
      ¿Es similar o diferente al proceso de producción de semillas en el resto de Colombia? (guardar, intercambiar, distribuir, criar, vender)

- How does your [organisation] [group][project] work with seeds?
  ¿Cómo trabaja su [organización] [grupo] [proyecto] con las semillas?

- What kinds of seeds do you store in the gene bank? What qualities of seeds are important in deciding which seeds to preserve? How are they chosen and by whom?

¿Qué tipos de semillas se conservan en el banco de genes? ¿Qué cualidades de las semillas son importantes a la hora de decidir qué semillas conservar? ¿Cómo se eligen y quién las elige?

- What conditions are they stored in? What kind of information about the seeds is stored with them? How often are they reproduced and by whom? Under what conditions?
  ¿En qué condiciones se almacenan? ¿Qué tipo de información sobre las semillas se almacena con ellas? ¿Con qué frecuencia se reproducen y quién lo hace? ¿En qué condiciones?

- Can farmers access seeds from the gene bank? Under what conditions and for what purposes?
  ¿Pueden los agricultores acceder a las semillas del banco de genes? ¿En qué condiciones y con qué fines?
    - What other stakeholders have access to the seeds in the gene bank? Under what conditions and for what purposes?
      ¿Qué otras partes interesadas tienen acceso a las semillas del banco de genes? ¿En qué condiciones y con qué fines?

- Does your [organisation] [group][project] educate or share knowledge with farmers about seeds and seed practices?
  ¿Su [organización] [grupo] [proyecto] educa o comparte conocimientos con los agricultores sobre semillas y prácticas con semillas?

- As far as you know, are there any local projects or programmes that support or educate farmers? Are there any important community organizations or social movements working on seeds and seed issues? How do you evaluate their work?
  Hasta donde usted sabe, ¿existen proyectos o programas locales que apoyen o eduquen a los agricultores? ¿Existen organizaciones comunitarias o movimientos sociales importantes que trabajen en el ámbito de las semillas? ¿Cómo valora su trabajo?

- How is the market involved in the seed production process?
  ¿Cómo interviene el mercado en el proceso de producción de semillas?
    - Is the mainstream market or informal market more important for seed production? Why?
      ¿Es más importante el mercado general o el informal para la producción de semillas? ¿Por qué?

- Do seeds have to be registered or certified? If so, what kinds of seeds and does this cost?
  ¿Hay que registrar o certificar las semillas? En caso afirmativo, ¿qué tipo de semillas y cuánto cuesta?

- How important is the role of the farmer in the Colombian seed system?
  ¿Qué importancia tiene el papel del agricultor en el sistema de semillas colombiano?

- How do most farmers in Colombia manage their seeds? How knowledgeable are farmers about seeds and seed reproduction and management? Are there any problems with farmer seeds? How has your organization tried to work with farmers to share information/ influence their practices?
  ¿Cómo gestionan sus semillas la mayoría de los agricultores de Colombia? ¿Qué conocimientos tienen los agricultores sobre las semillas y su reproducción y gestión? ¿Existen problemas con las semillas de los agricultores? ¿Cómo ha intentado su organización trabajar con los agricultores para compartir información/influir en sus prácticas?

- Who do you consider to be an expert on seeds, seed saving, and cultivation?

¿A quién considera un experto en semillas, conservación de semillas y cultivo?

- How important is the role of technology in the Colombian seed system?
  ¿Qué importancia tiene la tecnología en el sistema de semillas colombiano?

- How important is the role of the government in the Colombian seed system?
  ¿Qué importancia tiene el papel del gobierno en el sistema de semillas colombiano?

- How important are funding organizations to the Colombian seed system?
  ¿Qué importancia tienen las organizaciones de financiación para el sistema de semillas colombiano?

We have been talking about the seed system. Now I want to finish with some questions about changes, challenges and the future.
Hemos hablado del Sistema de semillas. Ahora quiero terminar con algunas preguntas sobre los cambios, los retos, y el future.

Changes, challenges, and the future – cambios, retos, y futuro

- What are some of the biggest changes you have noticed in the seed system in the past ten years?
  ¿Cuáles son los mayores cambios que ha observado en el Sistema de semillas en los últimos diez años?
  - How have these changes affected farmers?
    ¿Cómo han afectado estos cambios a los agricultores?

- Can you explain to me the recent changes in seed legislation in Colombia? Who enacted it and why? What were the goals of the changes? Did your [organization][group][project] play a role in the process, or in the resulting political negotiations or social movement?
  ¿Puede explicarme los recientes cambios en la legislación sobre semillas en Colombia? ¿Quién la promulgó y por qué? ¿Cuáles eran los objetivos de los cambios? ¿Tuvo tu [organización][grupo][proyecto] algún papel en el proceso, o en las negociaciones políticas o el movimiento social resultante?

- What are the local vulnerabilities and challenges in the seed system?
  ¿Cuáles son las vulnerabilidades y los retos locales del sistema de semillas?

- What needs to be prioritised in improving seed practices in Colombia?
  ¿Qué hay que priorizar para mejorar las prácticas de siembra en Colombia?

- Who should be involved in the effort to improve seed practices in Colombia?
  ¿Quién debe participar en el esfuerzo por mejorar las prácticas de siembra en Colombia?

- What does it mean for seed practices and the food system itself to be sustainable?
  ¿Qué significa que las prácticas con semillas y el propio sistema alimentario sean sostenibles?

- What kinds of seeds and seed practices should be used to improve the local food system?
  ¿Qué tipos de semillas y practices semilleras deben utilizarse para mejorar el Sistema local de semillas?

- How, if at all, does your [organization][group][project] consider the issue of climate change? How has it affected seed production in Colombia? How has it affected farmers

more generally? What is being done to combat or adapt to these changes? What kinds of seed are most important in adapting to climate change?
¿Cómo considera su [organización][grupo][proyecto] la cuestión del cambio climático? ¿Cómo ha afectado a la producción de semillas en Colombia? ¿Cómo ha afectado a los agricultores en general? ¿Qué se está haciendo para combatir estos cambios o adaptarse a ellos? ¿Qué tipo de semillas son las más importantes para adaptarse al cambio climático?

Final questions – preguntas finales

- Is there anyone that you could recommend I speak to about the seed system and practices in Colombia?
  ¿Podría recomendarme que hable con alguien que considere especialmente entendido en semillas en Colombia?

- Finally, is there anything else you would like to share with me that you might think is important?
  Por ultimo, ¿hay algo más quiera compartir conmigo y que considere importante?

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