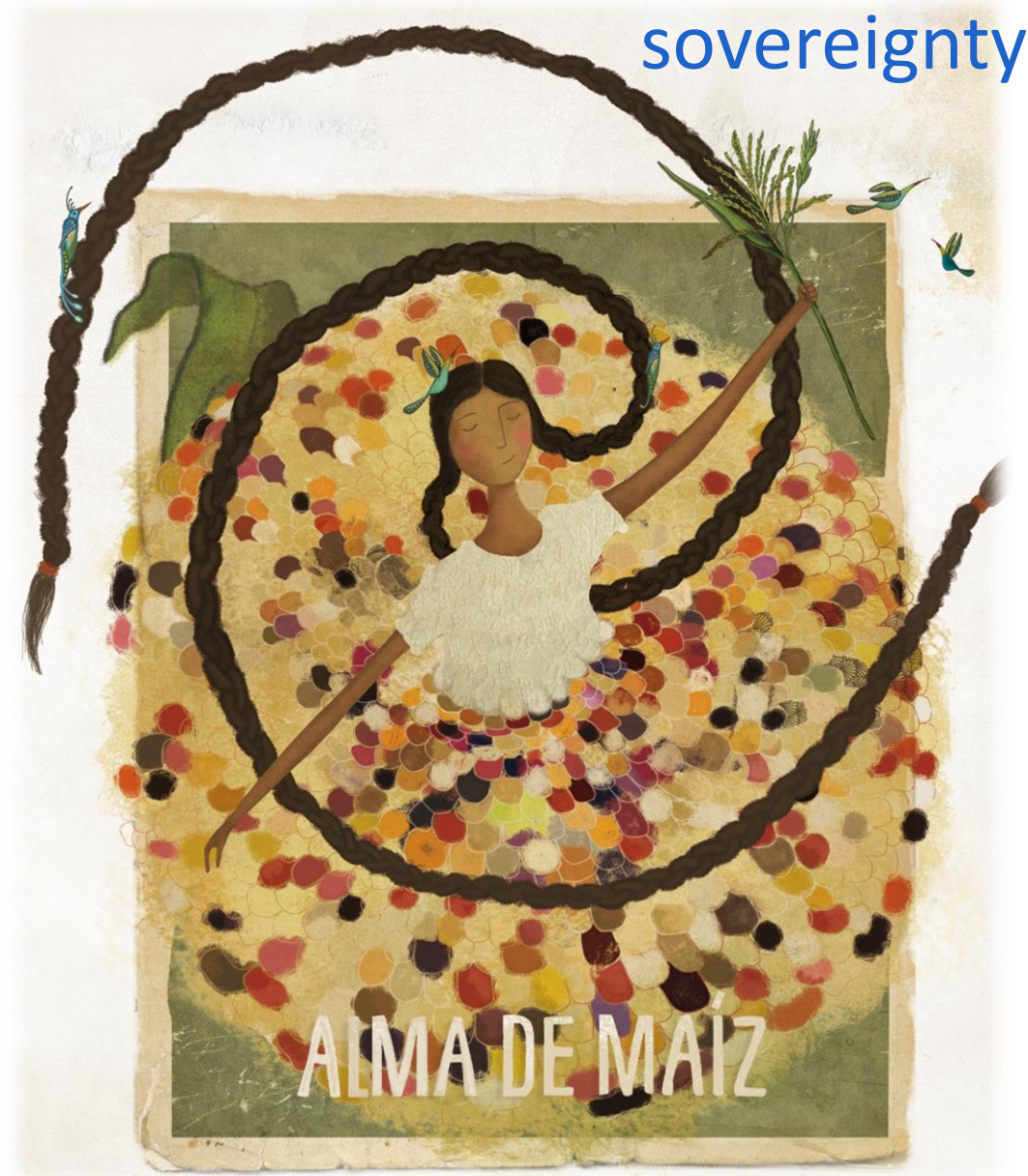


Operationalizing transdisciplinary agroecology for the co-creation of food sovereignty



Helga Gruberg Cazón

Promoters:

Prof. dr. ir. Joost Dessen

Department of Agricultural Economics, Ghent University, Belgium

Prof. dr. ir. Marijke D'Haese

Department of Agricultural Economics, Ghent University, Belgium

Prof. dr. Jean Paul Benavides

Instituto de Investigaciones Socio-económicas, Universidad Católica Boliviana "San Pablo",
Bolivia

Dean: Prof. dr. Els Van Damme

Rector: Prof. dr. Rik Van de Walle

**Operationalizing transdisciplinary agroecology for the co-creation of food
sovereignty**

Helga Gruberg Cazón

Thesis submitted in fulfilment of the requirements for the degree of “Doctor of
Bioscience Engineering: Socioeconomics”

Dutch translation:

Titel: Operationaliseren van transdisciplinaire agro-ecologie voor de co-creatie van voedselsoevereiniteit

Citation: Gruberg, H. 2023. Operationalizing transdisciplinary agroecology for the co-creation of food sovereignty. Ghent University, Belgium.

ISBN-number: 9789463575850

Cover page:

“Alma de maíz” by Ada Esquirol and Mariana Dotzauer

Eduardo Abaroa Plurinational State Award - 2018

www.eltaburetecg.com

Financial support: The research work of the dissertation was funded by VLIR UOS (Vlaamse Interuniversitaire Raad University Development Cooperation)

The author and the promoters give the authorization to consult and to copy parts of this work for personal use only. Every other use is subject to copyright laws. Permission to reproduce any material contained in this work should be obtained from the author.

Members of the examination board

Prof. dr. ir. Joost Dessein (Promoter)

Department of Agricultural Economics, Ghent University, Belgium

Prof. dr. ir. Marijke D´Haese (Promoter)

Department of Agricultural Economics, Ghent University, Belgium

Prof. dr. Jean Paul Benavides (Project Coordinator)

Instituto de Investigaciones Socio-económicas, Universidad Católica Boliviana “San Pablo”, Bolivia

Prof. dr. ir. Veerle Fievez (Chair)

Department of Animal Sciences and Aquatic Ecology, Ghent University, Belgium

Prof. dr. ir. Peter Goethals (Secretary)

Department of Animal Sciences and Aquatic Ecology, Ghent University, Belgium

Prof. dr. Gianluca Brunori

Department of Agriculture, Food and Environment, University of Pisa, Italy

Prof. dr. Maarten Crivits

Flanders Research Institute for Agriculture, Fisheries and Food, Belgium

Prof. dr. ir. Stijn Speelman

Department of agricultural economics, Ghent University, Belgium

To my son Sami

Acknowledgements

If I could plant a tree for all those people who supported me through the PhD process, I would have a beautiful and colorful forest. I thank you all infinitely for your support and love.

First, I want to thank my supervisors Joost, Marijke and Jean Paul who came together to give me a solid base to lean on. You became the meeting point between the complex realities of Bolivia and Belgium. One by one you helped me pass the challenges that came, making my insecurities vanish. A massive thanks goes to Joost for making this journey so enriching and making it so much easier and enjoyable. I appreciate all the laughs in our meetings. I am especially grateful for all the times you helped touch the ground when my head was spinning in confusion. Marijke, I am most notably thankful for your loving guidance, for all the time you invested, not only reviewing my work, and giving me critical insights that took it to the “next level”, but also for all the time you spent listening to me and caring for Sami. Jean Paul thank you for always taking me out of my comfort zone. Our conversation about Latin-American sociology and Marxism will stay with me forever as a pivotal point in my doctoral education. Thank you for giving so much space to experiment and finding my own voice as a researcher. Joost, Marijke and Jean Paul, you guided me through the metamorphosis from engineering to sociology/anthropology, which is not an easy task. I also want to thank Toby for encouraging me to pursue this journey.

This thesis study is part of Project 3 of the VLIR UOS IUC with Universidad Católica Boliviana “San Pablo” Program in Bolivia. I am grateful for the financial support to develop extensive transdisciplinary research in Tiraque. I am convinced that the program's efforts to increase the resilience of vulnerable communities in Bolivia are bearing fruit and will positively transform them. I would like to express my gratitude to Marcela for investing so much effort since day one to make any barrier on my way disappear. Likewise, I am thankful to Mark and Gerrit for your insights on transdisciplinarity and community-based participatory research in chapters 1 and 3 of the dissertation.

I thank the Universidad Católica “San Pablo”, the Exact Sciences and Engineering Research Center and CREA for having trusted me to be able to carry out this challenge. Each of the people from these institutions supported me, from resolving administrative issues to giving me words of support when I needed it most. Infinite thanks to Mauricio, Estela, Jaime, Wanderley, Gonzalo, Laurita, Eliana, Carlitos, Marcelo, Wen, Juanpi, Edwin, Marcela, Ivone, Paola, Alfonso, Romel and Dr. Renan (RIP). The same goes for the University of Ghent, where everyone, in many ways, helped me, even with personal issues, making the doctoral visits, with my little one, happy and memorable. In this regard, an especial thanks go to Lieve, Sibylle, Inge, Nancy, and Stephan. Also, I am thankful to my colleagues in Ghent, although we shared a brief time, I always enjoyed it. Thank you to the female power in the office: Fatemeh, Natalia, Branwen, Annelien, Sara, Eline, and Amber.

Every day, I am grateful for the blessing that the doctorate gave me by meeting my fellow doctoral students in Bolivia. A word of genuine appreciation goes to Celeste, Inti, Roco and Zorel, who through empathy, laughter, conversations and sometimes tears made this process so enriching and enjoyable. Hand in hand, we helped each other to continue and grow together through the process of the PhD. Uncountable times you made my fears go away and helped me find myself when I was lost. Maria, every day I thank the PhD for finding a sister in you.

Thank you to the students, research assistants and interns who passionately participated in this process of innovating in the co-creation of food sovereignty. Martin words fall short to express the deep gratitude I have for you as a colleague and friend. I am sure that this thesis

would not be a reality if it were not for you. Nataly I am profoundly grateful for your collaboration, especially during the last months of the PhD.

I wish to express especial gratitude to the communities of Virvini and Carhun Mayu, the Municipality of Tiraque, the social organizations of Tiraque, the Youth Council of Tiraque, the Agroecological Committee of Tiraque, Tata Estaban, Fé y Alegría, and to the staff, students and parents from the schools J.J. Carrasco and Jesus Terceros. I am thankful for opening your doors and giving me the opportunity to share and collaborate with you throughout this time. I owe my deepest gratitude to don Olegario and doña Irene from Virvini who trusted the process from the beginning and invested so much time, knowledge, and effort.

Belgium would not be the same without Janne and Dimi. Every single time, you manage to give me a sense of family. You have the power to take me back to beautiful memories from Wageningen while creating amazing new ones. When I am with you everything seems so much lighter, brighter, and easier. It is pleasant to know that time only makes my feelings toward you stronger. Jana, I am so happy to finally meet you and find a friend in you. My dearest Mieke and Billy, Sami and I are the luckiest ones to find a sweet home with you. I will always cherish you as family.

I express my greatest gratitude to Ada and Mariana for the beautiful cover of the book. Honestly, this thesis would not have happened without the help and courage of Nagara, Rocio and Ariel. When I look back to everything that we had overcome to bring me to this point, my heart is filled with gratitude for all those moments in which, as warriors, you stood in the front and protected me, so that no one could stop this process. Thank you, Rocio for being a second mom to me and grandmother to Sami. That reminds me that I have two wonderful families, the natural one and the one that life gave me with brothers and sisters from the heart (you know who you are). Monumental thanks to both families for the love and strength you gave me. I love you.

Gent, 2023

Helga

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION	1
1. GENERAL INTRODUCTION AND RESEARCH SCOPE	2
2. CONCEPTS, RESEARCH GAPS AND CONTEXT	5
2.1 FOOD SOVEREIGNTY	5
2.2 TRANSDISCIPLINARITY	9
2.3 AGROECOLOGY	19
2.4 THEORY OF CHANGE. TRANSDISCIPLINARY AGROECOLOGY	22
2.5 STRUCTURE OF THE DISSERTATION	24
CHAPTER 2. BACKGROUND INFORMATION	26
1. INTRODUCTION.....	27
2. INTER-UNIVERSITY COOPERATION PROGRAM	27
3. FOOD SOVEREIGNTY IN BOLIVIA.....	27
4. AGROECOLOGY IN BOLIVIA.....	31
5. MUNICIPALITY OF TIRAQUE.....	33
CHAPTER 3. METHODOLOGY.....	36
1. INTRODUCTION.....	37
2. MAIN OBJECTIVE AND RESEARCH QUESTIONS	37
3. CASE STUDY APPROACH	38
4. MIXED METHODS	38
5. PRIMARY DATA COLLECTION	38
6. SECONDARY INFORMATION	40
7. TRIANGULATION OF INFORMATION	40
8. REFLEXIVITY	40
9. THREE RESEARCH MOMENTS.....	41
9.1 DIMENSION: PRACTICES.....	41
9.2 DIMENSION: SCIENCE.....	42
9.3 DIMENSION: SOCIAL MOVEMENTS	42
CHAPTER 4. DIMENSION: PRACTICES.....	44
ABSTRACT	45
1. INTRODUCTION.....	45
2. CONCEPTUAL FRAMEWORK.....	47
3. CASE STUDY DESCRIPTION.....	49
4. METHODOLOGY	53
5. RESULTS.....	55
5.1 STARTING POINT.....	55
5.2 INSPIRATIONAL ACTIVITIES	55
5.3 NEGOTIATIONS	61
5.4 ACTION	62
5.5 THE COVID-19 PANDEMIC.....	63
5.6 NEGOTIATIONS	63

5.7 ACTION	64
5.8 INSPIRATION	65
5.9 NEGOTIATIONS	67
5.10 ACTION	68
5.11 WRAPPING UP THE PROCESS	68
6. DISCUSSION	70
7. CONCLUSIONS	76
CHAPTER 5. DIMENSION: SCIENCE	78
ABSTRACT	79
1. INTRODUCTION	79
2. CONCEPTUAL FRAMEWORK	82
3. ANALYTICAL FRAMEWORK	83
4. MATERIALS AND METHODS	83
4.1 CASE STUDY DESCRIPTION	84
4.2 PRIMARY DATA COLLECTION	86
4.3 SECONDARY INFORMATION	87
4.4 DATA ANALYSIS TECHNIQUES	88
5. RESULTS	88
5.1 KNOWLEDGE-PRACTICE-BELIEF COMPLEX FOR WEATHER FORECASTING	88
5.2 TRANSMISSION OF TRADITIONAL ECOLOGICAL KNOWLEDGE	91
5.3 FACTORS THAT AFFECT TRADITIONAL ECOLOGICAL KNOWLEDGE'S TRANSMISSION	93
5.4 STRENGTHENING THE TRANSMISSION OF TRADITIONAL ECOLOGICAL KNOWLEDGE	98
6. DISCUSSION	99
7. CONCLUSIONS	104
CHAPTER 6. DIMENSION: SOCIAL MOVEMENTS	106
ABSTRACT	107
1. INTRODUCTION	107
2. BACKGROUND	111
3. METHODOLOGY: A QUALITATIVE APPROACH TO THE POWER CUBE	114
4. RESULTS	116
4.1 PROCESS TOWARDS A WATER POLICY: A SUMMARY	116
4.2 VISIBLE POWER, KNOWLEDGE, AND PARTICIPATION	118
4.3 HIDDEN POWER, AGENDA, AND INTERESTS	120
4.4 INVISIBLE POWER AND SOCIO-POLITICAL STRUCTURES	123
5. DISCUSSION	124
6. CONCLUSIONS	127
CHAPTER 7. GENERAL DISCUSSIONS AND CONCLUSIONS	129
1. INTRODUCTION	130
2. SYNTHESIS OF THE MAIN FINDINGS	130
2.1 DIMENSION: PRACTICES - HOW CAN A COLLABORATIVE RESEARCH TEAM BE BUILT FOR SOCIETY-DRIVEN TRANSDISCIPLINARY AGROECOLOGY RESEARCH?	130
2.2 DIMENSION: SCIENCE - WHAT ARE THE MAIN SOCIOECOLOGICAL FACTORS THAT IMPACT THE TRANSMISSION OF TRADITIONAL ECOLOGICAL KNOWLEDGE WITHIN AND ACROSS GENERATIONS?	130

2.3 DIMENSION: SOCIAL MOVEMENTS - HOW DO POWER RELATIONS INFLUENCE THE PROCESS OF CO-CREATION OF FOOD SOVEREIGNTY?.....	131
3. GENERAL CONCLUSIONS AND CONTRIBUTIONS	131
3.1 FOLLOWING A SOCIOECOLOGICAL SYSTEM APPROACH	131
3.2 IMPLEMENTING “PHASE 0” FOR THE FORMATION OF COLLABORATIVE RESEARCH TEAMS.....	132
3.3 CONSIDERING POWER RELATIONS	133
3.4 EXPLORING THE STATE OF TRADITIONAL ECOLOGICAL KNOWLEDGE	135
3.5 CONSIDERING SYMBOLIC AND PHYSICAL SPACES.....	135
3.6 CONSTANTLY REFLECTING.....	136
3.7 TRANSDISCIPLINARY AGROECOLOGY IS AS AN ONGOING PROCESS	137
4. FINAL REMARKS	137
REFERENCES	139
APPENDIX 1. MOMENTS IN THE PROCESS OF TRANSDISCIPLINARY RESEARCH BETWEEN 2018 AND 2022 ...	165
APPENDIX 2. INDICATORS, FESTIVITIES, AND RITUALS	168
ACADEMIC CURRICULUM VITAE.....	173

LIST OF FIGURES

FIGURE 1. LEFT: NUMBER OF UNDERNOURISHED PEOPLE RIGHT: PREVALENCE OF UNDERNOURISHMENT	3
FIGURE 2. HISTORY OF FOOD SOVEREIGNTY.....	6
FIGURE 3. TYPOLOGY OF PROBLEMS	13
FIGURE 4. CONCEPTUAL MODEL OF TRANSDISCIPLINARITY	17
FIGURE 5. TRANSDISCIPLINARY AGROECOLOGY FOR THE CO-CREATION OF FOOD SOVEREIGNTY	24
FIGURE 6. STRUCTURE OF THE DISSERTATION	25
FIGURE 7. MUNICIPALITY OF TIRAQUE, COCHABAMBA, BOLIVIA	34
FIGURE 8. SCHEME OF THE ORGANIZATIONAL STRUCTURE OF A DEPARTMENTAL FEDERATION, STRESSING THE IMPORTANT ROLE OF THE CENTRAL PROVINCIAL LEVEL	35
FIGURE 9. TIMELINE OF THE THREE RESEARCH MOMENTS.....	41
FIGURE 10. DEGREES OF INTEGRATION AND STAKEHOLDER INVOLVEMENT IN INTEGRATIVE AND NON-INTEGRATIVE APPROACHES	47
FIGURE 11. LEFT: LARGE-SCALE WORKSHOP. RIGHT: SOCIAL CARTOGRAPHIES	50
FIGURE 12. PROBLEMS IDENTIFIED IN TIRAQUE AS A RESULT OF THE PARTICIPATORY DIAGNOSIS.....	51
FIGURE 13. SCHOOL'S ENTRANCE PAINTING BY ELEMENTARY STUDENTS "HEALTHY AND NUTRITIONAL FOOD THROUGH THE CONSUMPTION OF LOCAL PRODUCTS"	56
FIGURE 14. LEFT: A GROUP OF VISITING WOMEN APPRECIATING THE TREES IN AN AGROFORESTRY PLOT. RIGHT: VISITING FARMERS INCORPORATING <i>TERRA PETRA</i> TO IMPROVE SOIL FERTILITY.....	57
FIGURE 15. LEFT. ELEMENTARY STUDENTS SHARING THEIR EXPERIENCE WITH INTENSIVE GARDENS. RIGHT: PREPARATION OF A BIO-INTENSIVE PLOT	58
FIGURE 16. DRAWING BY A STUDENT ABOUT THE SIGNIFICANCE OF MEALS AS SPACES OF FAMILY ENCOUNTER ENTITLED "WEEKEND"	59
FIGURE 17. LEFT: PAINTING PROCESS OF THE MURAL. RIGHT: FINAL MURAL WITH EVERYONE INVOLVED	60
FIGURE 18. DIFFERENTIATION GAME BETWEEN "FOOD SECURITY" AND "FOOD SOVEREIGNTY" DEVELOPED BY PROJECT 4	61
FIGURE 19. FROM LEFT TO RIGHT: PARTICIPATORY COMMUNITY ZONING, EDAPHOLOGY WORKSHOP, AND SOIL SAMPLING	62
FIGURE 20. LEFT: WATER HARVESTER IN CONSTRUCTION. RIGHT: WATER HARVESTER FINALIZED	64
FIGURE 21. STUDENT USING THE WATER HARVESTED TO IRRIGATE THE SCHOOL GARDEN	65
FIGURE 22. FARMER-TO-FARMER IN CARBUN MAYU, TIRAQUE	66
FIGURE 23. FARMER-TO-FARMER WORKSHOP IN BATALLAS, LA PAZ	66
FIGURE 24. <i>BIOL</i> PREPARATION BY THE UNIVERSITY AND SCHOOL STUDENTS	67
FIGURE 25. STUDENTS WORKING ON THE SCHOOL GARDENS	68
FIGURE 26. LEVELS OF INTEGRATION THROUGHOUT "PHASE 0"	69
FIGURE 27. PROPOSAL FOR "PHASE 0" IN A TRANSDISCIPLINARY AGROECOLOGY RESEARCH.....	70
FIGURE 28. METHODOLOGIES FOR AGROECOLOGICAL TRANSITION ACCORDING TO THE DIMENSIONS OF AGROECOLOGY	72
FIGURE 29. FACTORS NEEDED FOR THE GENERATION OF A WINDOW OF OPPORTUNITY	75

FIGURE 30. REACHING A WINDOW OF OPPORTUNITY. THE TRIANGLE REPRESENTS A WINDOW OF OPPORTUNITY, THAT CAN CHANGE ITS SHAPE DURING THE PROCESS.	76
FIGURE 31. AGROECOLOGY COMBINES ELEMENTS OF TRADITIONAL FARMER’S KNOWLEDGE WITH ELEMENTS OF MODERN ECOLOGICAL, SOCIAL, AND AGRONOMIC SCIENCE.	80
FIGURE 32. LEVELS OF ANALYSIS IN TRADITIONAL KNOWLEDGE AND MANAGEMENT SYSTEMS – THE KNOWLEDGE-PRACTICE-BELIEF COMPLEX. SOCIOECOLOGICAL MANAGEMENT PRACTICES AND MECHANISMS	83
FIGURE 33. WATA PACHA	84
FIGURE 34. HISTORICAL MILESTONES IN THE AGRARIAN STRUCTURE OF TIRAQUE	85
FIGURE 35. K’OA OFFERING TO MOTHER EARTH	90
FIGURE 36. FIVE-YEAR GROUP AGE DISTRIBUTION IN THE COMMUNITY OF VIRVINI. TIRAQUE, BOLIVIA	95
FIGURE 37. WEATHER FORECASTERS IN BATALLAS ALERTING THEIR COMMUNITY OF A METEOROLOGICAL RISK BY BLOWING HORNS AND LIGHTING FIRECRACKERS, LA PAZ	99
FIGURE 38. SPACES FOR THE OBLIQUE MODE OF TRANSMISSION TO WORK.....	103
FIGURE 39. THE POWER CUBE: LEVELS, SPACES, AND FORMS OF POWER	110
FIGURE 40. LEFT: MUNICIPALITY OF TIRAQUE, BOLIVIA. RIGHT: HYDROSOCIAL TERRITORIES FORMED AROUND RESERVOIRS IN THE PUCARA WATERSHED	111
FIGURE 41. TIMELINE OF THE CO-CREATION OF THE PUBLIC POLICY FOR THE PROTECTION OF WATER SOURCES AND RECHARGE AREAS.....	118
FIGURE 42. POWER-INTEREST MATRIX.....	127

LIST OF TABLES

TABLE 1. OVERVIEW OF DISCIPLINARY INTERACTIONS: DISCIPLINARITY, MULTIDISCIPLINARITY, INTERDISCIPLINARITY, AND TRANSDISCIPLINARITY 10

TABLE 2. PHASES/STEPS FOR TRANSDISCIPLINARY RESEARCH ACCORDING TO DIFFERENT SOURCES..... 15

TABLE 3. SUMMARY OF THE RESEARCH TOOLS AND SAMPLES..... 40

TABLE 4. PRIMARY DATA COLLECTION SUMMARY 54

TABLE 5. PRIMARY DATA COLLECTION SUMMARY 86

TABLE 6. KNOWLEDGE OF NATURAL INDICATORS, FESTIVITIES, AND RITUALS KNOWN BY THREE GENERATIONAL GROUPS 89

TABLE 7. TRANSMISSION OF KNOWLEDGE AND FUTURE PERSPECTIVES 91

TABLE 8. IMPACTS ON SOCIOECOLOGICAL MECHANISMS BY SOCIOECOLOGICAL FACTORS 102

TABLE 9. PRIMARY DATA COLLECTION SUMMARY 115

TABLE 10. ACTORS INVOLVED IN THE CO-CREATION OF THE PUBLIC POLICY 117

Summary

In the 1970s, transdisciplinarity was introduced as a strategy to deal with complex sustainability problems such as achieving food sovereignty through the integration of various knowledge systems. Although principles and guidelines for transdisciplinary research have been developed, there are still methodological gaps for its implementation, and it is not clear what makes the society-driven collaborative research teams effective. Agroecology shares principles with transdisciplinarity since both are based on knowledge dialogues (*diálogo de saberes*). Agroecology is promoted as a science, social movement, and practice to achieve food sovereignty. Transdisciplinary agroecology that studies how agroecological systems are supported by transdisciplinary research is poorly understood, barely conceptualized and there is a lack of guidelines for its operationalization in the field.

Following these knowledge gaps, the general objective of this dissertation is to understand how in future research designs transdisciplinary agroecology can be organized to achieve food sovereignty. To fulfil this objective, three consecutive research questions were identified: 1) How can a collaborative research team be built for society-driven transdisciplinary agroecology research, 2) What are the main socioecological factors that impact the transmission of traditional ecological knowledge within and across generations, and 3) How are power relations influenced by people's interests, socio-political structures, and knowledge in the process of co-creation of food sovereignty.

This dissertation is composed of 6 chapters. The first chapter presents an introduction and general scope of the doctoral work. Central concepts and research gaps related to food regimes, food sovereignty, transdisciplinarity and transdisciplinary agroecology are also presented. This chapter closes by presenting the case study of the doctoral work to help contextualize and navigate the document. The second chapter presents background information on the case study. Then, chapter 3 expands on the methodology used in this work, which is based on the integrated case study and the mixed methods approach. Next, three empirical chapters are presented, each addressing one of the research questions. Thus, chapter 4 explores how a society-driven collaborative team for transdisciplinary agroecology can be formed. Chapter 5 identifies the main socioecological factors that are impaired by the transmission of ancestral ecological knowledge. Although power relations are transversal in all chapters, chapter 6 focuses on studying them in the process of transdisciplinary co-creation with a case study and the formulation of a public policy. The main objective and findings of the doctoral work, including the answers to each of the research questions, are discussed in chapter 7. This chapter also gives general guidelines to operationalize transdisciplinary agroecology and closes with final comments.

The research described in chapter 4 identified three key aspects related to the formation of society-driven collaborative research teams (phase 0): 1) an iterative spiral sequence of inspiration, negotiation, and action moments, 2) the composition of the research groups is not static, and 3) some factors cluster into a window of opportunity. Moreover, three factors must constellate creating a window of opportunity for this formation: 1) the perception of urgency, 2) key stewards, and 3) institutional will.

In chapter 5, four factors affecting traditional ecological knowledge transmission were identified: formal education, migration, a new religion, and the politicization of rural unions. Despite the slow disappearance of traditional ecological knowledge, it was found that interest in traditional ecological knowledge can be refreshed through the co-creation of hybrid knowledge.

Results of chapter 6 confirm that actors' interests, access to information, habits, and customs influence power relations in transdisciplinary agroecology. Through an *ex-post* implementation of the Power Cube in the construction of a water policy, it was found that actors use different forms, spaces, and levels of power to set policy-making agendas and to achieve their interests. Hence, it is important to analyze power relations before, during, and after the co-creation of a public policy and transdisciplinary research. Moreover, this case study shows the importance of stepping away from a silo thinking approach and fostering a system approach in the development of agroecology-related policies.

This dissertation concludes that the following conditions should be met, and guidelines are to be followed for transdisciplinary agroecology to be effective: stakeholders should 1) consider power relations, 2) consider symbolic and physical spaces, 3) use participatory and popular education methodologies, 4) implement phase 0, 5) promote the co-creation of hybrid knowledge, 6) follow a socioecological system approach, and 6) acknowledge that it as an ongoing process. It is expected that the findings of this work can enrich both the transdisciplinarity and transdisciplinary agroecology.

Samenvatting

In de jaren zeventig werd transdisciplinariteit geïntroduceerd als een strategie om complexe duurzaamheidsproblemen, zoals voedselsoevereiniteit te benaderen vanuit de erkenning dat verschillende kennissystemen hiervoor moeten worden geïntegreerd. Hoewel beginselen en kaders voor transdisciplinair onderzoek werden ontwikkeld, zijn er nog steeds methodologische lacunes wanneer het in de praktijk wordt gebracht. Zo is het niet duidelijk wat nodig is om onderzoeksteams vanuit verschillende disciplines effectief te laten samenwerken om een antwoord te bieden op een maatschappelijke vraag in partnerschap met maatschappelijke actoren. Agroecologie deelt beginselen met transdisciplinariteit aangezien het gebaseerd is op de dialoog van kennis (*diálogo de saberes*). Agroecologie wordt naar voor geschoven als wetenschap, een sociale beweging en een praktijk om voedselsoevereiniteit te bereiken. Transdisciplinaire agroecologie bestudeert hoe agro-ecologische systemen worden ondersteund door transdisciplinair onderzoek. Het wordt echter slecht begrepen, is nauwelijks geconceptualiseerd en er is een gebrek aan richtlijnen voor de operationalisering ervan in het veld.

Dit proefschrift tracht deze hiaten in kennis aan te pakken door te begrijpen hoe transdisciplinaire agro-ecologie kan worden georganiseerd om voedselsoevereiniteit te bereiken. Er worden drie onderzoeksvragen vooropgesteld: 1) Hoe kan een collaboratief onderzoeksteam worden samengesteld voor een maatschappelijk gedreven transdisciplinair agroecologisch onderzoek, 2) Wat zijn de belangrijkste socio-ecologische factoren die de overdracht van traditionele ecologische kennis binnen en tussen generaties beïnvloeden, en 3) Hoe worden machtsverhoudingen beïnvloed door de belangen van mensen, sociaal-politieke structuren en kennis in het proces van co-creatie van voedselsoevereiniteit.

Dit proefschrift bestaat uit 6 hoofdstukken. Het eerste hoofdstuk is een inleiding tot het werk en geeft een algemeen kader. Ook wordt een conceptuele kader rond voedselregimes, voedselsoevereiniteit, transdisciplinariteit en transdisciplinaire agro-ecologie gepresenteerd. Dit hoofdstuk sluit af met de inleiding over de gevalstudie waarop het proefschrift zich baseert. Het tweede hoofdstuk geeft meer uitleg over de gevalstudie terwijl het derde hoofdstuk de methodologische benadering uitlegt. Het proefschrift gebruikt een mixed-methods benadering die het toepast op een geïntegreerde gevalstudie. Vervolgens worden drie empirische hoofdstukken gepresenteerd, waarin telkens één van de onderzoeksvragen wordt onderzocht.

Hoofdstuk 4 onderzoekt hoe een maatschappelijk aangestuurd samenwerkingsteam voor transdisciplinaire agro-ecologie kan worden gevormd. Vervolgens identificeert hoofdstuk 5 de belangrijkste sociaal-ecologische factoren die de overdracht van voorouderlijke ecologische kennis belemmeren. Hoewel machtsverhoudingen in alle hoofdstukken belangrijk zijn, bestudeert hoofdstuk 6 hoe deze het proces van transdisciplinaire co-creatie beïnvloeden evenals een impact hebben op de formulering van een overheidsbeleid. Hoofdstuk 7 beprekt de doelstelling en de belangrijkste bevindingen van het doctoraat en formuleert zo antwoorden op elke onderzoeksvraag. Het hoofdstuk geeft tevens algemene richtlijnen om transdisciplinaire agro-ecologie te operationaliseren.

Het in hoofdstuk 4 beschreven onderzoek identificeerde drie belangrijke aspecten voor de vorming van maatschappelijk aangestuurde samenwerkingsteams (fase 0): namelijk 1) een iteratieve spiraalsequentie van inspiratie-, onderhandelings- en actiemomenten, 2) de samenstelling van de onderzoeksgroepen is niet statisch, en 3) sommige factoren clusteren tot een *window of opportunity*. Bovendien moeten drie factoren samenkomen om een window of opportunity mogelijk te maken voor het vormen van samenwerkingsteams, met name: 1) de perceptie van urgentie, 2) de aanwezigheid van sleutelbeheerders, en 3) de institutionele wil.

In hoofdstuk 5 werden vier factoren geïdentificeerd die de overdracht van traditionele ecologische kennis beïnvloeden: formeel onderwijs, migratie, een nieuwe religie en de politisering van plattelandsverenigingen. Ondanks het langzaam verdwijnen van traditionele ecologische kennis bleek dat de belangstelling voor traditionele ecologische kennis terug kan toenemen door de co-creatie van hybride kennis.

De resultaten van hoofdstuk 6 bevestigen dat de belangen, toegang tot informatie, en de gewoonten en gebruiken van actoren, de machtsverhoudingen in transdisciplinaire agro-ecologie beïnvloeden. Een Power Cube wordt gebruikt om na te gaan hoe een waterbeleid tot stand kwam. Het was duidelijk dat actoren verschillende vormen, ruimtes en machtsniveaus gebruiken om beleidsagenda's op te stellen en hun belangen te verwezenlijken. Dit toont het belang aan om aandachtig te zijn voor machtsverhoudingen wanneer overheidsbeleid wordt uitwerkt via een co-creatief proces. Bovendien toont deze gevalstudie aan hoe belangrijk het is om bij de ontwikkeling van agro-ecologisch beleid af te stappen van het silo-denken en een systeembenadering aan te nemen.

Dit proefschrift besluit dat transdisciplinaire agroecologie effectief kan zijn wanneer de volgende voorwaarden zijn voldaan en richtlijnen werden gevolgd. Belanghebbenden moeten: 1) rekening houden met machtsverhoudingen, 2) rekening houden met symbolische en fysieke ruimtes, 3) gebruik maken van participatieve en populaire onderwijsmethoden, 4) fase 0 implementeren, 5) de co-creatie van hybride kennis bevorderen, 6) een socio-ecologische systeembenadering volgen, en 6) erkennen dat het een doorlopend proces is. Verwacht wordt dat de bevindingen van dit werk zowel de transdisciplinariteit als de transdisciplinaire agro-ecologie kunnen verrijken.

CHAPTER 1. INTRODUCTION

This chapter is partly based on:

Gruberg Cazón, H. A (2019) Review of transdisciplinary approaches for the co-creation of food sovereignty. *Acta Nova*, 9(3), 329-356.

1. General introduction and research scope

Two of the main concerns of humankind are to cover the food necessities of a growing population and to reduce poverty (Atkins & Bowler, 2016). Throughout the post-industrial period, two groups of discourses dominated agricultural policy and practice with the goal of dealing with these concerns: 1) the production innovation/technology; and 2) economic growth (Thompson & Scoones, 2009). The production innovation/technology narrative started during the Industrial Revolution era to dramatically increase productivity and output by improving agricultural efficiency (Overton, 1996; Thompson & Scoones, 2009). In the beginning, mechanization and fertilization of agriculture were strongly promoted. Later, in the middle of the 20th century, came the Green Revolution with the development of high-yielding crop varieties (Atkins & Bowler, 2016; Thompson & Scoones, 2009). Since the 1990s the Green Revolution shifted to a Gene Revolution, based on recombinant DNA technology and molecular science to create genetically modified organisms with a primary focus on the private sector (Atkins & Bowler, 2016; Thompson & Scoones, 2009).

The Green Revolution has increased food production importantly in developing countries. In its early phase (1961-1980), a 21% growth in the production of modern varieties (wheat, rice, and maize) was reported; and in the later phase (1981-2000), the production growth is estimated to have increased by 40% (Evenson & Gollin, 2003; Thompson & Scoones, 2009). However, several significant socio-environmental problems have arisen as consequences of the technological packages developed (i.e., soil fertility loss, agrobiodiversity loss, water pollution, cultural erosion, etc.), bringing questions about the overall sustainability of the Green Revolution (Pielke & Linnér, 2019). For example, the safety of genetically modified organisms for human health and the environment is controversial among different sectors of society (Atkins & Bowler, 2016; Ludwig, 2018). Also, concerns are raised because of the high dependency of farmers on a few multinationals that provide genetically modified organisms seeds, and that dominate food production globally (De Lauwere et al., 2007). Likewise, concerns are raised about the germplasm resources of the planet because many are used for pharmaceuticals and as raw materials for industries. While the cultivation of a few varieties is promoted, improvements are linked to the loss of biodiversity (Altieri, 1993).

Although the economic growth narrative has similarities with the production innovation narrative, it focuses on the capacity of agriculture to take a country out of poverty (World Bank, 2005). This narrative aims at moving farmers from subsistence agricultural systems to commercial ones (OECD, 2006; Thompson & Scoones, 2009; World Bank, 2005). It advocates for specialization, commercialization, and globalization of agricultural production, which eventually also pushes for scale economies. To do so, the economic system and its agents require market incentives, institutional instruments, and technological innovation. This narrative is promoted by numerous multi-lateral development agencies such as the World Bank and the International Monetary Fund (Thompson & Scoones, 2009). Commercialization may have brought benefits to (some) small-scale farmers, but this is also challenging for many as gains depend on market access which is not guaranteed for all. Moreover, farmers have become more vulnerable to price fluctuations and risks because of the high levels of specialization (Krueger, 1996; Timmer, 2009).

Thanks to global efforts, the number of undernourished people and the prevalence of undernourishment in the world has decreased significantly. Figure 1 presents both indicators for the period 2000 and 2021 according to FAOSTAT indicators for the Sustainable Development Goals (FAO, 2023). In the figures, it is shown that in recent years both indicators suffered increases. For example, in the year 2021 FAOSTAT reported 828 million

undernourished people (FAO, 2023). The prevalence of undernourishment increased from 8% in 2019 to 9.8% in 2021. These changes in recent years are mainly attributed to the Covid-19 crisis (FAO et al., 2022). Just as the number of hungry people has decreased, so has the number of famine victims (Hasell & Roser, 2017). However, despite this considerable improvement, both poverty and hunger are still a global concern (FAO et al., 2022), together with related issues of environmental problems and social justice (Holt-Gimenez & Patel, 2012).

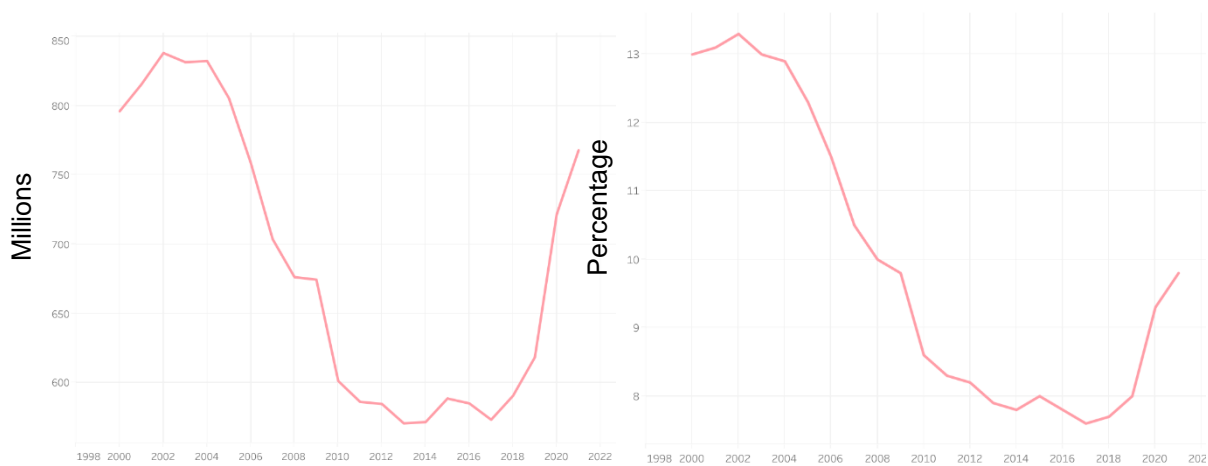


Figure 1. Left: Number of undernourished people Right: Prevalence of undernourishment

Note. Source: FAO (2023)

Transforming food systems is of major interest to humankind and has also been reflected in food policies throughout the world. However, this transformation is not necessarily into sustainable systems, but it tends to follow a new wave of the Green Revolution, implementing similar political and technological packages. According to Marin et al. (2016), some countries are still subject to processes of path dependency and lock-in, “consequently, attempts to introduce more sustainable practices in one part of an agri-food system are frequently incompatible with, or are undermined by, other incumbent components of the system as a whole” (Marin et al., 2016, p. 3). This means that sustainable transformations of agri-food systems are likely to require strategic, multi-actor, and multi-process interventions at different scales.

In the last decades, different agricultural alternatives have arisen to these narratives, aiming at developing more sustainable and equitable food systems (i.e., agroecology, permaculture, and eco-functional intensification, among others). Such alternatives follow eco-friendly and integral approaches to agroecosystems management, food production, and commercialization. Agroecology is an alternative to productivism that stands out and is catching the attention of practitioners, researchers, politicians, and activists because it is a set of practices, a science, and a social movement that aims at reaching food sovereignty (Wezel et al., 2009). It focuses on the generation, protection, and conservation of critical environmental services; and more importantly, it recognizes the dynamic nature of food systems that are deeply rooted in farmers’ knowledge and skills. It hereby recognizes the important role of all types of knowledge (Thompson & Scoones, 2009). Hence, agroecology is the main promoter of revaluing traditional ecological knowledge and the co-creation of situated knowledge, through the combination of local and scientific knowledge (Coolsaet, 2016).

Almost parallel to the rise of these agricultural alternatives, various horizontal and participatory research and development approaches have arisen as a counterpart to the neo-positivist approaches that are more of a top-down nature (Cuéllar-Padilla & Calle-Collado, 2011; Jacobs, 2016). These include Participatory Action Research, Participatory Rural Appraisal, and Farmer-to-Farmer Field Schools among many others (Chambers, 1994; Fliert, 1993; Tapia, 2016). Participatory Action Research is based on critical theory and constructivism, introducing "an ideal method for researchers who are committed to co-developing research programs *with* people rather than *for* people" (Baum et al., 2006, p. xxii; McIntyre, 2007, p. xii italics added). It is based on the premise that people have the fundamental right to participate meaningfully in defining their future (Attwood, 1997).

Numerous studies have shown that participatory alternatives do not necessarily fully integrate different stakeholders throughout the whole research and/or development project process (Minkler, 2004; Tress et al., 2005). For example, Participatory Action Research generally has been implemented by practitioners and activists without the participation of the academic sector (Agramont et al., 2019) while interdisciplinarity and multidisciplinary approaches only integrate academic participants (Tress et al., 2005). Hence, there is a need for approaches that integrate both academic and non-academic actors. Such integration is present in transdisciplinarity because it includes academic and non-academic participants (i.e., farmers, non-governmental organizations, consumers, government workers, etc.).

Agroecology and Participatory Action Research have common principles, and they go hand in hand in the development of sustainable food systems (Altieri, 2000; Bichler et al., 2020). However, agroecology can be more precisely described as "transdisciplinary agroecology" because it is characterized by a "transdisciplinary, participatory and action-oriented approach" by engaging different groups of stakeholders throughout a problem-solving process (Méndez et al., 2015). Transdisciplinary agroecology uses Participatory Action Research methodology to reach transdisciplinarity.

Thompson and Scoones (2009) explain that governance issues are often absent in narratives of agricultural development. Food systems transformation requires better governance (Thompson & Scoones, 2009). According to Vorley (2002), governance is composed of three main institutional actors: government, the private sector, and civil society. He argues that a poor distribution of power and interests among these institutional actors is a threat to the health, economy, and ecology of rural communities (Vorley, 2002). In this sense, the dynamics of power relations among stakeholders may determine whose knowledge is "valid" or "valuable", hence, appreciating one type of knowledge and undermining another. Rosendhal et al. (2015) argue that such power relations tend to be neglected in transdisciplinary research.

Several authors describe how transdisciplinary agroecology has the potential to overcome the path dependency and lock-in of agricultural development narratives through the co-design, co-production, and co-dissemination of sustainable food systems which foster food sovereignty (Gliessman, 2020; Méndez et al., 2015; Pimbert, 2016). Because of this outstanding potential, there has been growing interest in its study recently. However, there still are several knowledge and implementation gaps regarding transdisciplinary agroecology. For one, there is a lack of empirical data showing how food sovereignty can be co-created through transdisciplinary agroecology (Brink et al., 2018).

As well, transdisciplinary agroecology faces several challenges. For example, although it implements highly participatory approaches, power relations and interests of the various actors involved will be present and may change the course of research projects and activities (Méndez et al., 2015). Also, it is important to explore the socioecological factors that affect

agroecological knowledge (i.e., markets, governments, migration, and climate change, among others) (Méndez et al., 2015). Moreover, being a novel approach, new challenges and unknowns arise along the way. For example, guidelines have been developed for transdisciplinary research starting with the problem framing by a transdisciplinary research team (Phase 1). Yet, there are few guidelines on the previous steps (phase 0) about how to begin transdisciplinary research. These guidelines are superficial and do not elaborate on the details of Phase 0 (Cockburn et al., 2016; Enengel et al., 2012; Horcea-Milcu et al., 2022; Steger et al., 2021). They focused mainly on understanding the socioecological context. Until very recently, there were no guidelines on how to reach the formation of a transdisciplinary research team without falling into conventional and top-down processes (See Horcea-Milcu et al., 2022). Although Horcea-Milcu et al. (2022, p. 191) recently proposed such a “Phase 0” – the stage before the transdisciplinary process takes off-, it remains research-driven for contexts where civil society reports low levels of participation, thus it is not common that transdisciplinary research emerges as a demand from the society. Moreover, Horcea-Milcu et al. (2022) focus mainly on selecting the case study and less on the formation of the transdisciplinary research team itself. Hence, there are no specific guidelines about how to reach a transdisciplinary research team without pre-conceived academic perspectives.

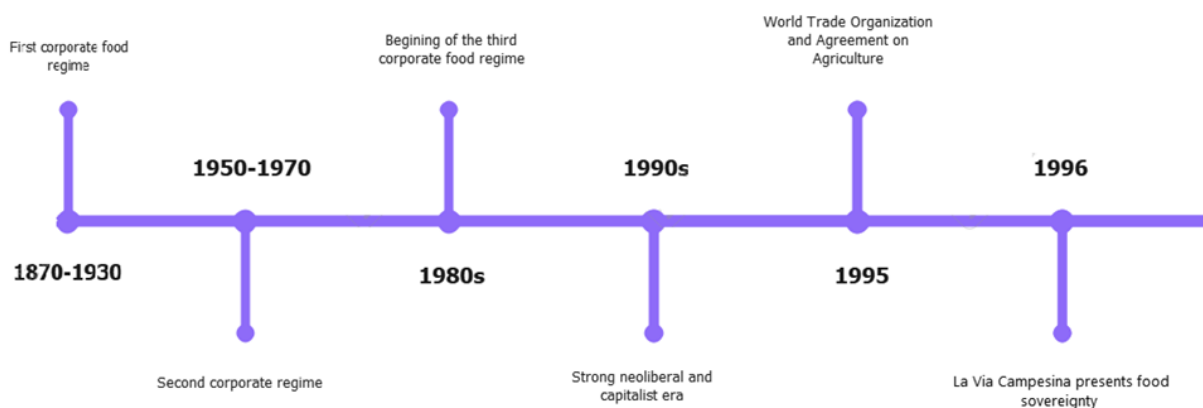
Against this background, the goal of this dissertation is to address these scientific and practical gaps by studying how food sovereignty can be co-created through transdisciplinary agroecology based in a rural municipality of Cochabamba in Bolivia (Plurinational State).

The following section introduces the main concepts and research gaps that support the PhD study. First, the section conceptualizes on food sovereignty and transdisciplinarity. Next, it links both through the notion of transdisciplinary agroecology.

2. Concepts, research gaps and context

2.1 Food sovereignty

In this section, a brief historical account of the world food regimes since the industrial era with an emphasis on the concept of food sovereignty is presented in Figure 2.



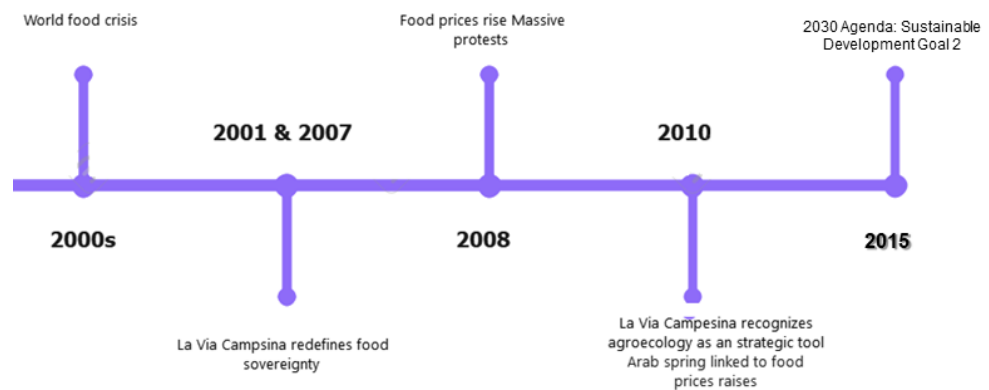


Figure 2. History of food sovereignty

Note. Source: Author

The beginning of the food sovereignty framework can be traced back to the 1980s (Edelman, 2009). It gained momentum in the 1990s when La Via Campesina¹ (The biggest peasant international movement in the world) promoted it as an opposition to the severe food crisis provoked by the corporate food regime (McMichael, 2014). Holt Giménez and Shattuck (2011) propose three main periods for the development of the corporate food regime. The first moment corresponds to the period between 1870 to 1930, which is characterized by the flow of raw materials and “cheap food” from the colonies of the Global South to Europe for its industrialization (Holt Giménez & Shattuck, 2011). The second period covered the 1950s, 1960s, and 1970s with the rise of the Green Revolution. This moment is characterized by the industrialization of agriculture, with the promotion and uprise of monocultures of high-yield varieties, especially wheat and rice (Khush, 1999). Likewise, the use of heavy machinery and agricultural chemical inputs such as fertilizers and pesticides increased sharply (Pellegrini & Fernández, 2018). As a result, the flow of “cheap food” reverted from Europe to the Global South as subsidized food (Sasson, 2012). In 1974, the Universal Declaration on the Eradication of Hunger and Malnutrition was adopted at the World Food Conference (OHCHR, 2022). At this conference, the concept of “food security” was first presented as the: “availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices” (FAO, 1975, p. 3). At this conference the goal of eradicating hunger in 10 years was set. Since then, the notion of food security has been introduced into world policies (Mentschel, 2019).

The third period (1980s) was marked by the rise of neo-liberalization. Its start was marked by the Structural Adjustment Programs that were imposed on countries in the Global South by the International Monetary Fund and World Bank in return for loans. These programs dictated financial austerity while eliminating tariffs, dismantling national marketing boards, eliminating price guarantees, and cutting budgets for national agricultural research and extension systems (Holt Giménez & Shattuck, 2011). This moment is characterized by overproduction and strong food dumping by world powers, like the United States of America, to the South due to policies that favored and prioritized “transnational” issues over “national” ones (McMichael, 2005, 2012). Moreover, value chains increased producers’ vulnerability by leading them (McMichael, 2014, p. 941):

¹ For further information check <https://viacampesina.org/>

[...] into competitive markets over which they have little or no control, in return for contracting for agri-food inputs (seed, fertilizer, chemicals) that extract new value from producers via their products and centralize agricultural knowledge as ‘intellectual property’, with increased exposure to debt and dispossession for producers, and reduction of local food security. There is a high dependence on external inputs, loss of local knowledge, indebtedness, finally food security is lost.

The creation of the World Trade Organization in 1995 and the Agreement on Agriculture led to further market liberalization (Holt Giménez & Shattuck, 2011). The Agreement on Agriculture was an attempt to reach a balance between the liberalization of the agricultural trade market and the States’ rights to develop policy goals for agriculture (WTO, 2016). The World Trade Organization (2016) explains that food security was part of those policy goals as long as they did not interfere with trade. Therefore, tariffs and non-tariffs were eliminated to make markets more accessible. As a result, the State’s role in trade was minimized and food trade was regulated by the market, impacting domestic actors negatively (WTO, 2016).

The number of victims of famines has decreased substantially. For example, in the 1960's the highest value of victims of famines was reported (16,628,617), while the famines of the period 2010-2016 in Somalia were less deadly (255,000) (Hasell & Roser, 2017). This does not mean that the level of importance of food crisis in modern times can be downplayed. In this regard, different food crises have been reported such as the world grain shortage of 1995 and the increment in food prices in 2008 that led to several social manifestations around the world but especially in African countries (Oya, 2009; Paarlberg, 1996). In 1996, faced with the food crisis generated by a world shortage of grains in 1995 and the inability of the Agreement of Agriculture to reduce external dependency and subsidies, La Via Campesina issued a declaration on food sovereignty (McKay et al., 2014; Paarlberg, 1996). They defined food sovereignty as “the right of each nation to maintain and develop its own capacity to produce its basic foods, respecting cultural and productive diversity” (Vía Campesina, 1996). This first approach to food sovereignty calls for State control over food to reduce external dependence (McKay et al., 2014). Through a series of encounters and knowledge dialogues (*diálogos de saberes*) among social movements, in 2001, La Via Campesina presented a new definition of food sovereignty that links the concept more to self-determination and less to State control:

The right of peoples to define their own agriculture and food policies, to protect and regulate domestic agricultural production and trade in order to achieve sustainable development objectives, to determine the extent to which they want to be self-reliant, and to restrict the dumping of products in their markets. (Campesina 2001)

Later, in 2007 at the International Food Sovereignty Forum (Nyéléni – Mali)², the reference to the scale of control over food was changed in the definition of food sovereignty, from State to local control: “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 agriculture systems” (Sélingué, 2007). At this Forum, the following principles of food sovereignty were presented: food sovereignty 1) focuses on food for people, 2) values food providers, 3) localizes food systems, 4) puts control locally, 5) builds knowledge and skills, and 6) works with nature (Sélingué, 2007). Hence, the policy framework for food sovereignty was developed considering ecological, socio-political, and economic aspects (Pimbert, 2016). At this point, an incoherence in food sovereignty is found because it calls for “sovereignty” itself. Hence, it implies that the decisions are in the hands of the people and not of the state. But the State also needed to define policies for the development and redistribution of power, which in

² It had the participation of over 600 participants from 80 countries.

turn can become a threat to the State (McKay et al., 2014). This incoherence may lead to tensions because the State cannot achieve food sovereignty by itself neither can communities. McKay, Nehring, and Walsh-Dilley (2014, p. 1177) argue that to overcome this tension the “state efforts to support food sovereignty must involve some degree of structural reform to distribute power in ways that facilitate such local autonomy”. Trauger (2014, p. 1145) advocates for a more radical stand: “food sovereignty may implement its radical vision within the existing structures of the modern liberal nation state by working with, against and in between its juridical structures by reworking the central notions of sovereignty: territory, economy and power”.

Over time, the corporate regime policies harmed the livelihoods of small-scale farmers, while empowering large landowners. As a result, production is more concentrated than ever with a few producers possessing more land and production shares than ever before. For example, in the United States of America, the number of farms decreased from 7 million farms in 1935 to 1.9 million in 1997 (Holt Giménez & Shattuck, 2011). Globally, two corporations (Cargill and ADM) held 75% of the world's cereal trade in the 21st century (Vorley, 2003).

The end of the 2000s is marked by food price spikes. In 2007/2008, significant increases in food prices led to a global food crisis followed by a series of massive demonstrations around the world (McMichael, 2014). However, there was no global shortage of food; on the contrary, the food crisis occurred when global harvests and agri-food corporations’ profits hit records. For example, in 2008, there was a record grain harvest of 22.87 million metric tons (Holt Giménez & Shattuck, 2011). Furthermore, over the last decades, production increased by 2% per year while the population growth had reduced to 1.09% (Holt Giménez & Shattuck, 2011). Hence, there was food, the problem relied on the model of distribution of food and income and not on lack of food because food is affluent among the richer areas of the world and the richer parts of the population (Holt-Gimenez et al., 2008). It is scarce in poorer areas and amongst resource-poor households (Holt-Gimenez et al., 2008). Along similar lines, Arab Spring (2010-2013) initially was triggered by an increase in food prices (Rosenberg, 2011).

The International Food Policy Research Institute in 2012 explained that the problem of malnutrition and food insecurity relies on the Global South’s:

[...] high dependency on food imports, diminished capacity for generating foreign exchange to finance food imports, rising food demand driven by continued high population growth, and limited potential for agricultural growth because of severe water constraints and water resource management issues. (Breisinger et al., 2012, p. 2)

For example, in Haiti, due to the neoliberal measures imposed, next to high oil prices and harvest failures, the price of rice doubled in one week, with a dependency on imports of 82% (McMichael 2014). To counteract this situation the governments of Haiti, Bahamas and Jamaica issued new measures following the logic from the local farm-to-table (Cave, 2013). In a period of three years, food prices increased by 83% (Wiggins & Levy, 2008). Because of this situation, the American President Clinton recognized that food cannot be commodified: “Food is not a commodity like others [...] It is crazy of us to think we can develop a lot of these countries (by) treating food like it was a color television set” (McMichael, 2014, p. 947).

Holt Giménez and Shattuck (2011) contrasted the politics, discourses, orientation, and model of the corporate regime vs the food movements. Under the corporate regime, neoliberal and reformist politics are positioned, and progressive and radical politics are considered part of the food movements. The discourse of food security is under reformist politics, following modernization theories, with the premise that “continued development of the north was

essential to finance the development of the south” (Holt Giménez & Shattuck, 2011, p. 119). In an attempt to bring food security as a concept closer to the defense of the rights of producers and consumers, the initial definition was modified in 2020, including notions of agency and sustainability (HLPE, 2020). While food sovereignty is positioned in a radical current as a food movement through restructuring and transformation since to achieve the "transformation of the agriculture and food system [...] you require a complete transformation of the society" (Magdoff et al., 2000, p. 188). Furthermore, the concept of food security is complemented by the Sustainable Development Goals of the 2030 Agenda for Sustainable Development were established in 2015 and came into force in 2016 (UN, 2022). From the set of 17 goals, number two focuses on the end of hunger, achieving food security and improved nutrition and promoting sustainable agriculture. This goal is monitored through eight targets and 13 indicators helping to also monitor food security around the world (Roser & Ortiz-Ospina, 2018).

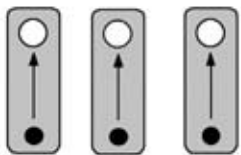
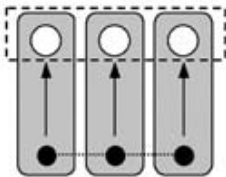
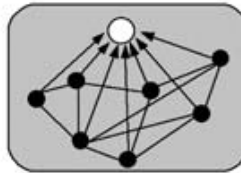
Completing the spectrum is the concept of food justice that belongs to more progressive policies with a discourse of food justice through the empowerment of people because issues of gender, race, and class influence the production and consumption of food (Alkon, 2014). Hence, food justice comes to reinforce both agricultural sustainability and environmental justice (Alkon & Norgaard, 2009). Nevertheless, other authors argue that conceptually linking sustainability and environmental justice does not necessarily mean that food justice will be achieved in practice (Gottlieb & Joshi, 2010).

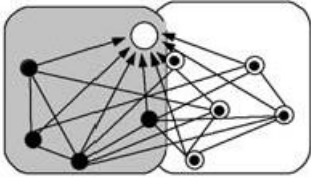




Currently, the dominant food system is still characterized by agri-food corporations, globalized animal protein production, and consumption, food and fuel economics, a hyper supermarket revolution, liberalized trade in food, concentrated land, and depletion of natural resources (Howard, 2017; Werner, 2021). It is substantively characterized by land grabbing for food and agrofuel production and the promotion of genetically modified organisms. The agri-food sector is in the hands of a few companies. For example, Bayer/Monsanto owns 29% of the world seed market and 24% of the pesticide market (Bratspies, 2017). Therefore, it is crucial to gain insights into how transdisciplinary agroecology can contribute to the transition of this food system to one that is more sustainable and just, which is at the core of this dissertation.

2.2 Transdisciplinarity

Integrative approaches in research emerged in the late 1960s and 1970s (Klein, 2004). A milestone for the development of integrative approaches is the Organization for Economic Cooperation and Development Conference in Paris in 1970, where participants expressed the inability of science to relate with society (OECD, 1972). As a result, relevant inputs emerged for the development of disciplinary interaction concepts such as disciplinarity, multidisciplinary, pluridisciplinary, interdisciplinary, and transdisciplinary (OECD, 1972). Pluridisciplinary and multidisciplinary were merged into one. Currently, disciplinary interactions can be 1) disciplinary/monodisciplinary; 2) pluri/multidisciplinary; 3) interdisciplinary; and 4) transdisciplinary (Table 1) (Cummings et al., 2013). Although there is a growing interest in these concepts, they are still confused between each other and used interchangeably, limiting their applicability and the end results (Nicolescu, 1996; Winder, 2003). For example, Tress et al. (2005) found that amongst 232 respondents who concluded integrative projects in 28 countries around the world, only in 47% of the projects' members had reached a common understanding of these concepts.

Table 1. Overview of disciplinary interactions: disciplinarity, multidisciplinary, interdisciplinarity, and transdisciplinarity

CONCEPT	DEFINITION	CHARACTERISTICS	VISUALIZATION
Disciplinarity	Takes place within the boundaries of currently recognized academic disciplines, while fully appreciating the artificial nature of these boundaries and the fact that they are dynamic. The research is oriented towards one specific goal, looking for an answer to a specific question.	<ul style="list-style-type: none"> • Within one academic discipline • Disciplinary goal setting • No cooperation with other disciplines • Development of new disciplinary knowledge and theory 	
Multidisciplinary	Involves different academic disciplines that relate to a shared goal, but with multiple disciplinary objectives. Participants exchange knowledge, but they do not aim to cross subject boundaries in order to create new integrative knowledge and theory. The research process progresses as parallel disciplinary efforts without integration.	<ul style="list-style-type: none"> • Multiple disciplines • Multiple disciplinary goal setting under one thematic umbrella • Loose cooperation of disciplines for exchange of knowledge • Disciplinary theory development 	
Interdisciplinarity	Involves unrelated academic disciplines in a way that forces them to cross subject boundaries. The concerned disciplines integrate disciplinary knowledge to create new knowledge and theory and achieve a common research goal.	<ul style="list-style-type: none"> • Crosses disciplinary boundaries • Common goal setting • Integration of disciplines • Development of integrated knowledge and theory 	

CONCEPT	DEFINITION	CHARACTERISTICS	VISUALIZATION
Transdisciplinarity	Involves academic researchers from different unrelated disciplines as well as non-academic participants [...] to create knowledge and theory and research a common question. Transdisciplinarity combines interdisciplinarity with a participatory approach.	<ul style="list-style-type: none"> • Crosses disciplinary and scientific/academic boundaries • Common goal setting • Integration of disciplines and non-academic participants • Development of integrated knowledge and theory among science and society 	
Discipline Non-academic participants Goal of a research project Movement towards goal Cooperation Integration		Thematic umbrella  Academic knowledge body  Non-academic knowledge body 	

Note. Source: (Tress et al., 2005, pp. 484, 488)

These disciplinary interactions mainly differ in the level of integration of different disciplines³, the intensity of the cooperation among them, and the integration of non-academic actors (Brink et al., 2018). In *disciplinary/monodisciplinary* research, problems and solutions are defined by one academic discipline (Block et al., 2022; Ramadier, 2004). As a result, a new disciplinary knowledge and theory is created (Tress et al., 2005). *Pluri/multidisciplinary* research is aware of the existence of different realities, disciplines are considered complementary and the point of view of each discipline is respected (Ramadier, 2004). It looks for the interaction between academic researchers, from different disciplines, that contribute to studying a theme from disciplinary goals, with loose cooperation of disciplines (Block et al., 2022; Ramadier, 2004). There is disciplinary theory development, not co-creation (Tress et al., 2005). An example of multidisciplinary collaboration is the Environmental Evaluation Studies in Bolivia, where different disciplines study the impacts of the same activity or project from the discipline and bring the information together in a coherent report. In *interdisciplinary* research different disciplines interact to co-create knowledge with a common goal (Block et al., 2022; Ramadier, 2004). Theories created following this approach cannot be detangled into disciplines (Tress et al., 2005).

Transdisciplinary interactions transcend the previous types of interactions by including non-academic actors (Block et al., 2022; Cummings et al., 2013; Ramadier, 2004). It was originally presented by Erich Jantsch at the above-mentioned conference in Paris as: "a common system of axioms for a set of disciplines" that are brought together with a common goal (OECD, 1972, p. 24). The conceptualization of the "system of axioms" was considered vague but still called for the attention of the scientific community (Jahn, 2008). Since then, efforts have been invested in clarifying the term. For example, Nicolescu (1996) in his "Manifesto of Transdisciplinarity" presented three pillars for transdisciplinarity: 1) multiple levels of reality, 2) the logic of the included middle, and 3) complexity. According to Nicolescu (1996, p. 24), there are many levels of reality occurring at the same time, both ontological and pragmatic. The included middle is "the passage from one level of Reality to another". It is in the passage that a middle ground for work can be found for transdisciplinary to happen. He further explained that a classical logic is grounded in three axioms: 1) the axiom of identity: A is A, 2) the axiom of non-contradiction: A is not non-A, and 3) the axiom of the excluded middle: there exists no third term T ("T" from "third") which is at the same time A and non-A (Nicolescu, 1996, p. 29). He challenged the third axiom on complexity by arguing that there is an "included middle T" (Nicolescu, 1996, p. 29).

Hence, transdisciplinarity builds up from the other disciplinary interactions because these interactions are like "arrows shot from but a single bow: knowledge" (1996, p. 37). Therefore, it is important to acknowledge that they are not mutually exclusive, and not one is better than the other (Klein, 2008). For example, transdisciplinarity takes from multidisciplinary the recognition that there are multiple realities and from interdisciplinary the co-creation of non-fragmentable knowledge (Ramadier, 2004). Therefore, transdisciplinarity requires the integration of knowledge of academic and non-academic actors from different sectors (Bergmann et al., 2005). Sectors could be defined as private, public, and social or through their link with specific natural resource management systems (Pohl & Hadorn, 2007; Wiek & Walter, 2009).

Through the integration of disciplines, knowledge, and actors, transdisciplinarity has the capacity to deal with challenging, interdependent, and complex sustainability problems, being

³ Defined by Oxford Dictionaries as a "branch of knowledge" (Oxford University, 2019). Each discipline "has its own set of tools, methods, procedures and theories" (Tress et al., 2005, p. 484).

considered a key approach to transform⁴ socioecological systems into more sustainable ones (Brink et al., 2018; Wamsler, 2017). Complex or “wicked” sustainability problems (Rittel & Webber, 1973) are socially and ecologically relevant, non-linear, not predictable, and represent highly political interests (Klein, 2004; Lang et al., 2012, p. 29). According to Block et al. (2019, p. 3), complex sustainability problems occur when there is high 1) uncertainty and controversy regarding the knowledge base for solving them, and 2) disagreement on the values and norms underlying alternative problem definitions and solution proposals (Figure 3). For example, climate change, food sovereignty, poverty, and genetically modified organisms are complex sustainability problems because they are highly controversial with high levels of uncertainty in order to find solutions (Hisschemöller & Hoppe, 2018; Pohl & Hadorn, 2007).

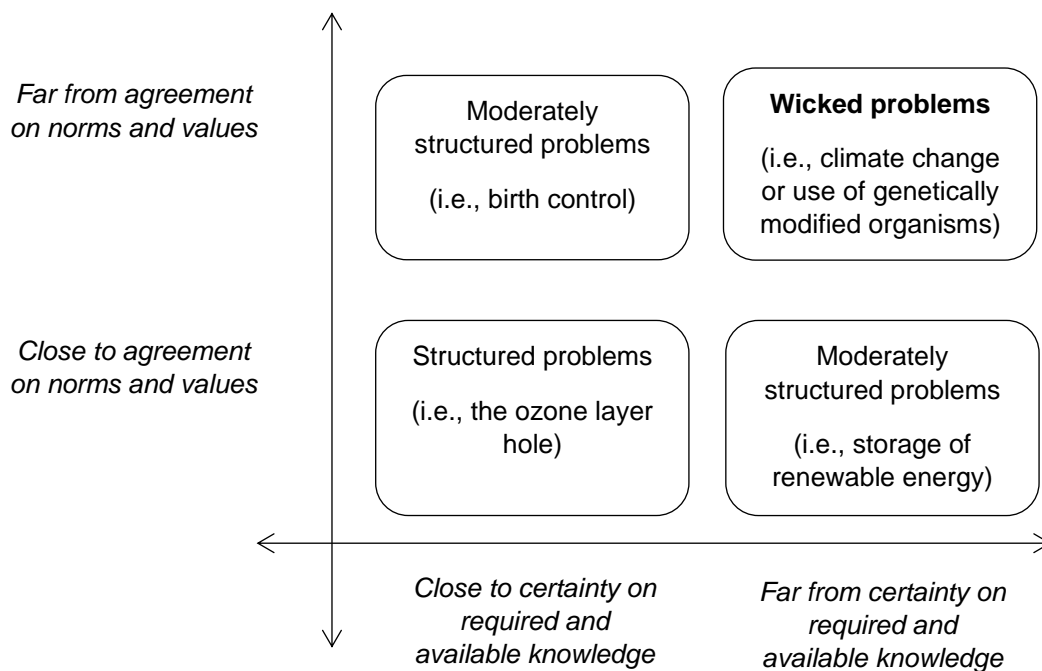


Figure 3. Typology of problems

Note. Source: Block et al. (2019, p. 4)

Dealing with such problems requires “constructive input from various communities of knowledge to ensure that the essential knowledge from all disciplines and actor groups related to the problem is incorporated” (Lang et al., 2012, p. 26). Moreover, a solution-oriented approach requires the co-creation of situated knowledge⁵, which considers power relations, social norms, technologies, and practices because they will be key assets to guide the implementation of the solutions (Lang et al., 2012; Pohl & Hadorn, 2007). Not considering such socio-cultural aspects could jeopardize the integration of academic and social partners (Pohl & Hadorn, 2007). The construction of scientific research questions from complex sustainability problems from every day realities allows the objects of study to be clearly identified and solutions specific enough to work and be useful to be developed (Jahn, 2008; Schneidewind, 2001). As a result, “win-win” situations can be created for all parties involved while dealing with issues that cannot be solved individually while creating a sense of ownership, accountability, and legitimacy (Lang et al., 2012; Rosendahl et al., 2015; Wamsler, 2017). Hence,

⁴ Deliberate process of structural change in a normative direction (Feola, 2015).

⁵ Defined as “knowledge embedded in a physical site or location” (Sole & Edmondson, 2002, p. 20).

transdisciplinarity addresses complex sustainability problems by recognizing that there are multiple levels of reality, and through the logic “included middle” (Nicolescu, 1996, p. 24). The logic of the included middle describes “coherence among different levels of reality, inducing an open structure of unity” (Klein, 2004, p. 516).

Throughout the years, several discussions have aroused around transdisciplinarity. Hence, there is still no “canonical” definition of it, and, according to Jahn, this will not be in the near future (Jahn, 2008, p. 2). However, to carry out the PhD study the following understanding of transdisciplinarity was chosen:

Transdisciplinarity is a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge. (Lang et al., 2012, pp. 25-26)

2.2.1 Knowledge integration

Although there are debates on the definition of transdisciplinarity, a consensus has been reached on some of its characteristics. Pohl (2011, p. 619) summarizes these characteristics as follows: 1) the focus on socially relevant issues, 2) transcending and integrating disciplinary paradigms, 3) doing participatory research, and 4) the search for a unit of knowledge beyond disciplines. These characteristics are the ones that govern the present study.

Although there is a consensus on these characteristics, the weight that each one of them has within transdisciplinary research is under debate, especially regarding the integration of knowledge. According to how different definitions weight these characteristics Pohl (2011) grouped them as A, B, and C definitions. In the definitions from group A, academic knowledge, organized in a disciplinary way, needs to be “reorganized and reassessed to make it relevant to address socially relevant issues” (Pohl, 2011, p. 619). This perspective of transdisciplinarity is built on academic knowledge. While according to definitions from group B, transdisciplinarity starts from concept A but non-academic actors are included. The level of participation of these actors must be established. Finally, definitions from group C seek to unify knowledge to concept A. Then there is a reorganization of “academic knowledge to make it useful to address socially relevant issues” beyond any discipline (Pohl, 2011). The present study is in between concepts B and C, in the sense that it seeks the integration of not only academic knowledge but also non-academic knowledge, considering different levels of integration of the participation scale. However, achieving all four characteristics in a transdisciplinary study is practically a difficult task because there are constant negotiations and trade-offs. According to Tress et al. (2005, p. 487), “these definitions lift transdisciplinarity to the level of a mystic supra-paradigm that can hardly – if ever – be achieved in the daily practice of research”. However, they are guidelines to carry out transdisciplinary processes (Pohl, 2011).

Through transdisciplinary research, socially robust and situated knowledge is co-created, fostering a sense of ownership and legitimacy (Gibbons et al., 1994; Mauser et al., 2013; Rosendahl et al., 2015; Spangenberg, 2011). It is expected that over time transdisciplinarity will mainstream the research world as a new science. This new science has been defined by Gibbons et al. (1994) as Mode 2 Science, differentiating it from older research paradigms (Mode 1 Science) (Block et al., 2022; Mauser et al., 2013; Regeer et al., 2009).

2.2.2 Transdisciplinarity models

Throughout the years, different authors have proposed principles for transdisciplinary research (Bergmann et al., 2005; Max-Neef, 2005; Pohl & Hadorn, 2007; Wiek & Walter, 2009). Some authors presented criteria and principles for the evaluation of transdisciplinary research (Bergmann et al., 2005; Blackstock et al., 2007; Klein, 2008; Lang et al., 2012; Regeer et al., 2009). Likewise, different models to carry out transdisciplinary research based on decision-making and planning have been elaborated. Table 2 presents the phases/steps proposed by different authors for transdisciplinary research. As shown in the table, usually the models propose an initial phase in which the main problem and the main goal or guiding question are identified. This is because the problem should be transformed into a scientific question to be studied (Jahn, 2008). Next, a process of analysis is needed to find solutions and finally, the results are presented. Some authors, like Stauffacher et al. (2008) and Scholz and Binder (2011), propose intermediate phases that expand the model up to six phases.

Table 2. Phases/steps for transdisciplinary research according to different sources

SOURCES	PROPOSED PHASES/STEPS
Bergmann et al. (2005)	Phase A. Team formation Phase B. Project execution and methodology Phase C. Results, products, creating value
Jahn (2008)	Phase A. Construction of a common research object Phase B. New transferable knowledge Phase C. Transdisciplinary integration
Stauffacher et al. (2008)	Phase 1. Goal formation Phase 2. System analysis Phase 3. Scenario construction Phase 4. Multicriteria assessment Phase 5. Generation of operations
Pohl and Hadorn (2007)	Phase 1. Problem identification Phase 2. Problem analysis Phase 3. Bringing results to fruition
Wiek (2007) Wiek and Walter (2009)	Phase 1. Goal formation Phase 2. System analysis Phase 3. Scenario construction Phase 4. Multicriteria assessment Phase 5. Strategy building
Scholz and Binder (2011)	Step 1. Define a guiding question Step 2. Facet the case Step 3. Perform a system analysis Step 4. Construct scenarios using formative scenario analysis

SOURCES	PROPOSED PHASES/STEPS
	Step 5. Multicriteria analysis Step 6. Develop orientations

Note. Source: Author based on cited documents

Lang et al. (2012) introduced a Conceptual Model of Transdisciplinarity (Figure 4), which is based on the work of the authors presented in Table 2, but mainly on Jahn (2008)s “Ideal-typical Conceptual Model”. In Lang et al. (2012)ʼs model, the transdisciplinary research process (central column) goes beyond the pathway of societal practice (left column) or the pathway of scientific practice (right column) because it finds an interface between the two that allows generating solutions that are embedded in both discourses (Lang et al., 2012). At this interface different interests, knowledge systems, power relations, and values meet (Rogge et al., 2013). As a result, the transdisciplinary research process can generate transferable knowledge relevant to societal and scientific practices (Lang et al., 2012). Do to so, the model has three phases: a) collaboratively framing the problem and building a collaborative research team, b) co-producing solution-oriented and transferable knowledge through collaborative research, and c) (re-)integrating and applying the produced knowledge in both scientific and societal practice. First, the model integrates the societal and scientific problems that can be studied through transdisciplinarity (phase A). At the end of this phase, the problem is framed, research goals and objectives are set, and the research team is formed (although it does not explain how). Then, collaborative research takes place to co-create situated knowledge (phase B) that can be transferred into societal practice and to the scientific practice (phase C). The practical implementation of transdisciplinary research has shown that the process does not follow a linear sequence (Popa et al., 2015; Spangenberg, 2011; Wiek & Walter, 2009). It is a highly interactive process due to the constant reflection of the research team, there are feedback loops, and the phases can intermingle, overlap or work in parallel (Enengel et al., 2012).

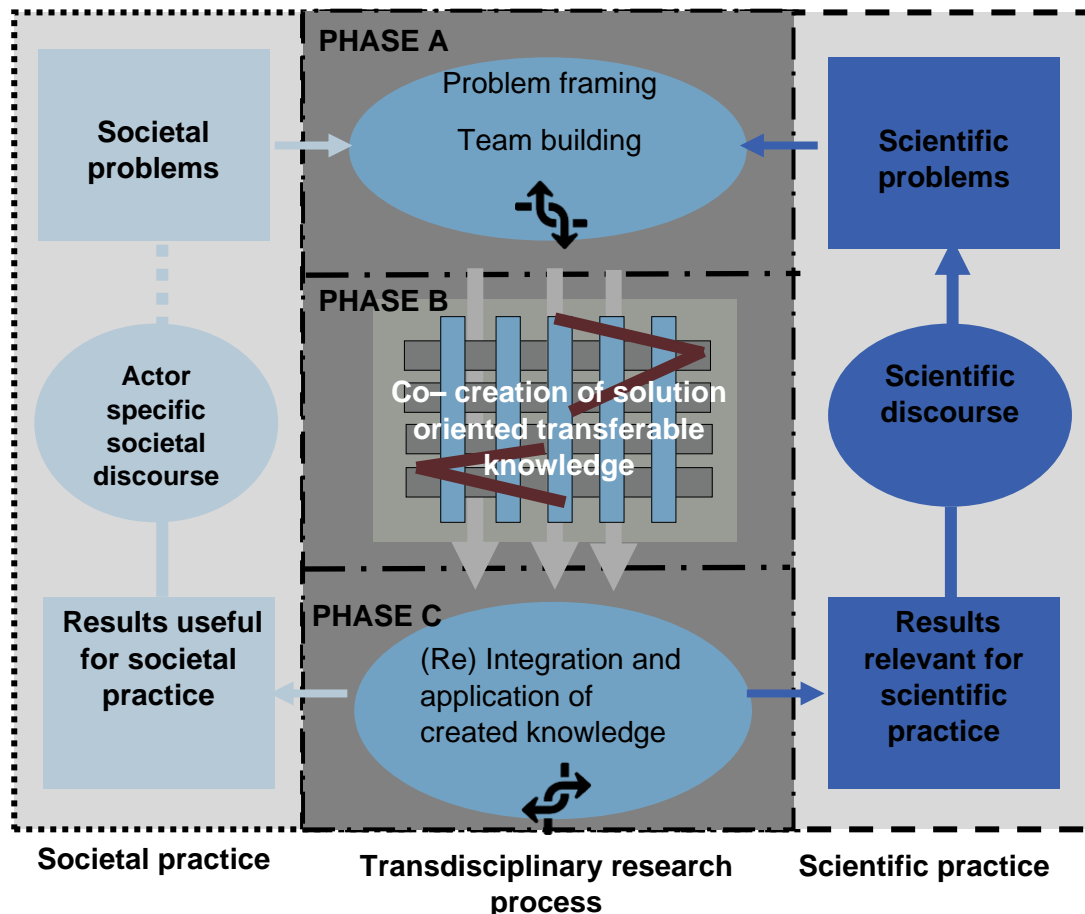


Figure 4. Conceptual model of transdisciplinarity

Note. Source: Lang et al. (2012, p. 28)

Lang et al. (2012)'s model is accompanied by a set of design principles for each phase of the transdisciplinary research process. These design principles are in turn accompanied by a set of guiding questions that could be used to carry out assessments: ex-ante, during, and after the research. Both the design principles and guiding questions have been applied by different projects in rural and urban contexts (Brink et al., 2018; Lang et al., 2012). Specific guidelines on how transdisciplinary research teams are formed are yet missing. A related guiding question reads: "Does (did/will) the project team include all relevant expertise, experience, and other relevant "stakes" needed to tackle the sustainability problem in a way that provides solution options and contributes to the related scientific body of knowledge?" (Lang et al., 2012, p. 30). This question is related to the composition of the team. However, it is not considering the creation of the team as a pre-phase or phase 0, which is a general trend in transdisciplinary literature. For example, Bergmann et al. (2005) identify three types of actors for team formation: practice partners, practice representatives, and practice actors. Pohl and Hadorn (2007, p. 30) explain that the actors involved should be identified according to four requirements for transdisciplinary research: 1) grasp the complexity of problems, 2) account for the diversity of life-world and scientific perceptions of problems, 3) link abstract and case-specific knowledge, and 4) develop knowledge and practices that promote what is perceived to be the common good. Hence, Lang et al. (2012)'s model does not document how phase A is to be reached in a transdisciplinary way, and generally, it is assumed that people already know how to reach this phase or that they will learn how to do it along the research process (Horcea-Milcu et al., 2022, p. 190).

In the literature, two publications were found dealing with a pre-phase or phase 0 in a more systematic way. On the one hand, Muhar et al. (2006) describe the process of initiating transdisciplinarity in academic case study teaching in Austria. They describe the preparation phase as long (approximately one year) but extremely important. They followed a research-driven approach composed of different activities: stakeholder analysis, network analysis, workshops, and in-depth interviews. A steering group strongly involved in the project was formed. Also, an advisory group with key stakeholders was formed to make sure that the development goals were reached and a reference group that discussed and analyzed the work in each subgroup was formed. In total, 70 people actively participated in the process and 300 people participated in key events.

On the other hand, Horcea-Milcu, Leventon, and Lang (2022, p. 187) recently proposed the so-called phase 0 composed of three sub-phases: sub-phase 0.1) selecting the case study; sub-phase 0.2) understanding the case study context from a transdisciplinary perspective; and sub-phase 0.3) fostering premises for coming together. Phase 0 partly overlaps with phase A of Lang (2012)'s model. Although sub-phase 0.3 describes the premises needed to come together in a transdisciplinary research team, the proposal described in Horcea-Milcu et al. (2022) is strongly research-driven because it first focuses on selecting the case study and then the transdisciplinary team is created by inviting matching actors. This approach follows the process of a) describing the potential cases, b) matching those cases with research interest, and c) assessing those cases against refined selection criteria (Horcea-Milcu et al., 2022, pp. 190-191). In the process of selecting a case study, potential partners or collaborators are identified and finally selected.

The pre-phase or phase 0 could be society-driven or research-driven. In society-driven, the initiative to develop transdisciplinary research comes from society. In the research-driven approach, the initiative comes from academia; hence academic researchers contact other actors to be part of the research (Horcea-Milcu et al., 2022, p. 190). Horcea-Milcu et al. (2022) and Muhar et al. (2006) followed the research-driven approach. The study described in Horcea-Milcu et al. (2022) took place in a context of "low levels of civic participation" in which it is not common for research initiatives to come from the society (Horcea-Milcu et al., 2022, p. 191). The study described by Muhar et al. (2006) was a teaching project. Evidence for a phase 0 in a society-driven approach is, as far as we know, absent from the literature. This methodological void could jeopardize the core phases of the transdisciplinary model by falling into top-down approaches (Leventon et al., 2022; Mitchell et al., 2015). Moreover, the need to further develop models to operationalize transdisciplinarity has been identified by some scholars like Bergmann (2005), Jahn (2008), and Regeer (2009). Chapter 4 of this PhD dissertation addresses this knowledge gap.

2.2.3 Power relations in transdisciplinarity

When developing transdisciplinary research, it can be assumed or expected that power relations between actors are leveled granting equitable participation among all. However, this is not necessarily the case and, on the contrary, if power relations are not considered, the most vulnerable and marginal actors in a population can be left out of the process (Brouwer et al., 2013). This can limit the integration of different knowledge systems since the process can fall into more traditional and top-down approaches, non-academic actors are seen only as sources of information, knowledge, and ideas, needed for the validation of results (Bergmann et al., 2005). Muhar et al. (2006) explain that it is not enough that non-academic actors have the option to contribute from their experience and because of other criteria, but their contribution

should also reflect their interests, dreams, and fears, which allows non-academic actors to be in the option of assuming responsibilities and active roles to transform their lives.

Stauffacher et al. (2008, p. 410) took up the participation ladder developed by Arnstein (1969) and linked it to empowerment and transdisciplinary research grouping the eight levels of participation as follows: non-participation (manipulation, therapy), degree of tokenism (informing, consultation, placation), and degree of citizen power (partnership, delegated control, citizen control). Based on this ladder, they proposed a new scale to reflect the level of integration, which ranges from information, consultation, cooperation, collaboration to empowerment. They explain that the impact of information and consultation can be weak for integration as it mainly concerns one-way communication. Empowerment is achieved after cooperation and collaboration because these are ways of two-sided communication, giving the same level of responsibility to the parties in the process. However, Stauffacher et al. (2008) recognize that the level of involvement of the actors may vary according to the progress of the transdisciplinary process. For example, in their research, they started with the selection of the case study with the involvement of non-academic actors at a level of “information”. This level of involvement of non-academic actors increased to “consultation” and “cooperation” when during the search for partners. Then, the level of involvement scaled up to “collaboration” with non-academic partners during the definition of the problem and planning of the research project. The level of involvement lowered back to “consultation” during the writing process of the research project. In the next phases of their research, the level of involvement oscillated between “consultation” and “collaboration”. It is important to note, that in their study the level of involvement did not lower back to an “information” level. Finally, the “empowerment” level of involvement of non-academic actors was reached in the final phase of the process when the identified solutions are implemented (Stauffacher et al., 2008).

2.3 Agroecology

Social movements, such as Brazil’s Movimento dos Trabalhadores Sem Terra (Landless Workers Movement), recognized that food sovereignty is not only about a “struggle for the land” but it is also about a “struggle on the land” because agricultural transformation is needed (De Almeida et al., 2000, p. 25). As such, agroecology was presented by La Via Campesina as a means to achieve food sovereignty because “agroecological farms are substantially more productive ... [and] a more integrated farm is one that combines crops and livestock, intercrops and rotates crops, employs agroforestry, and generally exhibits a higher level of functional biodiversity” (Via Campesina, 2010). Numerous studies show that agroecology can feed the world within a framework of social justice and environmental sustainability (Badgley et al., 2007; Pretty & Hine, 2000; Rosset, 2000). Worldwide, it was shown that agroecology can improve the production and productivity of food systems and can revalue traditional ecological knowledge, and empower local communities (Holt -Gimenez and Altieri 2013, FAO 2018). It can also increase the resilience of households by guaranteeing nutritious, healthy, and diverse foods. In addition, it contributes to reducing the dependency on external inputs, the sensitivity to market fluctuations, and the vulnerability to climate change. However, the implementation of agroecology at a large-scale to meet global food needs raises concerns among different international organizations and academics (Bernard & Lux, 2017; Feder et al., 2004; IAASTD, 2009; Parmentier, 2014; Rockstrom et al., 2007). Moreover, although the general principles of agroecology are not questioned, principles linked to organic agriculture are questioned. For example, there is evidence of the benefits of polycultures on the increase of nutrients and efficient use of water on small-scale farms, but not on their implementation on large-scale farms (Brooker et al., 2015; Cassidy et al., 2013; Ramankutty et al., 2018). Hence, practitioners and scientist are dedicating their efforts to finding ways to scale up agroecology (i.e.,

computational agroecology, policy changes, partnerships, etc.) and scale out agroecology to other farmers and communities through dissemination (Bernard & Lux, 2017; Gliessman, 2019; Lilja et al., 2004; Raghavan et al., 2016; World Future Council, 2018).

Like food sovereignty, the concept of agroecology has evolved and changed over time. It is important to mention that indigenous groups and farmers have already developed and used agroecological techniques throughout history (García López et al., 2020). Yet as a concept, it was first mentioned in the 1920s and 1930s by Bensin, referring to it as a science, defined as “the application of ecology in agriculture” (Wezel et al., 2009, p. 2). Within this current of thought, there are definitions of agroecology that portray it simply as part of the natural sciences, rooted in western scientific knowledge, providing important ecological information but not including socio-political issues of the agri-food systems (Méndez et al., 2015).

Another current of agroecology includes multiple knowledge systems, social movements, and practices in its definitions (Méndez et al., 2015; Wezel et al., 2009). This current dates from the 1970’s and was developed as a contraposition to the corporate regime. Therefore, it seeks sustainable food production in alliance with the socio-ecosystem considering social, cultural, and political aspects, defining agroecology as:

Agroecology is a scientific discipline, a set of practices and a social movement. As a science, it studies how different components of the agroecosystem interact. As a set of practices, it seeks sustainable farming systems that optimize and stabilize yields. As a social movement, it pursues multifunctional roles for agriculture, promotes social justice, nurtures identity and culture, and strengthens the economic viability of rural areas. Family farmers are the people who hold the tools for practicing agroecology. They are the real keepers of the knowledge and wisdom needed for this agenda. Therefore, family farmers around the world are the key elements for producing food in an agroecological way. (FAO, 2022 Italics added)

Following this logic, agroecology is much more than a set of agronomic techniques; it is understood as knowledge and has become a great emancipatory social movement, that recognizes the mutual dependence of these dimensions. It is in this understanding that agroecology observes and studies the complexity and dynamism of socioecological systems⁶ to generate more sustainable agroecosystems.

2.3.1 Agroecology as a practice

In its early years, agroecology focused on substituting inputs and harmful agricultural practices of the agro-industrial system for inputs that are more friendly to the environment (Gliessman, 2018). Over time this has changed, and agroecology no longer focuses only on the substitution of inputs and practices. Currently, the practice dimension of agroecology seeks the transformation of the food system across scales, from the farm to the transformation of the global food system (Wezel et al., 2009). Moreover, agroecology recognizes the fundamental role of farming families not only in the development of agroecological practices but also in their transmission of knowledge from generation to generation, acknowledging also that the practice of traditional knowledge is essential for its repetition and retention. Thus, agroecology also rescues and revalues the practices of peasant wisdom that were once mistreated (García López et al., 2020).

⁶ Defined as “a coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner” (Redman et al., 2004, p. 163).

Five ecological principles are applied in the design and implementation of technological innovations and practices (Altieri, 2015, p. 8):

- Enhance recycling of biomass, optimizing nutrient availability and balancing nutrient flow.
- Secure favourable soil conditions for plant growth, particularly by managing organic matter and enhancing soil biotic activity.
- Minimize losses due to flows of solar radiation, air and water by way of microclimate management, water harvesting and soil management through increased soil cover.
- Species and genetic diversification of the agroecosystem in time and space at the field and landscape level.
- Enhance beneficial biological interaction and synergisms among agrobiodiversity components, thus resulting in the promotion of key ecological processes and services.

2.3.2 Agroecology as science

In contraposition to the corporate regime that believes in “monocultures of knowledge” (*monocultura del saber*) (De Sousa Santos, 2010, p. 22), agroecology’s dimension as a scientific discipline recognizes that there are different knowledge systems besides the one provided by academics. For example, agroecology also considers local, traditional, and autochthonous knowledge. This knowledge has been defined as “absences” (*ausencias*) by De Sousa Santos (2010) because they are left outside of the monoculture of knowledge. Hence, agroecology distances itself from “hegemonic sciences that have considered that what is not known does not exist [and] consider that what has no economic value does not deserve to be understood in depth” (Crespo & Frank, 2022, p. 28 author’s translation).

By recognizing that there are different knowledge systems, agroecology promotes a *diálogo de saberes* between academics, farmers, civil society, and the state for the co-creation of knowledge (Martínez-Torres & Rosset, 2014). Moreover, it recognizes that every day, farmers are constantly observing and experimenting, and are prime holders and creators of local agroecological knowledge. Hence, they are aware of the “history, the nature of problems, possible solutions, changing circumstances and capricious local dynamics” of their socioecological systems (Leeuwis & Ban, 2004, p. 54).

Therefore, the *diálogo de saberes* recognizes that there are many types of knowledge, forms of knowledge, and worldviews and that from these encounters of knowledge new ones can be co-created and conflicts avoided, being a “collective construction of mobilizing frames for resistance” (Martínez-Torres & Rosset, 2014, p. 980). The “agroecology pedagogy” or “peasant pedagogy” which is heavily based on the *diálogo de saberes*, introduces processes of knowledge transfer from peasant to peasant and field schools among others (Holt-Giménez, 2006; Martínez-Torres & Rosset, 2014). This work is built based on Freire’s pedagogy of the oppressed (Freire, 1982). This recognition is empowering and emancipatory for farmers as they can become shapers of their future (Leeuwis & Ban, 2004; Méndez et al., 2015; Nelson & Wright, 1995).

Hence, the *diálogo de saberes* that agroecology promotes is considered a tool to achieve food sovereignty. Martínez-Torres and Rosset (2014) explain that it is thanks to the *diálogo de*

saberes that La Via Campesina has managed to maintain itself through time as a social movement and to become even more empowered:

Representatives of this immense diversity come together to exchange, dialog, discuss, debate, analyze, strategize, build consensus around collective readings of reality, and agree on collective actions and campaigns with national, regional, continental or global scope. (Martínez-Torres & Rosset, 2014, p. 979)

2.3.3 Agroecology as a social movement

Agroecology as a social movement is based on the principles of equity and sustainability, with the goal of empowering people to take control of their own food systems. It calls for the exchange of experiences and knowledge among farmers, the use of local inputs and the development of local innovation (Altieri & Rosset, 2018). More importantly, by recognizing that there are different knowledge systems, it promotes a *diálogo de saberes* between academics, farmers, civil society, and the state for the co-creation of knowledge (Martínez-Torres & Rosset, 2014). The *diálogo de saberes* has helped to accelerate the agroecological movement as an alternative to the Green Revolution (Martínez-Torres & Rosset, 2014).

In this research, the dimension of social movements is approached from an empowerment point of view because power relations are part of food sovereignty and agroecology. For instance, it is about the people's power to get organized and demand their rights. Also, it is about the people's agency to decide on the composition and purpose of their food systems (Resler & Hagolani-Albov, 2021). Above all, it has the character of challenging the dominant power structures in the corporate regime (Altieri & Rosset, 2018). Likewise, agroecology also recognizes that in Participatory Action Research processes, the different actors have their own interests and power relations are present (Méndez et al., 2017). Therefore, agroecology is highly political (Altieri & Rosset, 2018).

Empowerment is also part of the definition of food sovereignty given by La Via Campesina:

Food sovereignty prioritizes local and national economies and markets and empowers peasant and family farmer-driven agriculture, artisanal-fishing, pastoralist-led grazing, and food production, distribution and consumption based on environmental, social and economic sustainability. (Sélingué, 2007)

Contrary to what is often assumed, agroecology is not a final objective because it is a continuous process that seeks the sustainable transformation of food systems (Anderson et al., 2021). The social movements' Declaration of Agroecology in the Forum on Agroecology in 2015 argued that agroecology is cross-sectoral since food systems depend on the integral management of natural resources (Nyeleni, 2015). It is in this sense that agroecology is gaining ground not only in academic spaces but also in higher decision-making spaces. Efforts focus not only on the development of policies on scaling agroecology, but also the regularization of natural resources linked to food systems (Méndez et al., 2013). This intersectoral look requires "adopting a transdisciplinary, participatory and action-oriented research approach that combines the natural and social sciences with the local knowledge" (Anderson et al., 2021, p. 137).

2.4 Theory of change. Transdisciplinary agroecology

The three dimensions of agroecology, supports the resistance to the westernized colonization of knowledge, farming, and territories that has led to the unsustainability of modern agri-food

systems (Fernandes et al., 2021; Pérez Neira & Soler Montiel, 2013). In this process of decolonization, agroecology has focused on the recovery and revaluation of ancestral and traditional knowledge, on the development of alternative models of production and consumption based on respect for life (Pérez Neira & Soler Montiel, 2013). Moreover, looking at agroecology from the three above-mentioned dimensions shows that it has a very close link with transdisciplinarity (Rosset et al., 2022). In this regard, Gliessman (2018, p. 599) mentions:

Agroecology is the integration of research, education, action, and change that brings sustainability to all parts of the food system: ecological, economic, and social. It's transdisciplinary in that it values all forms of knowledge and experience in food system change. It's participatory in that it requires the involvement of all stakeholders from the farm to the table and everyone in between. And it is action-oriented because it confronts the economic and political power structures of the current industrial food system with alternative social structures and policy action. The approach is grounded in ecological thinking where a holistic, systems-level understanding of food system sustainability is required.

Despite the clear link between agroecology and transdisciplinarity, not much is found in the literature about it. Transdisciplinary agroecology is mentioned in the publications of some scholars but superficially, as taken for granted, and without a clear definition (Gliessman, 2022; Méndez et al., 2015; Nawn et al., 2018; Pimbert, 2015, 2016; White et al., 2022). Moreover, in these documents, agroecology is presented as a space or opportunity to develop transdisciplinary research and/or education. Yet, no research is found on how to operationalize transdisciplinary agroecology to obtain food sovereignty. Although transdisciplinary agroecology may seem tautological, it is vital to gain insights into its operationalization to achieve food sovereignty. This is a challenge taken by this PhD study.

To achieve this, the present study understands transdisciplinary agroecology as a collaborative and society-driven research, based on the *diálogo de saberes* for the co-creation of more sustainable, equitable, and empowering agri-food systems. This co-creation follows a bottom-up, multi-actor, multi-level, and multisectoral approach with the integration of various systems of knowledge. Moreover, transdisciplinary agroecology comprehensively encompasses the three dimensions of agroecology: practices, science, and social movement. Therefore, innovation in one of these dimensions cannot be at the expense of another but should enhance them.

Therefore, this dissertation explores each one of these dimensions to find insights into the operationalization of transdisciplinary agroecology from a society-driven approach. In this dissertation, the practices dimension of transdisciplinary agroecology focuses on giving insights about “phase 0” for the conformation of a collaborative research group for agroecological innovation. This is addressed in chapter 4. The dimension of science is explored in chapter 5 by identifying which factors are affecting the transmission of traditional knowledge. This identification is key to performing transdisciplinary research and promoting an equitable integration of knowledge. Power relations can affect the participation of various actors but can also define which knowledge has more value over another (Pohl & Hadorn, 2007). For example, academic knowledge may be given more weight over traditional knowledge. This is also reflected in the way the contribution of non-academic actors is recognized in transdisciplinary research (Muhar et al., 2006). Moreover, the lack of recognition of traditional knowledge can also be observed in the peasant and indigenous communities themselves, where this type of knowledge is valued and recognized by younger generations (Milton, 2001). Therefore, it is important to explore power relations in transdisciplinary processes in general and in the co-creation of food sovereignty in specific to gain insights on

how to achieve true empowerment through transdisciplinary research. Chapter 6 of this dissertation deals with this knowledge gap. Although each empirical chapter addresses one dimension of transdisciplinary agroecology, the other two dimensions are transversally integrated in the analysis.

Figure 5, developed by the author, presents a summary of the transdisciplinary agroecology approach for the co-creation of food sovereignty used in this dissertation. Transdisciplinary agroecology is at the core of food sovereignty, represented by the shared space of the Venn Diagram, where three dimensions are integrated. In the dissertation, each dimension explores a specific knowledge gap. The dimension of practices focuses on “phase 0”. The dimension of science focuses on traditional ecological knowledge, while the dimension of social movements focuses on power relations.

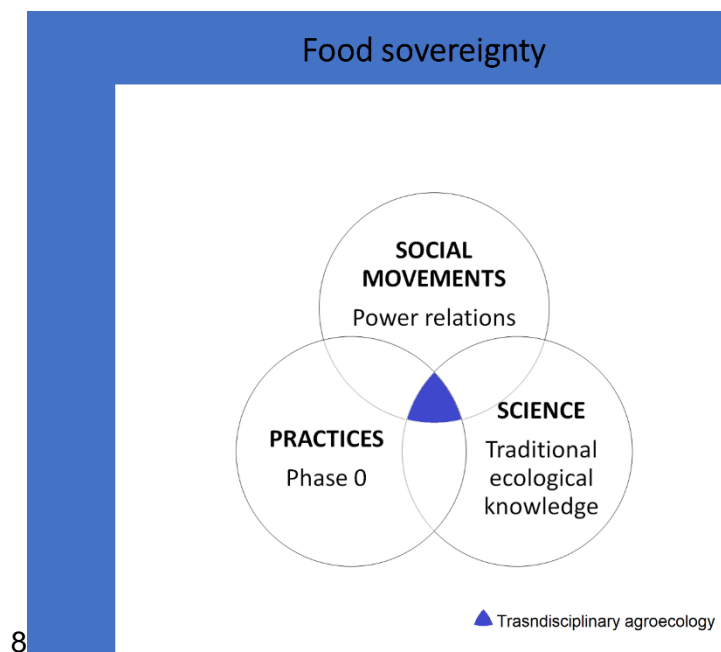


Figure 5. Transdisciplinary agroecology for the co-creation of food sovereignty

Note. Source: Author

2.5 Structure of the dissertation

The PhD dissertation has six chapters (Figure 6). The first chapter presented the general introduction of the dissertation including the central concepts, research gaps, and a description of the case study in Bolivia. Chapter 2 presents the referential framework of the case study. Chapter 3 proceeds with giving the main objective, the research questions, and the methodology of the study. Then, chapter 4 presents the findings regarding the operationalization of “phase 0” for society-driven transdisciplinary agroecology research. It is a reflexive article about two transdisciplinary cases of technological innovation in Tiraque. Chapter 5 identifies the socioecological factors that impact the transmission of traditional ecological knowledge within and across generations. Chapter 6 presents the findings regarding the influence of people’s interests, socio-political structures, and knowledge in power relations. Chapter 7 wraps up by answering each research question and presenting a series of “take home” lessons about how transdisciplinary agroecology can be organized for the co-creation of food sovereignty. To do so, this chapter first presents the synthesis and findings of the PhD study, answering each research question. Then, the main theoretical and methodological

findings are presented for the co-creation of food sovereignty. The chapter ends with final reflections on the overall thesis research with a focus on my role as a researcher in a transdisciplinary study.

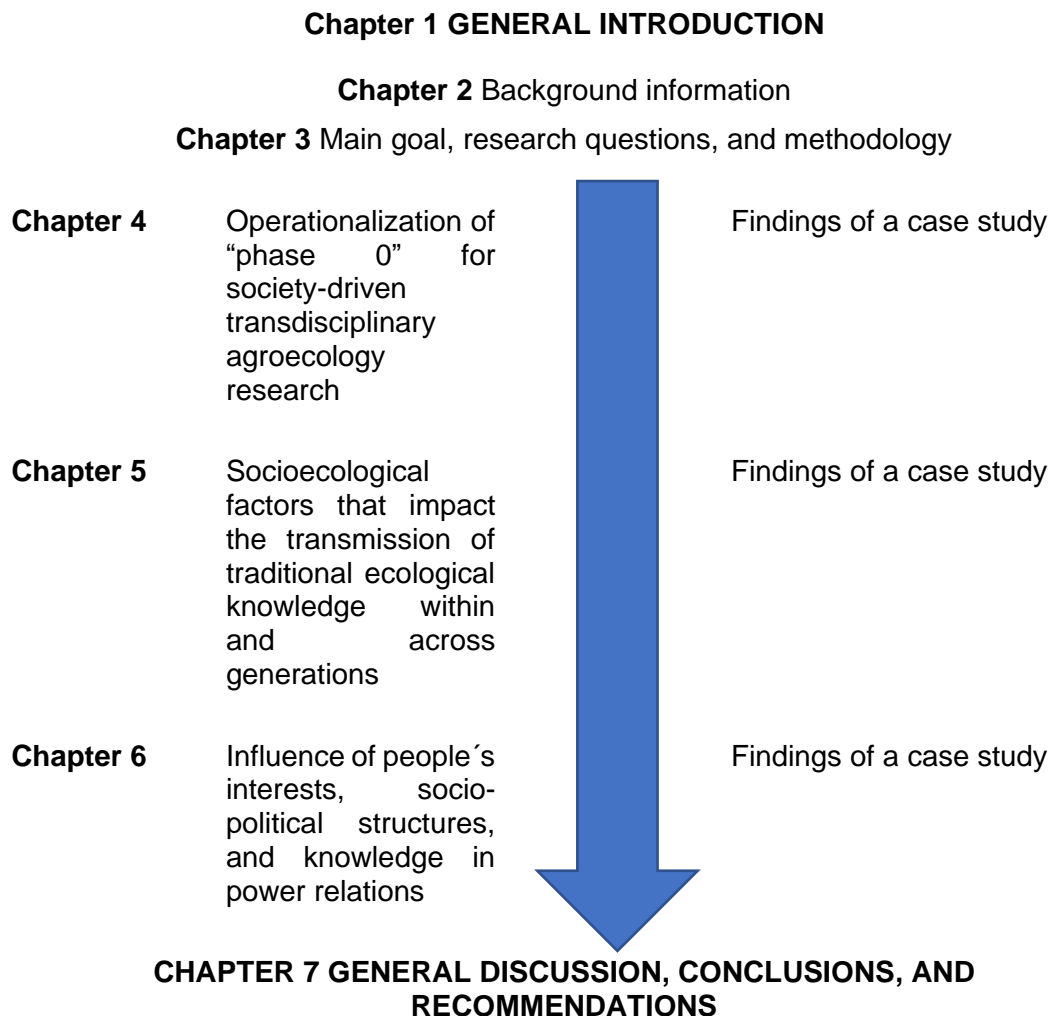


Figure 6. Structure of the dissertation

Note. Source: Author

CHAPTER 2. BACKGROUND INFORMATION

1. Introduction

The PhD study is part of the Inter-University Cooperation Program VLIR UOS IUC with Universidad Católica Boliviana “San Pablo” in Bolivia. This section gives a detailed description of the case study. First, the program is presented, followed by a description of the state of food sovereignty and agroecology in Bolivia. Next, the rural municipality of Tiraque and its socioecological system are introduced.

2. Inter-University Cooperation Program

The present research is part of the Inter-University Cooperation Program VLIR UOS IUC with the Universidad Católica Boliviana “San Pablo” (UCB). The program has the following objective:

Rural and urban communities in cooperation with UCB and public universities in the different geographical regions of Bolivia increased their resilience to respond to complex local problems related to economic, social, climate and environmental changes in an integrative way, with the aim to maintain and improve the quality of life for all their members, especially families, women, children and adolescents. (UCB & VLIR-UOS, 2016, p. 9)

To achieve its goal, the program is composed of six projects, each with its own set of goals. Projects contribute to one of two strategies (VLIR-UOS, 2017):

- Improving and expanding currently developed UCB research in the areas of (a) social development and safety (Projects 1, 4, and 5), (b) environment and natural resources (Project 2), and (c) food sovereignty (Project 3) at the four regional UCB regional campuses.
- Integrating and transforming the aforementioned UCB research into a transdisciplinary and collaborative learning community approach (Project 6).

This research is part of Project 3 which is a “Project to promote food sovereignty and nutritional innovation”. It aims to identify innovative strategies to promote food production, productivity, and resilience and as such to contribute to reduce vulnerability in the communities located in the four regional campuses of the University (UCB, 2018, p. 3). This project has three research lines: 1) conflicts over natural resources and technology transfer for food production; 2) agricultural production and productivity; and 3) agribusiness and nutrition models. Although this PhD covers several aspects of the three research areas, it specifically aligns with research line 2. A detail description of the transdisciplinary dynamics of the Inter-University Cooperation Program is presented in chapter 4.

3. Food sovereignty in Bolivia

During the 1980s, a neoliberal structure was established in Bolivia. It was based on the New Economic Policy that dismantled public services and increased the vulnerability of indigenous and original peasant communities to accumulate capital (McKay et al., 2014). Later, the country experienced a series of transformations that resulted in the election of Evo Morales from Movimiento al Socialismo as president in 2006. With Evo Morales as the head of the State, the so-called “process of change” began, following a Productive Community Social Economic Model (Ministerio de Economía y Finanzas Públicas, 2011). This process is meant to dismantle the neoliberal and colonizing structures from the past to establish the development paradigm

of *Vivir Bien* (living well) (McKay et al., 2014). Because food sovereignty is part of the process of change and *Vivir Bien*, it became part of the new Political Constitution of the State in 2009 where the right to food is established in article 16- "I: Everyone has the right to water and food. II. The State must guarantee food security, through healthy, adequate and sufficient food for the entire population" (Bolivia, 2009 Author's translation). Food sovereignty is addressed in article 297-II-8: "Food security and sovereignty for the entire population; import ban, production and commercialization of genetically modified organisms and toxic elements that damage the health and the environment" (Bolivia, 2009 Author's translation). Likewise, it is covered in articles 309-4, 405, 406-I, and 407-1.

Later, laws and regulations were issued related to food sovereignty. For example, since the year 2011, food sovereignty is regulated through Law N° 144 of the Agricultural Community Productive Revolution. To achieve sustainable rural development with food sovereignty, this law establishes 16 State policies (Estado Plurinacional de Bolivia, 2011). In article 6-8, it defines food sovereignty as follows: "Bolivian people, through the Plurinational State, define and implement their policies and strategies aimed at the production, collection, transformation, conservation, storage, transportation, distribution, marketing, consumption and exchange of food" (Estado Plurinacional de Bolivia, 2011).

This law seeks to share the responsibility for food sovereignty between the State and the Bolivian population. For example, the third chapter of the law recognizes the following communities as central for food security: native indigenous peasants, intercultural, and Afro-Bolivian communities (Estado Plurinacional de Bolivia, 2011 Art. 8). This chapter recognizes the capacity of these communities to manage their territories. Moreover, it recognizes the co-responsibility of these communities and government agencies to achieve food sovereignty, including the formulation of public policies. Likewise, article 6 presents the guiding principles of the law. Among them are complementarity and co-responsibility, defined as follows (Estado Plurinacional de Bolivia, 2011 Art. 6 2-3):

- Complementarity. Food sovereignty is based on the concurrence of all the efforts, initiatives, principles, and policies of the State, the indigenous nations and peoples of peasant origin, intercultural and Afro-Bolivian communities, other actors of the plural economy, and the population in general, who will act jointly to the satisfaction of the food needs of Bolivian men and women.
- Co-responsibility. Food sovereignty is the obligation and responsibility of the State at all levels of government and of all Bolivians.

Hence, under this law, the State intends to share the responsibility of sovereignty with the social bases. However, the State's presence remains important. Furthermore, the law declares the importance of some strategic crops of an extensive and agro-industrial nature intended mainly for export, such as sorghum (Estado Plurinacional de Bolivia, 2011 Segunda I). This and other inconsistencies of the State regarding food sovereignty are detailed later. The following regulations are related to food sovereignty (Jimenez, 2020, p. 53):

- Autonomy and decentralization framework law "Andrés Ibáñez" (N° 031)
- Law on Mother earth rights (N° 071)
- Law of declaration of national priority of the production, industrialization, and commercialization of quinoa in the producing regions of the country (N° 98)

- Declaration of national priority of the production, industrialization, and commercialization of chili and peanuts in the regions that have this productive vocation law (N°141)
- Law on the creation of the fund to support dairy production complex – PROLECHE (N° 204)
- Framework law of Mother Earth and integral development to live well (N° 300)
- Law on the support to food production and forest restitution (N° 337)
- Law on peasant and indigenous economic organizations (OECAS) and community economic organizations (OECOM) for the integration of sustainable family farming and food sovereignty (N° 338)
- Law against subjugation and land trafficking (N° 477)
- Law on school meals within the framework of food sovereignty and the plural economy (N° 622)

Moreover, food sovereignty is one of the pillars of the General Economic and Social Development Plan 2025: Food security with sovereignty, export promotion with added value, and tourism development (Estado Plurinacional de Bolivia, 2013). In this case, the discourse shifts from “food sovereignty” to “food security with sovereignty”. The latter focuses on the sovereignty of the State, not on food. Hence, these laws and regulations were created to gain State control over food systems.

Bolivia is also committed to advancing the 2030 Agenda and its Sustainable Development Goals that were approved in 2015 by the United Nations General Assembly. According to the Voluntary Report for the year 2021, Bolivia aims at:

Ending hunger, achieving food security, and improving nutrition by the year 2030 are addressed by the Plurinational State of Bolivia through the implementation of actions aimed at improving access to food and increasing the production of diverse foods. In this sense, it seeks to achieve **food security with sovereignty**, considering the implementation of policies under an import substitution approach that allows supplying the domestic market with food of national origin and the strengthening of family farming as the main actor in the provision of healthy and nutritious food (Estado Plurinacional de Bolivia, 2021, p. 26 bold added, author’s translation).

For Sustainable Development Goal N° 2 (Zero Hunger, or in full: end hunger, achieve food security and improved nutrition, and promote sustainable agriculture), Bolivia set a series of goals. One of them is to increase agricultural production through technology and expansion of the cultivated surface. According to a State report of 2021, the cultivated surface increased from 3.6 million hectares in 2015 to 3.9 million hectares in 2020 (Estado Plurinacional de Bolivia, 2021). The report estimates that production increased by 20.2 million tons.

With this arsenal of public policies, a major change in the country’s food sovereignty would be expected. However, this is not the case. McKay, Nehring, and Walsh-Dilley (2014) in their study on the state of food sovereignty in Latin America presented the political projects and alternative pathways for Venezuela, Ecuador, and Bolivia. According to their study, Bolivia had at the time of their study not yet achieved food sovereignty in practice beyond the political discourse. Extractivist policies have been developed in favor of the agro-industrial sector in the

lowlands⁷ of the country promoting the expansion of the agricultural frontier, *chaqueo*⁸, and genetically modified organisms (McKay et al., 2014). In 2014, during the Session of Honor for the 204 years of the independence of Santa Cruz, former vice president García-Linera challenged the agribusiness sector of Santa Cruz to increase the cultivated area in an effusive speech:

We have the purpose of increasing half a million hectares each year. My dream is to have one million, so that in 2020 we go from 2.5 million hectares to 7.5 million. So, we are going to guarantee food for the population. We will guarantee a strong economy and we would turn Bolivia into one of the food centers of the continent. (La Razón, 2014 Author's translation)

Soon after, he put this purpose into practice and distributed and delivered land property titles of approximately 300,000 hectares to entrepreneurs of the agribusiness sector in Santa Cruz:

Let's take on the challenge of producing big, producing a lot, investing a lot, generating a lot of wealth. Your State is here to serve you. It is not there to bother you. To make your activity difficult. But you invest. (La Razón, 2014 Author's translation)

Under the pretext of increasing food production in the lowland region of the country, a series of laws were enacted that promoted the expansion of the agricultural frontier through *chaqueo*. Cartagena and Peralta (2021, p. 7) explain that "laws 337, 502, 739 and 952 legalized illegal clearing, thereby consolidating the change in land use in the lowlands" (Cartagena & Peralta, 2021, p. 7). In 2019, a supreme decree was issued authorizing the clearing of land for forestry purposes. As a result, in that year, 6.43 million hectares were burned (Cartagena & Peralta, 2021). This situation was complemented by the Supreme Decree N° 4232, which was approved by the controversial government of Añez, and shortened the process of evaluating transgenic seeds in the country (Estado Plurinacional de Bolivia, 2020). This decree was annulled in 2021 by Arce following massive social protests in 2021.

The shifts in favor of the agribusiness sector result from the State's vision of increasing the country's income, calling into question the contribution of family farming to the country's economy. This has seriously affected the support that family farming receives in economic, technical, and political terms (Czaplicki, 2021). Instead, the State supports the large-scale commercial exploitation of mainly soybean, livestock, and forest production. An estimated 64.5 million hectares are used for livestock rearing, intensive arable farming, plantations, and logging (Czaplicki, 2021, p. 19). However, family farming feeds the country and represents almost 99% of the basic family food basket (Czaplicki, 2021). Yet, it does not even occupy 70% of the country's cultivated agricultural area (Velarde et al., 2021). The soybean production is not destined to feed the country but is mainly used as animal feed, exported, and, to a lesser extent, transformed into soybean oil. Czaplicki (2021) explains that the substantial increase in the country's cultivated area between 2009 and 2014 is mainly due to the increased production of agro-industrial crops such as soybeans (42%), sorghum (21%) and corn (15%). Hence, because there is no support for the sector that does produce Bolivian food, imports of agricultural products doubled between 2006 and 2014 (Czaplicki, 2021).

⁷ Mainly the departments of Santa Cruz and Beni. This region is dedicated to the industrial production of soy, sorghum, and maize for export.

⁸ Deforestation through slash and burn practices.

According to the State of Food and Nutrition Security in the World 2021, Bolivia reported a decrease in the number of undernourished⁹ people from 2.5 million in the period 2004-2006 to 1.5 million in the period 2018-2020 (FAO et al., 2021). The prevalence rate of undernourishment of 12.6% for the period 2018-2020 was also lower compared to the rate of 26.8% that was estimated for the 2004-2006 period. Despite the reduction in hunger, Bolivia continues to be among the 56 countries with the highest number of undernourished people in the world (FAO et al., 2021). Bolivia struggles with a double burden of malnutrition as also the number of overweight adults (over 18 years of age) increased from 1.1 million in 2012 to 1.4 million in 2016 (FAO et al., 2021).

In addition to the state support given to the agribusiness sector, the State programs linked to food sovereignty seem to depend on external financing. Hence, the meaning of sovereignty is lost, and the discourse of decolonization does not come into practice (McKay et al., 2014). In addition, the Movimiento al Socialismo has monopolized the social organizations (McKay et al., 2014). Hence, they have lost their ability to claim, becoming the executive branch of the Movimiento al Socialismo. In sum, despite the great legal advances in Bolivia, there is still much to be done in terms of sovereignty and even more in terms of food sovereignty.

4. Agroecology in Bolivia

Catacora et al. (2017) distinguish two agroecological trajectories in Bolivia. The first, broad trajectory corresponds to the agriculture developed by the pre-Hispanic cultures, who developed complex agroecological knowledge and technology based on a deep understanding of the local environment (i.e., *suka Kollus*¹⁰, agrobiodiversity management and weather forecasting through bio-indicators). For example, the Aymara agricultural system has extensive knowledge of wild plants and crops. This system of agriculture was passed down through generations, and it was an integral part of Andean culture and society. This knowledge was used to extend as much as possible the altitudinal limit of the cultivation of Andean tubers and grains, reaching cultivation up to 4,500 masl (Murra, 1988 author's translation). Using this knowledge, they also developed territorial and natural resources management systems that allowed them to co-evolve along with their socioecological system to produce food sustainably (Norgaard & Sikor, 1999).

Tapia (2002, p. 81) emphasizes that the knowledge generated in the Bolivian Andes must be recognized as a science since this knowledge "although based on different categories (metaphors, beliefs, myths, etc.) can be recognized as a science, removing the prejudice that they are poor knowledge and without logical functioning". Likewise, Rosset et al. (2022, p. 4) explain that pre-Hispanic civilizations had developed "complex conceptual frameworks" based on "their own epistemes and ontologies originating". Hence, this first agroecological trajectory not only represents the dimension of practices but also that of science. Nevertheless, the agroecological dimension of social movements can be contested because it was not used as organized grassroots activism to promote a political and social agenda (Cruz et al., 2022). Part of this agroecological knowledge, although it has undergone modifications, has managed to reach our times despite the socioeconomic and political transformations caused by the colony and the republic, showing resistance to westernization and globalization (Altieri & Toledo,

⁹ Undernourishment is defined as the condition in which an individual's habitual food consumption is insufficient to provide the amount of dietary energy required to maintain a normal, active, healthy life. In the FAO et al. report, hunger is defined as being synonymous with chronic undernourishment (FAO et al., 2021, p. 193).

¹⁰ Raised crop beds interspersed with water canals. This ancestral technology allows the generation of a microclimate to increase the resilience of crops to climatological risks (Rocha & Solivia, 2004).

2011; Tapia, 2002). The second - short - trajectory corresponds to the process of institutionalization of agroecology in Bolivia. It started in the 1970s as a rejection of the Green Revolution (Catacora-Vargas et al., 2017). Since then, a series of actions were implemented to promote agroecology in Bolivia. For example, academic bodies and non-governmental Organizations are dedicated to revaluing rural communities' traditional ecological knowledge, promoting agroecological production, commercialization, and consumption, and strengthening agroecological organizations (Catacora-Vargas et al., 2017). Also, social organizations of organic and agroecological producers were created. In the 1980s, certification initiatives for exporting organic products began (AGRECOL, 2018). In 1991, the Association of Ecological Producers of Bolivia was created, which today brings together 85 affiliated partners consisting of associations, peasant agricultural cooperatives, and peasant corporations, representing an estimated 70,000 agroecological producers in 77 municipalities of Bolivia (AOPEB, 2022). The Association of Ecological Producers of Bolivia supports the production and marketing of organic products (AOPEB, 2022). It also conducts participatory research, supports the transformation and value-adding of products, and provides support in organizational strengthening (AOPEB, 2022). Additionally, the organization has ecological schools to train agroecological promoters. So far, the Association of Ecological Producers of Bolivia has had a political impact with the approval of organic standards and laws such as Law N° 3225 (2006) on the Promotion of Organic Production (Catacora-Vargas et al., 2017) and the development of participatory guaranteed systems for the certification of products without the need for high-cost certifying agencies (Catacora-Vargas et al., 2017). Another organization that promotes agroecology in Bolivia is the Coordination for the Integration of Peasant, Indigenous and Native Economic Organizations of Bolivia, which ensures the "strengthening of the OECAs [peasant economic organizations, native indigenous] under the principles of Solidarity Economy, Sustainable Agriculture, Food Sovereignty and Peasant Self-Management" in national and international arenas (FAO, 2015). Also, the Indigenous and Native Economic Organizations of Bolivia support the marketing and commercialization of agroecological products (FAO, 2015). Other organizations have been created over time that are region or product specific, such as the National Association of Quinoa Producers or the Association of Groups of the Commonwealth among many others (AGRECOL, 2018).

AGRECOL (2018) published a diagnosis on the state of agroecological organic certified production in Bolivia. The diagnosis included 35 municipalities of six macro-regions of Bolivia. The diagnosis concludes:

In 2015, 15,814 agricultural production units (UPA) were registered as certified organic producers, equivalent to 2% of all units. The area with certification reached 240,000 ha, equivalent to 6.44% of the total cultivated area. Total certified organic production reached 162 thousand MT, equivalent to 0.94% of total agricultural production. In the five-year period 2011-2015, production growth was 122% and 10.5% of the area under organic production. (AGRECOL, 2018, p. 12 Author's translation)

The Universidad Mayor de San Simón in Cochabamba pioneered agroecological education and research in Bolivia by establishing a University Centre AGRUCO within the Faculty of Agricultural, Livestock and Forestry Sciences in the 1980s (Catacora-Vargas et al., 2017). AGRUCO innovated with the Revaluing Participatory Research framework based on the *diálogo de saberes* and transdisciplinarity (Delgado, 2010). Later, other private and public universities in the country followed in their footsteps. Currently, training programs are offered at different academic levels. Some Bolivian scholars are part of the Scientific Association of Agroecology of Latin America. All these organizations and initiatives demonstrate that Bolivia has been advancing in the institutionalization of agroecological production.

During the last decades, significant advances have been made in agroecology as a social movement, science, and practice because of the efforts invested especially by non-governmental organizations. As concluded by AGRECOL (2018, p. 17), ecological production in Bolivia “lives mainly for the dedication and interest of producers and consumers”. However, as will be explained later (see chapter 4), there still are many barriers to overcome.

5. Municipality of Tiraque

Since 2017, researchers from Universidad Católica Boliviana “San Pablo” worked in the Municipality of Tiraque on a participatory diagnosis, building trust with community members, non-governmental organizations, social organizations, and municipal staff. Moreover, staff members of the University have been actively involved in the process of co-creating a water policy in Tiraque. Hence, this PhD research is built on previous experience and aligned with the ongoing work in Tiraque.

Through a participative diagnosis, the main socioecological problems were identified by the communities and social organizations of Tiraque in 2018. Among the main ecological problems identified was the lack of strategic natural resources such as water and land, soil degradation, as well as a high incidence of pests and adverse climatological factors (Azero, 2018). Among the most relevant socioeconomic problems was the challenge of engaging in unsustainable agricultural practices had brought a series of negative impacts such as the substantial loss of agrobiodiversity and dependence on external inputs such as pesticides. Other problems identified were high prices of imported agricultural products, lack of market access, scarce work options, insufficient income, lack of productive undertakings, and lack of innovations. In the cultural dimension, the following factors linked to the loss of local/ancestral knowledge and nutrition have been identified: bad eating habits linked to the westernization of food and the general devaluation of local and traditional food (Azero, 2018).

Tiraque is a rural municipality in the department of Cochabamba (Bolivia) (17 ° 20 'to 17 ° 33' LS and 65 ° 37 'to 65 ° 45' WL) (Figure 7). It stretches approximately 1,739 km² (Cabero Villazón & Ferreira, 2022a). It is divided into five ecological zones: yugas (500 – 1,500 masl), valleys (2,900 – 3,100 masl), head of the valleys (3,100 – 3,250 masl), transition zones (3,500 – 3,650 masl) and puna (3,650 – 4,500 masl). The annual average temperature is 9.6 °C, with a maximum of 26.0 °C and a minimum of -8.5 °C (Consultores, 2003). The average annual rainfall varies between 300 to 1,500 mm. Approximately 89.4% and 91.2% of rainfall occur in the wet period, and between 10.6% and 8.8% in the dry period (Consultores, 2003).

Tiraque has two watersheds with several rivers, dams, and over 20 lagoons that supply water to its population. Highlands are dedicated to grassing and rain-fed agriculture for household consumption, while intensive production systems are deployed in the lower areas (PTDI, 2016). According to the latest census, Tiraque has a total population of 21,231 inhabitants (INE, 2012b). It has a gender distribution of 49% males and 51% females (INE, 2012a). The total migration rate for the period 2007-2012 is -14.9% which indicates a net population loss (INE, 2018). The migration gender ratio is 98 men for every 100 women who migrate (INE, 2018).

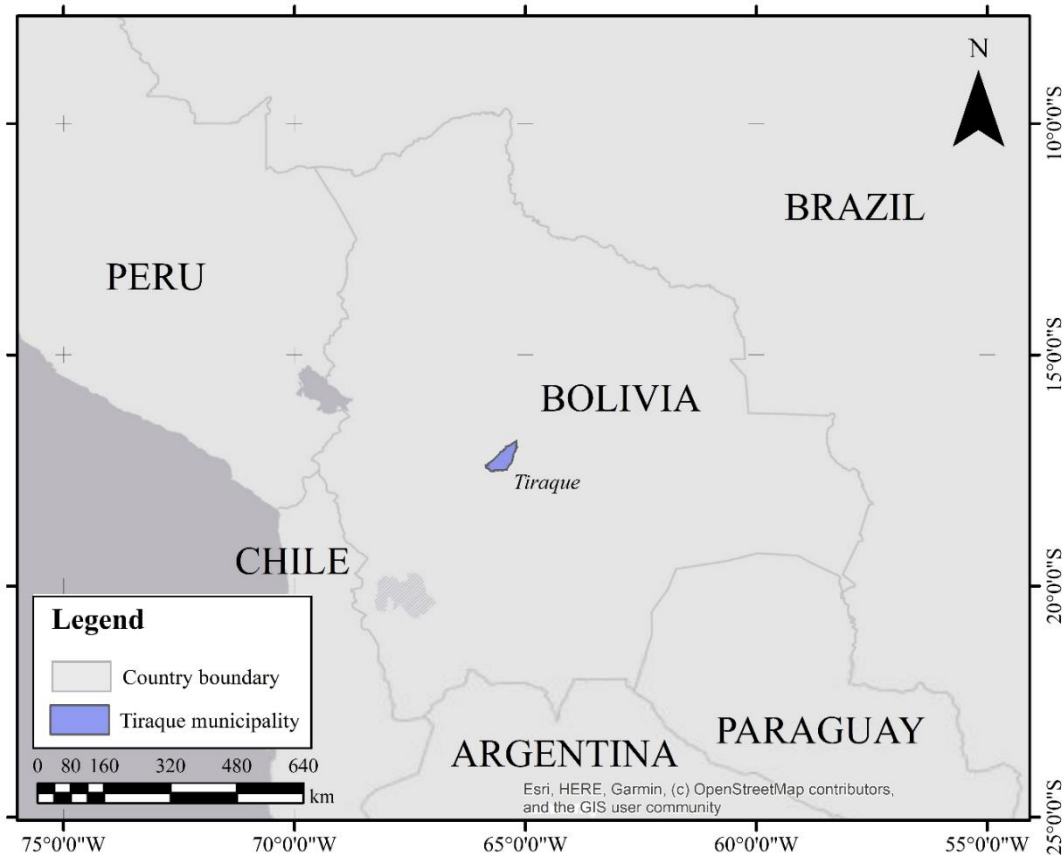


Figure 7. Municipality of Tiraque, Cochabamba, Bolivia

Note. Source: Author

An estimated 88% of the population makes a living from agriculture (PTDI, 2016). Nearly 9,976 hectares are used to cultivate annual crops and fodder, 13 hectares are dedicated to fruit trees and 3,867 hectares remain uncultivated (Consultores, 2003). Potato is the major crop, followed by beans, peas, corn, wheat, barley, oats, and Andean tubers among others (INE, 2017). Cattle, sheep, pigs, and horses are the main breeding animals in the municipality. Smaller animals such as birds and guinea pigs are bred mainly for family consumption (INE, 2017).

Before the Land Reform in 1953, most of the land and water resources were under the control of wealthy landowners (mostly Spanish descendants) (Antequera, 2018). In return for shelter and food, estates were cultivated by *colonos* (indigenous workers). Outside the estates, small surfaces of land were owned by *piqueros* (mestizo and free indigenous families) (Antequera, 2018). After the Land Reform, estates disappeared and were transformed into peasant communities, and peasant unions started to emerge (Bustamante et al., 2019).

The period between 1978 and the early 1990's was marked by a major presence of the State with the re-organization of the peasant irrigation systems (López et al., 2019). In the late 1970's, agrarian unionism gained strength with the creation of the National Confederation of Peasant Workers of Bolivia and the National Federation of Peasant Women of Bolivia 'Bartolina Sisa' (Costas et al., 2005). The National Confederation of Peasant Workers of Bolivia, the largest organization in the country, counts over 3 million farmers affiliated (CSUTCB, 2019). It has a hierarchical structure, whose base units are the communities represented by agricultural unions. Associated unions form sub-centrals, which in turn are grouped into *cantonales*, which grouped make up central provincial representations, in turn,

grouped into nine departmental federations. Finally, the latter group collectively makes up the National Confederation (Figure 8).

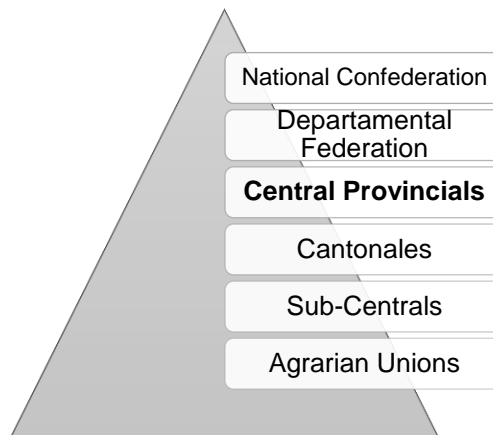


Figure 8. Scheme of the organizational structure of a Departmental Federation, stressing the important role of the Central Provincial level

Note. Source: Costas et al. (2005)

In Tiraque, the highest level of social organization is the Central Provincial Peasant Workers Union of Tiraque. From this level down to the agricultural unions, organizations are legally established and have organized and consolidated structures. According to a municipal planning tool, a total of 147 rural communities and 7 Neighborhood Councils are organized in Sub-Centrals (PTDI, 2016). The Central of Indigenous Peasant Women 'Bartolina Sisa' has 1,200 affiliates (PTDI, 2016). Specifically, concerning water management, there are the Federation of Indigenous Agricultural Irrigators of Cochabamba, the Tiraque Drinking Water Committees, and the Tiraque Irrigation and Services Association. The Federation of Indigenous Agricultural Irrigators of Cochabamba, which is composed of eight irrigation associations, was created in 2008 as a strategic organization during a water conflict with a neighboring municipality (Rocha-López, 2020).

CHAPTER 3. METHODOLOGY

1. Introduction

This chapter first presents the main objective and research questions of the dissertation designed to fill in the knowledge gaps identified in the previous chapter. Then it describes the main methodology followed throughout the PhD study based on an embedded case study and mixed methods approach. Finally, it presents the structure of the dissertation.

2. Main objective and research questions

The general objective of this dissertation is to understand how in future research designs transdisciplinary agroecology can be organized to achieve food sovereignty. This objective was defined based on the knowledge gaps identified in the previous chapter regarding the operationalization of transdisciplinarity and transdisciplinary agroecology. To fulfill this objective the three dimensions of transdisciplinary agroecology were explored and used as entry points. For each dimension a research question was designed:

Dimension: Practices - How can a collaborative research team be built for society-driven transdisciplinary agroecology research?

The first research question is intended to fill a methodological gap in the models for transdisciplinary research: the operationalization of a preparation “phase 0” following a society-driven approach. This question is studied in chapter 4.

Dimension: Science - What are the main socioecological factors that impact the transmission of traditional ecological knowledge within and across generations?

The second research question seeks to identify the factors that affect the transmission of traditional ecological knowledge. This question is studied in chapter 5.

Dimension: Social movements - How are power relations influenced by people’s interests, socio-political structures, and knowledge in the process of co-creation of food sovereignty?

The third research question explores how different aspects influence power relations in a transdisciplinary process because power relations can obstruct the process and prevent the empowerment of vulnerable and marginalized actors. This question is studied in chapter 6.

Although each empirical chapter addresses one dimension of transdisciplinary agroecology and one research question, the other two dimensions are transversal in the analysis of the chapters.

3. Case study approach

The research questions were operationalized and answered following an embedded case study approach in a rural municipality of Bolivia as the general methodology. This approach was chosen because through different sources of information, it allows us to explore in-depth daily practices and interactions between actors and their socioecological context (Leeuwis & Ban, 2004; Yin, 2009). Other studies on transdisciplinarity have followed an embedded case study approach because it allows the integration of different knowledge systems, including quantitative and qualitative knowledge, which is the main purpose of transdisciplinarity (Scholz & Tietje, 2002). Hence, through an embedded case study, transdisciplinary research can be structured and organized (Scholz & Binder, 2011).

4. Mixed methods

In conducting an embedded case study, the thesis adopts a critical qualitative research approach (Merriam & Tisdell, 2015). This approach was chosen because it recognizes that research is grounded in power relations, social structures, and people agency, allowing to study of people's realities (Bhavnani et al., 2014). Moreover, it requires reflexivity and empathy from researchers (Bhavnani et al., 2014). Some empirical cases follow a mixed methods approach, combining both qualitative and quantitative methods because it provides a deeper understanding of complex issues such as power relations, knowledge, and transdisciplinarity itself (Mertens, 2007; Schoonenboom & Johnson, 2017). Moreover, the study followed a transformative design because the order and priority of quantitative and qualitative methods changed over time according to the emerging research needs (Schoonenboom & Johnson, 2017). For instance, in some cases, the qualitative results were enhanced with quantitative findings and *vice versa*. The details of the methods are explained further in the individual empirical chapters.

5. Primary data collection

Primary and secondary data were collected in Bolivia between 2019 and 2022 through a combination of sources, sample techniques, and research tools and procedures:

- Communal transect. Communal transects were carried out with a key informant during the initial phases of the PhD research. This allowed us to obtain relevant socioecological information about the community (Leeuwis & Ban, 2004).
- Participatory zoning mapping. This visual technique allowed us to obtain, complement, and validate the socioecological information gathered with the transect, but also to gather information about resource management in the community (PAR, 2018, p. 68). As result, the territory was contextualized and the interactions of people with their environment were visualized. It triggered interesting discussions with the members of the community (Chambers, 1992; Leeuwis & Ban, 2004).
- Semi-structured, open-ended, and in-depth interviews. These interviews helped to learn about peoples' visions and perceptions about specific topics (Leeuwis & Ban, 2004). According to Leeuwis et al. (2004), this type of in-depth interview not only allows us to explore *what* people do, *how*, *where*, and *when* they do them but also allows knowing *why* they do it. The actors interviewed belong to different private and public sectors such as academia, non-governmental organizations, municipality, social

organizations, and communities. Likewise, they belong to different scales of governance: community, municipality, and regional. Actors were identified through stakeholder mapping and snowballing. Some actors were interviewed several times at various stages of the process to validate information or to deepen further into specific issues.

- Focus groups and workshops. These are a type of in-depth group interview, in which a topic of interest is discussed with key informants. The Platform for Agrobiodiversity Research (2018) explains that focus groups are useful to explore important characteristics of the socioecological system, such as ecosystem composition and functions, natural resources management practices, traditional ecological knowledge, and related problems among other topics.
- Surveys. These are quantitative method par excellence that uses a structured questionnaire (PAR, 2018). Surveys were carried out to obtain information about traditional ecological knowledge with former students from a bachelor program “Water Resources Engineering for Agriculture” in Tiraque.
- Participant observation. Participant observation was done throughout the whole experience. It is one of the main tools for the co-creation of knowledge because it allows the researcher to integrate naturally and actively into the daily routine of the participants of the research process (Delgado, 2010; Kawulich, 2005; Tapia, 2002). A field diary and a repository of videos and pictures were kept throughout the study.

Although the project in which this study is framed was already working in the field and the community and municipal actors already gave their permission to conduct research, permission was asked from the Agrarian Union of the community of Virvini where most of the study activities took place. Likewise, a specific agreement was signed between the Universidad Católica Boliviana “San Pablo”, the Education District of Tiraque, and two local non-governmental Organizations to pursue research on traditional ecological knowledge, water harvesting, and school food gardens. Most information was gathered in Spanish. However, some interviews and meetings were held in *Quechua*. In those situations, help from a translator was required. Following the General Data Protection Regulation, prior and informed consent was given by all interviewees and confirmed in writing.

Table 3 presents a summary of the research tools and samples achieved.

Table 3. Summary of the research tools and samples

RESEARCH TOOL	SAMPLE
In-depth interviews	83
Survey	22
Communal transect	1
Field notes	97
Workshop and meeting audio	34
Participatory zoning workshop	8
Field videos	48

Note. Source: Author

6. Secondary information

Secondary information, relevant to the research, was gathered throughout the doctoral research. To do so, governmental, and non-governmental organizations' technical reports, government planning tools, national and local policies, meeting minutes from local social organizations, national and international research publications, national statistical data, local myths, and chronicles, and scientific papers were gathered, and reviewed. Likewise, data previously gathered by Project 3 within the VLIR UOS program with the Universidad Católica Boliviana "San Pablo" between 2017 and 2019, such as the participatory diagnosis of 2018, was part of the secondary information reviewed in the PhD.

7. Triangulation of information

The variety of techniques and sources of information used allowed us to triangulate information, hence increasing the validity of the results (Jalongo & Saracho, 2016). Triangulation of sources was used to explore the same issue from multiple perspectives. Moreover, triangulation was used to corroborate data and to achieve a multi-actor and multi-scale analysis.

8. Reflexivity

Exploring the operationalization of transdisciplinary agroecology was an experience of "learning by doing". Thus, reflexivity was a continuous aspect of the study, both as an individual researcher and as a collaborative team. It was important to constantly reflect on the interactions among actors and also, to reflect on the different actors' epistemologies and cultural backgrounds (Schmidt et al., 2020). Moreover, the methodology, tools, and results were evaluated to steer improvement (Lang et al., 2012).

9. Three research moments

Three empirical chapters each explored one dimension of transdisciplinary agroecology: practices, science, and social movements (Figure 9). Each chapter represents a research moment, composed of its individual research questions and methodology. However, all three chapters do consider and discuss the other two dimensions of transdisciplinary agroecology. A detailed description of the methodology is presented in each empirical chapter. However, this section presents a summary of the implemented methodology.

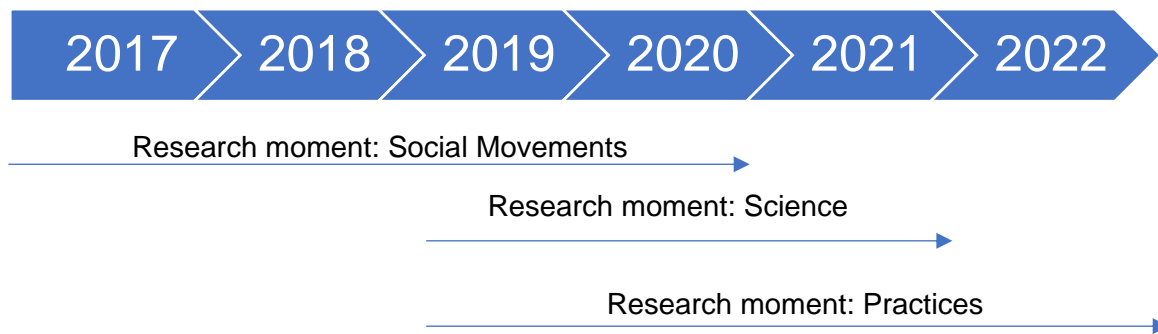


Figure 9. Timeline of the three research moments

Note. Source: Author

9.1 Dimension: Practices

This chapter explores the dimension of practices through the development of agroecological innovation. To do so, it was required to conform to a collaborative research team for society-driven transdisciplinary research. However, there were no guidelines on how to achieve the formation of such teams. Hence, this chapter addresses the research question: how a collaborative research team can be built for society-driven transdisciplinary agroecology research. A Grounded Theory methodology was chosen because of the exploratory nature of the study. Moreover, the study was “grounded” in data, and we wanted to extend knowledge in existing transdisciplinary theoretical frameworks (Charmaz, 2006; Gibbs, 2012).

The field study was developed between July 2019 and September 2022. Primary data was collected through participatory observation, allowing us to participate actively in the transdisciplinary research process (Delgado, 2010; Tapia, 2002). Throughout the case study, a field diary and a repository of videos and pictures were kept in a data base of the project. The participatory observation was complemented by a total of 16 in-depth and open-ended interviews with actors from different sectors, genders, and ages in Tiraque. Interviewees were chosen as key informants based on their recognized role in agricultural, education, and youth issues in Tiraque. Moreover, they were chosen based on their involvement in the research process. Leaders of social peasant organizations at three levels of governance were interviewed to have a multilevel perspective on the topics addressed by the research. For each group of interviewees, a set of open-ended questionnaires were designed.

Secondary data was collected and reviewed about the main socioecological problems related to agriculture, food sovereignty, and nutrition in Tiraque. The starting point was the review of a report from a general diagnosis written in 2018 by researchers in the six projects of the Interuniversity program. Likewise, different technical reports from the government and local

non-governmental organizations were collected and reviewed, including the report from the general diagnosis was written in 2018.

The analytical process for Grounded Theory methodology proposed by Gibbs (2012, p. 1) was used as follows: 1) compiling the corpus of data, 2) detailed reading of the transcripts, 3) explicitly searching for categories and patterns in the data, and 4) constructing thematic outlines using the codes to lay out the sequence in which topics will be considered.

9.2 Dimension: Science

This chapter explores the dimension of science focusing on traditional ecological knowledge for weather forecasting. Through a mixed methods approach it identifies the main socioecological factors that impact the transmission of traditional ecological knowledge within and across generations.

Data was collected between 2019 and 2021. A total of 30 open-ended and intergenerational interviews were held in the community of Virvini. Interviews were based primarily on age and gender. Generational group 1 was composed of ten interviewees between the ages of 15 and 24 years old. Generational group 2 was composed of ten interviewees between the ages of 25 and 49 years old. Generational group 3 was composed of ten interviewees from ages over 50 years old. Each group had a 50% ratio of females and males. Interviewees needed to be related to agriculture. In Virvini, also a participatory zoning workshop helped. The workshop had the attendance of eight villagers between the ages of 18 and 60 with a 50% ratio of female and male attendants. The information gathered through the participatory zoning workshop was validated through a communal transect with a key informant.

A survey about the role of formal education was given to 22 graduates of the bachelor program in Water Resources Engineering for Agriculture in Tiraque. During the research, graduates were living in their communities or outside Tiraque. Hence, they were contacted through WhatsApp, informed about the research, and asked to continue answering the online questionnaire if they gave their consent.

Nine open-ended interviews were held with key informants in Tiraque from different sectors and scales of the territory. Finally, a group of eight national experts, identified through literature review and snowballing, were interviewed using open-ended questionnaires.

To identify the historical milestones in the agrarian structure, education, climate change, and natural indicators that could affect the transmission of traditional ecological knowledge, secondary information was gathered. Likewise, secondary information was collected about the Andean worldview. Finally, an in-depth literature review of successful cases of traditional ecological knowledge transmission for weather forecasting using natural indicators in the Andean Region of Bolivia was conducted. Finally, following Huberman and Miles (2019) data collected were transcribed, read, and coded.

9.3 Dimension: Social movements

This chapter explores the dimension of social movements by studying how power relations are influenced by people's interests, socio-political structures, and knowledge in the process of co-creation of food sovereignty. These interactions were analyzed using the Power Cube (Gaventa, 2006).

Data was collected through a qualitative methods approach in intensive fieldwork between 2017 and 2020. Between 2017 and 2019 data were collected by the Project 3 team of researchers and kept in a data base. Between 2019 and 2020 data were collected by the PhD student. A total of 34 in-depth interviews were developed with different stakeholders (i.e., farmers, academia, State, and non-governmental organizations).

Field notes (n=10), field videos (n=31), and workshop audios (n=4) were made through participatory observation at meetings with social organizations and municipality staff members and water policy workshops and transects to identify water sources and recharge areas. Likewise, meeting audios (n=30) with different stakeholders were collected during coordination, analysis, and/or reflection meetings on the process of construction of the water policy.

Secondary information about the case was reviewed such as state planning tools, maps, scientific papers, policy drafts, and technical reports from non-governmental organizations and a university among others.

All data collected were transcribed and a content analysis was developed following Erlingsson & Brysiewicz (2017). The Power Cube analysis was complemented by an exploration of the interrelations with knowledge, interest, and socio-political structures. These categories were chosen in advance based on the set of guiding questions presented by Hunjan and Pettit (2011, p. 22).

CHAPTER 4. DIMENSION: PRACTICES

This chapter is based on:

Gruberg, H., Dessen, J., D'Haese, M., Muñoz, D., Benavides, J., Ferreira, W., Cabrera J., Ledezma, A., Cossio, O., Ricaldes, I., Ávalos, P., Puña, I., Laura, M. Hoffmann, N., Rodriguez, C., Saat G., Salguero, J. Porcel, F. & Gutierrez, S. Unpublished. Proposal of a "phase 0" for transdisciplinary agroecology research.

Abstract

Agroecology is promoted to achieve food sovereignty by different international organizations. Likewise, over the last years, transdisciplinary research has been gaining popularity because it facilitates the co-creation of knowledge by involving different academic and non-academic knowledge systems. Despite the clear link between agroecology and transdisciplinarity there is not much published about transdisciplinary agroecology nor about how to operationalize it. As well, the different models and guidelines for transdisciplinary research usually propose an initial phase in which the main problem, the main goal, and the guiding question are identified by a collaborative research team. At this initial point, there is a methodological gap because it is unclear how such a team can be formed following a society-driven approach. If research teams are not collaborative, research suffers from conventional and top-down processes. To fill this knowledge gap, we conducted an exploratory and critical qualitative study using a Grounded Theory methodology in two case studies on the co-creation of agroecological innovation. We were able to distinguish three moments in the formation of a society-driven collaborative research team for transdisciplinary research: 1) inspiration, 2) negotiation, and 3) action. Moreover, we found three prerequisites, for creating a window of opportunity: 1) perception of urgency, 2) key steward, and 3) institutional will. Although this chapter primarily centers on agroecology's dimension of practices, it also tackles the dimension of science and social movement by studying the co-creation of knowledge and power relations throughout the process.

Keywords: Transdisciplinarity; Participatory Action Research; Window of Opportunity; transdisciplinary agroecology

1. Introduction

Different horizontal and participatory research and development approaches have arisen as counterparts to neo-positivist approaches to food production, where it is believed that agricultural innovation and social transformation can be planned and achieved with a vertical top-down approach (Cuéllar-Padilla & Calle-Collado, 2011; Jacobs, 2016; Leeuwis & Ban, 2004). These include Community-based Participatory Research, Participatory Action Research, Participatory Rural Appraisal, Participatory Technology Development, and Farmer-to-Farmer Field Schools, among many others (Chambers, 1994; Fliert, 1993; Leeuwis & Ban, 2004; Tapia, 2016). For example, Participatory Action Research is based on the recognition that people have the right to be active shapers of their own future (Attwood, 1997). Hence, Participatory Action Research introduces the notion that academics should co-develop research *with* the people instead of developing research *of* the people or *for* the people (Baum et al., 2006; McIntyre, 2007). Also, Community-based Participatory Research is well recognized among Research and Development scholars because it recognizes that to promote sustainability and foster a greater impact it is crucial to integrate the community's knowledge, experiences, and points of view in the process of research (Heinzmann et al., 2019).

Evidence from practice shows that through these participatory approaches, high levels of integration of knowledge are not always achieved (Tress et al., 2005). For example, non-governmental organizations usually develop Participatory Action Research that mainly works with non-academic actors and excludes academic actors. However, participatory approaches are crucial when it comes to dealing with complex sustainability problems such as food sovereignty, climate change, and genetically modified organisms (Block et al., 2022). These problems occur due to the interaction of humans with nature (Block et al., 2019). Until recently, the boundaries between societies and nature seemed clear, but, as Jahn (2008) mentions, in

recent times these boundaries seem to be blurring. He explains that complex sustainability problems transcend social, spatial, and temporal limits, reaching both local and global levels, as well as states, communities, and transnational companies. It is in this sense that to deal with these problems new forms of knowledge creation, such as transdisciplinarity, are needed (Jahn, 2008).

Transdisciplinarity can help achieve a higher level of integration by summing up these participatory approaches (Tress et al., 2005). For example, in their research with Native American communities, Heinzmann et al. (2019) found that a transdisciplinary approach is essential to community-based participatory research because it recognizes that community knowledge is an essential part of collaborative research. Likewise, Schensul et al. (2006) presented a successful international experience of implementing transdisciplinarity in community participatory research in an HIV/STD prevention project in India.

The transdisciplinary approach is already over forty years old (OECD, 1972). During this time, various authors have presented principles for transdisciplinary research, as well as criteria for the design and evaluation of transdisciplinary studies, and models and guidelines for their implementation (Bergmann et al., 2005; Blackstock et al., 2007; Klein, 2008; Lang et al., 2012; Regeer et al., 2009). Table 2 of chapter 1 presents the phases/steps proposed by different authors for transdisciplinary research. In general, these models are composed of three core phases. In the initial phase the main problem, the main goal, and the guiding question are identified so that it can be transformed into a research question (Jahn, 2008). In the next phase, a process of analysis is given to find solutions. Finally, in the last phase, the results are presented. Some authors propose intermediate phases that extend the model up to six phases (Scholz & Binder, 2011; Stauffacher et al., 2008), but the general connotation of the models is similar. Bergmann et al. (2005) and Jahn (2008) include an initial collaborative team formation phase.

Most guidelines mention that it is crucial to create a collaborative multi-actor research team, with whom to frame the problem and the research question (Jahn, 2008; Lang et al., 2012). However, in practice, outsiders often predefine the research topic (Heinzmann et al., 2019). Usually, this outsider is identified as someone “who has the time, skill, and commitment, and who almost inevitably is a member of a privileged and educated group” (Reason, 1994, p. 334). This happens, not because outsiders want to monopolize the research process, but because they find it difficult to actively engage members of the community. Engagement may be increasingly difficult for the most marginalized and vulnerable groups as they are highly constrained in time to participate (Díaz & Simmons, 1999). It could also be because of methodological and cultural clashes between academics and non-academics in the research teams (Minkler, 2004). There may be other reasons why transdisciplinary research is difficult in practice but setting up a collaborative research team is a key building block to transdisciplinary research. However, the above-mentioned literature is rather silent on what is needed to make this a success. Moreover, the need to further develop models to operationalize transdisciplinarity has been identified by some scholars like Bergmann (2005), Jahn (2008), and Regeer (2009). Likewise, because of agroecology’s links to transdisciplinarity, it has been described as “transdisciplinary agroecology” (Gliessman, 2022; Nawn et al., 2018; Pimbert, 2015, 2016; White et al., 2022). However, there is not a clear definition of what transdisciplinary agroecology entails nor guidelines on how to operationalize it to obtain food sovereignty.

Building on a process analysis of own experiences in setting up society-driven transdisciplinary research, this chapter intends to address the following research question: *How can a collaborative research team be built for society-driven transdisciplinary agroecology research?* We reflect on two transdisciplinary agroecology field experiences in Tiraque between 2017 and

2022. Research activities in Tiraque started in 2017 with a series of participatory diagnostic actions. In the two years that followed, relations with different stakeholders were tightened and the community needs were rather clear. Yet, less clear were the next steps. This chapter reports on how ‘windows of opportunity’ were found and approached in two concrete contributions to the community’s expressed needs in food sovereignty and nutrition. These transdisciplinary agroecology contributions were the development of a kit for participatory soil evaluation and community land management and the implementation of water harvesting for a local school garden. We are confident that by providing an account of these field experiences, we can provide valuable insights for future transdisciplinary research endeavors. Although this chapter primarily centers on agroecology’s dimension of practices through agroecological innovation, it also tackles the dimension of science and social movements by studying the co-creation of knowledge and power relations throughout the process.

2. Conceptual framework

Participatory approaches do not necessarily integrate different stakeholders in the research process (Minkler, 2004; Tress et al., 2005). Figure 10 shows the degrees of integration and stakeholders’ involvement in integrative and non-integrative approaches developed by Tress et al. (2005). The definitions of the different types of disciplinary integrations (multi-, inter, and transdisciplinarity) were already presented in chapter 1. Participatory approaches are included in this figure because they are usually related, and even confused, with transdisciplinarity. However, participatory approaches do not necessarily entail research neither inter- nor transdisciplinary research. It “can be disciplinary or multidisciplinary studies that include non-academic participants” but show a low integration of academic and non-academic participants in complex sustainability problems (Tress et al., 2005, p. 487). For example, in Latin America Participatory Action Research has been implemented mostly by practitioners and activists with the involvement of local actors but without the academic sector (Agramont et al., 2019). Likewise, multidisciplinary and interdisciplinarity work only with academic participants and did not necessarily include non-academic actors (i.e., villagers and practitioners) (Block et al., 2022; Ramadier, 2004). Higher integration is present in transdisciplinarity because it includes academic and non-academic participants (Tress et al., 2005). In this sense, transdisciplinarity is seen as an essential aspect to deal with complex sustainability problems (Brink et al., 2018).

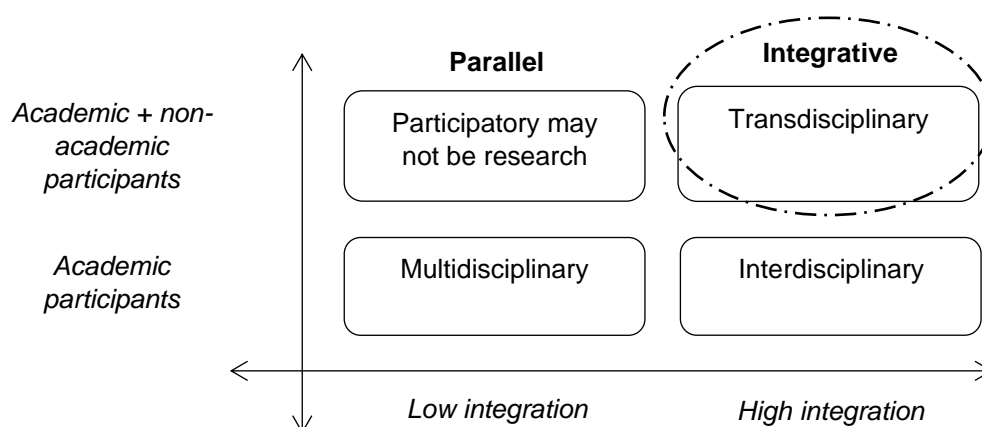


Figure 10. Degrees of integration and stakeholder involvement in integrative and non-integrative approaches

Note. Source: Tress, Tress, and Fry (2005, p. 484)

Agroecology follows a combination of participatory, action-oriented, and transdisciplinary approaches by engaging different groups of stakeholders throughout a problem-solving process (Méndez et al., 2015). Agroecology and Participatory Action Research resonate because they have common principles, and they go hand in hand in the development of sustainable food systems (Altieri, 2000; Bichler et al., 2020). For instance, like agroecology, Participatory Action Research aims “to counter ‘hegemonic’ approaches where research methodology serves to confirm oppressive knowledge” by integrating and rising the voices of those that are usually left out of research and policy-making process (Masson et al., 2021, p. 498). Hence, agroecology can be more precisely described as “transdisciplinary agroecology” because it uses Participatory Action Research methodology to achieve true and meaningful transdisciplinarity (Méndez et al., 2015). Likewise, Nix et al. (2019) describe Participatory Action Research as a framework for transdisciplinarity research. Moreover, Pohl and Hadorn (2007) explain that participatory methods in transdisciplinary research also help to test the socioecological relevance and transferability of the results found.

However, not much is developed in the literature regarding the concept of “transdisciplinary agroecology”. Publications are limited to mentioning it without going into depth, providing a clear definition, and much less a way to operationalize it in the field (Gliessman, 2022; Nawn et al., 2018; Pimbert, 2015, 2016; White et al., 2022). Hence, to execute transdisciplinary agroecology in the field it is required to revisit the transdisciplinary research models that have been developed so far (Bergmann et al., 2005; Blackstock et al., 2007; Klein, 2008; Lang et al., 2012; Méndez et al., 2015; Regeer et al., 2009). From these models, we take on the Conceptual Model of Transdisciplinarity by Lang et al. (2012) which is based mainly on Jahn’s (2008) Ideal-typical Conceptual Model (See Figure 4 in chapter 1).

There are three phases in the Conceptual Model (Lang et al., 2012, p. 27):

- A. Collaboratively framing the problem and building a collaborative research team;
- B. Co-producing solution-oriented and transferable knowledge through collaborative research;
- C. (Re-)integrating and applying the produced knowledge in both scientific and societal practice.

Phase A of the Lang et al. (2012) model requires a collaborative research team. However, they do not present guidelines on how to reach phase A and how to form such collaborative research teams (Lang et al., 2012). Recognizing this methodological void, Horcea-Milcu et al. (2022) proposed a phase 0, composed of three sub-phases: sub-phase 0.1 selecting the case study, sub-phase 0.2 understanding the case study context from a transdisciplinary perspective and sub-phase 0.3 fostering premises for coming together.

Phase 0 partly overlaps with Phase A of Lang’s (2012) model, as sub-phase 0.3 describes the premises needed to come together in a transdisciplinary research team. As their proposal strongly focuses on first selecting the case study among scientists and then creating a collaborative team by inviting actors and collaborators that match the information requirements of the case, this is a research-driven approach to transdisciplinarity (Horcea-Milcu et al., 2022). However, they recognize that phase 0 could also be society-driven with local actors identifying their problems and reaching out to researchers. Horcea-Milcu et al. (2022) followed the research-driven approach because in the context of their case study, it is not common for research initiatives to come from society. This approach follows the process of a) describing the potential cases, b) matching them with research interest, and c) assessing them against refined selection criteria (Horcea-Milcu et al., 2022, pp. 190-191).

Hence, it is important to gain insights into how these collaborative teams are formed not from a research-driven approach, but from a societal perspective. As argued by Mauser et al. (2013), the process of co-design depends on the societal emergence of the main topic, in the sense that collaborative teams and research questions are delineated by social actors instead of being pre-defined by academics (Mauser et al., 2013).

3. Case study description

The present research is part of the Inter-University Cooperation Program VLIR UOS IUC with Universidad Católica Boliviana “San Pablo”. The program has the objective to increase the resilience of local communities to complex sustainability problems in rural and urban areas of Bolivia (UCB, 2018). The program is composed of six projects, each with its own set of goals (VLIR-UOS, 2017): Project 1 - Social vulnerability, Project 2 - Integrated Water Management, Project 3 - Food Sovereignty, Project 4 - Indigenous Rights, Project 5 - Productive Development and a Project 6 - Transversal. The last one is a transversal methodological project about transdisciplinarity and collaborative learning communities.

This research is part of Project 3 entitled “Project to promote food sovereignty and nutritional innovation”. It has the objective of identifying innovative strategies to promote food production, productivity, and resilience (UCB & VLIR-UOS, 2016), therefore, aiming to contribute to reducing vulnerability in the communities located in the areas of four regional campuses of the University (UCB, 2018, p. 3). The University has four decentralized regional campuses in Cochabamba, La Paz, Tarija, and Santa Cruz. Each regional campus has research teams for each of the six projects. This case study took place in Cochabamba, in the rural municipality of Tiraque.

The research program and the projects in each regional campus of the Universidad Católica “San Pablo” defined that a transdisciplinarity research approach was going to be conducted (Vargas et al., 2019). However, transdisciplinarity and the methodological framework to achieve it were not defined because these were supposed to be created and delivered as outcomes by Project 6 (UCB & VLIR-UOS, 2016). Hence, at the beginning of the Program, there were no specific guidelines on how to proceed with transdisciplinarity within the individual projects. Although Project 6 has presented a series of publications on transdisciplinary research¹¹, to date it did not present a methodological proposal, nor a joint definition of transdisciplinarity.

The program asked each campus to get organized into Transdisciplinary Learning Communities, which were defined as: “spaces for interaction where disciplinary limits merge, meet and generate new knowledge to propose improvements in intervention plans, in the formulation of protocols and local public policies that benefit the quality of life of local communities” (VLIR-UOS, 2021). Although these learning communities were composed of academics and university students from different disciplines, research projects remained mostly disciplinary following the focus area of their project. Moreover, they did not include non-academic actors. These learning communities were used as spaces to coordinate and organize research activities on the sites. Hence, these communities have functioned more as research hubs than transdisciplinary learning communities. Moreover, initially, the PhD proposal had transdisciplinarity as the main subject of study. However, when the proposal was shared with a team leader from Project 6 alarm bells rang because I was stepping into their

¹¹ For further information on Project 6 publications please check: <https://repositorio.ucb.edu.bo/xmlui/handle/20.500.12771/87>

field of study. Hence, I was asked to study food sovereignty using transdisciplinarity as a methodological approach. This situation shows how protective were the projects of their fields of study. Although, it is important to mention that at the end of December 2019, the learning community of Cochabamba formulated a shared complex question to be studied as a community. However, this question is not part of the scope of this PhD investigation.

In 2018 the six projects conducted a general, participatory diagnosis in Tiraque to identify the main socioecological problems related to each project. This diagnosis included a large-scale workshop with 180 attendees from local communities that represented different sectors (i.e., agriculture, health, education, youth, commerce, etc.) (Rodriguez, 2022). First, the local authorities from the government and civil organizations were contacted through formal letters of invitation. Then, coordination meetings were held with them to explain the purpose of the research program and the diagnosis workshop. The agreed objective was to identify the main problems and potentialities (present and future) in Tiraque. Authorities extended the invitation to other actors. The workshop was held at the coliseum of Tiraque. Attendees were divided into working groups corresponding to the six research projects. The methodology followed by Project 3 was “brainstorming” about the main problems and potentialities regarding food sovereignty in Tiraque. To finalize the workshop representatives of each group presented their results to the rest of the attendees (Figure 11).

A few days later, social cartographies were made with 46 leaders from six regional social organizations of Tiraque (Rodriguez, 2022). Drawing social cartography is a participatory method that helps to visualize a collective understanding of people’s socioecological context (Liebman & Paulston, 1994). Hence, attendees were asked to identify the above-mentioned aspects in a map of Tiraque using markers, cards, and stickers (Figure 11). This workshop was organized through higher level authorities of the six Regionals of Tiraque in a previous meeting in August. In that meeting, the methodology was explained, and the objectives were defined with them. This event was held at the municipality headquarters. Attendees were divided into six working groups, one for each research project. The goal for Project 3 was to identify the socioecological system functions linked to food sovereignty and to identify the main socio-political borders of the communities, the main institutions present in Tiraque, and the main agricultural products and markets.



Figure 11. Left: Large-scale workshop. Right: Social cartographies

Note. Source: P3 data base

The information gathered in the diagnosis and social cartography workshops was systematized by academics from each project at Universidad Católica Boliviana “San Pablo”. Then, the systematized information was shared with other project teams at a meeting. A set of inspiring questions were previously agreed upon for discussion. Then a second level of systematization

was reached towards identifying possible problems that could be tackled by each research project. In the context of Project 3, the following problems related to food sovereignty and nutrition were identified and categorized as follows:



Figure 12. Problems identified in Tiraque as a result of the participatory diagnosis

Note. Source: TLC (2018)

In 2019 a PhD student (lead author of this chapter) was selected to conduct the transdisciplinary research of Project 3 in Tiraque, which has the general objective of identifying innovative strategies to promote food production, productivity, and resilience and as such to contribute to reduce vulnerability in the communities located in the four regional campuses of the university (UCB, 2018, p. 3). This project has three research lines: 1) conflicts over natural resources and technology transfer for food production; 2) agricultural production and productivity; and 3) agribusiness and nutrition models. Although this PhD covers several aspects of the three research areas, it specifically aligns with research line 2. Hence it was clear that the PhD needed to focus on agricultural innovation to increase the production and productivity of agricultural systems to foster food sovereignty with a transdisciplinarity approach. Moreover, a shift towards agroecological production has been promoted by different stakeholders in Tiraque as means to reverse the negative impacts of conventional agriculture in the region and to achieve food sovereignty. Hence, we knew that transdisciplinary agroecology innovation was going to be the core of the research. However, still, then there were no specific guidelines on how to conduct transdisciplinary research in the program, nor a common definition of transdisciplinarity. As we did not want to impose anything and aimed at following as much of a collaborative approach as possible, we decided to follow the transdisciplinary research model by Lang et al. (2012). However, this resulted in a methodological stalemate as there were no guidelines on how to enter the community and how to form a transdisciplinary research team from a society-driven approach because this specific context informed the present case study.

This case study took place in the rural municipality of Tiraque, located 60 kilometers south of the city of Cochabamba (Bolivia). A detailed socioecological description is presented in chapter 2. In this section, we will describe the agricultural sector with a focus on the main agricultural

and food problems of the municipality. Tiraque is dedicated mainly to agriculture as about 90% of its population depends on this activity (PTDI, 2016). According to the latest municipal planning tool land cover is distributed as follows: sugar cane (0.2 ha), cereals (10,485.5 ha), dried beans (25.9 ha), cultivation of plants that prepare stimulant drinks, species and aromatic plants, vegetables (1,017.7 ha), fruits and nuts (7.1 ha), oleaginous fruits or grains (1.2 ha), edible roots and tubers (3,080.0), fodder products, fibers, live plants, cut flowers and buds (220.2 ha), commercial forest (895.2 ha), native forests (3,004.8 ha), fallow land (3,579.2 ha) other lands (416,5 ha), and natural pastures (1,767.6 ha) (PTDI, 2016). Cattle, sheep, pigs, and horses are the main breeding animals in the municipality. Smaller animals such as birds and guinea pigs are bred mainly for family consumption (INE, 2017).

Cabero Villazón and Ferreira (2022a) presented a socio-territorial study of Tiraque. According to their study, 13% of the population has a second job apart from agriculture to be able to cover the economic needs of the family (Cabero Villazón & Ferreira, 2022a). Almost 40% of the respondents answered that their second job belongs to the diverse services sector, followed by transportation (22%) (Cabero Villazón & Ferreira, 2022a). Half of these second jobs are conducted in other municipalities. Most of the income of the households is spent on food (Cabero Villazón & Ferreira, 2022a). Hence, agriculture is an important part of the livelihoods of the communities of Tiraque. However, villagers are dealing with different problems regarding agriculture. These problems are presented in Figure 12 on the previous page.

As in the rest of the country, the agricultural sector in Tiraque presents a series of limitations. Among them are weak intersectoral coordination, low access to technological innovation, and poor access to markets, information on prices, and credits (Ministerio de Desarrollo Rural y Tierras, 2017; UDAPE, 2017). Since the 1980s, there has been a shift in agriculture in favor of conventional agriculture based on mechanization and the use of chemical inputs. Since this transformation in the agricultural model, the implementation of bad agricultural practices is observed, such as the reduction of fallow periods, vegetal cover, and excessive use of the plow (Muñoz, 2021). Likewise, Tiraque has reported an increase in the use of chemical pesticides for agricultural use and chemical fertilizers (Hoffmann, 2022). These poor agricultural practices have led to the loss of fertility of Tiraque's agricultural soils (Chirveches et al., 2013).

The crops that use the most chemical fertilizers are carrots, potatoes, fava beans, and peas (Cabero Villazón & Ferreira, 2022b). These agricultural chemicals are dragged and accumulated in bodies of water. In a modeling study developed by Hoffmann (2022, p. 78), it was shown that the use of fertilizers (organic and inorganic) generates "an excess of nitrogen in all geofoms, and an excess of phosphorus in the slopes, high plains, and gently sloping fans". In her study Hoffmann (2022) determined that the concentrations of total phosphorus exceed the permissible limits in the basin outlet zone. Villagers complained that their families and cattle could not consume the water from this region because they got sick (Hoffmann, 2022).

Farmers are also affected by the drop in prices for the sale of their crops and a parallel increase in the prices of agricultural inputs (Cabero Villazón & Ferreira, 2022b). Added to this is the high incidence of pests and diseases and losses of their crops due to drought (Cabero Villazón & Ferreira, 2022b). These problems in the agricultural sector affect the population's diet. Cabero Villazón and Ferreira (2022b) determined the Latin American and Caribbean Food Security Scale, which measures mild, moderate, and severe food insecurity (Segall Corrêa et al., 2012). They found that in the municipality of Tiraque, almost 80% of households enter one of the categories of food insecurity (Cabero Villazón & Ferreira, 2022b). Moreover, approximately 40% of the households are in the category of moderate food insecurity, which consists of

lowering the quality of food, reducing its quantity, and skipping meals (Cabero Villazón & Ferreira, 2022b). The risks of this level of insecurity are malnutrition (obesity, micronutrient deficiencies, reduced work capacity) and sub-nutrition (stunting, wasting) (Cafiero, 2016, p. 22).

4. Methodology

Although there are models and guidelines for transdisciplinary research, they do not explain how to build a society-driven collaborative team for transdisciplinary agroecology research. To fill this methodological void, an embedded and qualitative case study in Tiraque was chosen because it allows researchers to gain insights into the daily experiences of the participants (Kawulich, 2005). Moreover, since we wanted to extend the models for transdisciplinary research by providing guidelines for “phase 0”, we followed a Grounded Theory methodology. This methodology was chosen because it can be used to venture into new topics or areas, but it also allows for extending knowledge in existing theoretical frameworks (Charmaz, 2006). This methodology was introduced by Glaser and Strauss (1967), arguing that middle-range theories can be developed from data and require keeping an open mind, defined as *theoretical sensitivity* (Gibbs, 2012). Hence, it allows one to explore a topic without theoretical preconceptions because it builds up from the data (Charmaz, 2006; Peters, 2014). Moreover, Grounded Theory allows the study of complex interpersonal relationships and people’s behavior in social groups (Noble & Mitchell, 2016).

Gibbs (2012, p. 1) summarizes the analytical process in Grounded Theory methodology as follows: 1) compiling the corpus of data, 2) detailed reading of the transcripts, 3) explicitly searching for categories and patterns in the data, and 4) constructing thematic outlines using the codes to lay out the sequence in which topics will be considered.

Participant observation allows one to integrate naturally and actively into the daily routine of the participants of the research process (Delgado, 2010; Tapia, 2002). Therefore, we actively participated in the collaborative research team. Throughout the case study, a field diary and a repository of videos and pictures were kept in a data base of the Project.

A total of 16 in-depth and open-ended interviews were held with actors from different sectors, genders, and ages in Tiraque such as municipal technical staff (2), high school teachers (3), farmers (4), school parents (2), members of a youth organization (2), and leaders of social peasant organizations (3). Municipal interviewees were chosen based on their recognized authority role in agricultural production and health in the municipality. Highschool teachers and parents were chosen based on their involvement in the research project and the Social-Productive Project of the school. Farmers were chosen based on their involvement in the Agroecological Committee and their participation in the research project. Two representatives of the Youth Council were chosen based on their recognized leadership in their organization. Finally, leaders of social peasant organizations at three levels of governance were interviewed to have a multilevel perspective on the topics addressed by the research. Open-ended questionnaires were designed for each group of interviewees. These interviews helped us corroborate and complement our findings regarding the agroecological innovations that were co-developed by the collaborative research teams. Some interviews were carried out in *Quechua* which required the help of a translator. Prior and informed consent was signed for each interview.

A summary of the primary data collection is presented in Table 4.

Table 4. Primary data collection summary

SOURCE	SAMPLE	LOCATION	SAMPLE TECHNIQUE	RESEARCH TOOLS
Municipal technical staff	2	Tiraque	Direct	Face-to-face in-depth interviews
Highschool teachers	3	Tiraque	Direct	Face-to-face in-depth interviews
Farmers	4	Virvini	Direct	Face-to-face in-depth interviews
School parents	2	Tiraque	Direct	Face-to-face in-depth interviews
Field notes	87	Tiraque and Cochabamba	---	Diary
Field videos	17	Tiraque	---	Cameras

Note. Source: Authors

A series of Participatory Action Research activities were designed as part of the study. Because these activities are part of the results of the research, they are explained in detail in the results section. For example, a detailed explanation of the purpose of each activity, the details of the participants, and the outcomes are given in that section.

Secondary data about the main socioecological problems related to agriculture, food sovereignty, and nutrition in Tiraque was collected and reviewed. This included different technical reports from the government and local non-governmental organizations that were collected and reviewed. Likewise, the report from the general diagnosis written in 2018 by researchers in the six projects of the Interuniversity program was reviewed.

All transcripts were read in detail to “gain an impression of their content as a whole and to begin to generate ideas, hunches, categories and themes that interpret the phenomena” (Gibbs, 2012, p. 1). To structure and analyze the qualitative data, a coding methodology was used following open, axial, and selective coding (Glaser & Strauss, 1967; Rogge & Dessen, 2015). For this, the data that had been generated was reviewed, creating a timeline. At this point we asked ourselves the following questions:

- What are the main moments in the process?
- What characteristics do these moments have?
- Who is present?
- What is the context like at each moment?
- How do these moments help to form a collaborative team?

5. Results

In this section, we present the main results of extensive fieldwork in the municipality of Tiraque. First, we reflect on the overall process of building a society-driven collaborative team in two transdisciplinary agroecology cases: a kit for participatory soil assessment and school gardens. We describe the main moments identified in this process. Then, we analyze the factors that occurred together creating a window of opportunity to build a transdisciplinary research group from a society-driven approach. Finally, we discuss our findings and formulate a proposal to reach a window of opportunity for building such collaborative teams.

We were able to distinguish three moments in the formation of a society-driven collaborative research team for transdisciplinary research: 1) inspiration, 2) negotiation, and 3) action. In between these moments, we identified feedback loops, triggered mainly by negotiations, that made the team reflect on the path forward that can make the moments overlap or intermingle.

5.1 Starting point

Being part of an ongoing research project that has the goal of promoting food sovereignty and nutritional innovation, it was clear that the transdisciplinary research in Tiraque had to be framed under this thematic umbrella. Moreover, based on the participatory diagnosis developed in 2018 the main problems regarding the thematic umbrella were already identified. Hence, we knew that there were three premises: 1) to work with food sovereignty and nutrition, 2) to deal with one or more of the complex sustainability problems identified in the diagnosis, and 3) to develop agroecological innovation. However, we did not know how to build a society-driven collaborative team for transdisciplinary agroecology in Tiraque without falling back into more conventional top-down research and development modes.

5.2 Inspirational activities

At the very initial point of this study, the group of academics was composed of local scientists: an environmental engineer (lead author of this chapter), an agricultural engineer, a junior psychologist, a chemical engineering student, and a senior sociologist. The group also included a Belgium senior agricultural engineer and a senior economist. We decided to carry out a series of agroecological activities inspired by the *diálogo de saberes* to bring together different groups of actors and inspire them, hoping that this would result in research interest and initiative coming from them (Martínez-Torres & Rosset, 2014). These activities were also thought to help us explore the context and the different possibilities for moving forward. The activities carried out with the communities can be grouped into three categories: agroecology exchanges, art sessions, and farmer-to-farmer capacity-building workshops.

These activities were carried out with groups of actors with whom the project had previously been working to build trust and gain legitimacy in the field. As such, three groups of actors were identified: social organizations, a local school, and the committee of agroecological farmers.

Since 2018, the research team had provided technical and logistical support for the formulation of a public policy for the conservation of water sources in Tiraque (for a detailed description of this process, see chapter 6). Various actors from social organizations of peasants and irrigators participated in this process. While formulating the public policy, social organizations expressed their interest in carrying out different studies in the municipality. However, these research requests had a monodisciplinary and unidirectional perspective, with researchers presenting results or possible solutions to the municipality. For example, by request, a study was carried

out on the nutritional content of various products from Tiraque with the intention of selling them for the school breakfasts offered by the government.

A local school in the urban center of Tiraque had expressed its intention to improve the nutrition of its students. The government sponsored a "school breakfast" at mid-morning for the students. However, the director and teaching staff found its nutritional content deficient because the two dishes served to the students were based on rice and lentils without vegetables or fruits. Hence, students, tired of these dishes, tend to fill their plates with mayonnaise. For many students, school breakfast is their main dish of the day, and hence extremely important. Staff members were also concerned about the loss of traditional ecological knowledge linked to production and food. In this regard, a former school director explained:

The main problems that we identified are scarce knowledge of food and its nutritional value. Also, many students come from distant places, and they do not come to school fed. Hence, sometimes on Mondays during training some students faint. We ask them why they faint, and they tell us that there was not enough food at home before coming to school. (School director)

A schoolteacher explained that the lack of nutritional intake also affects students' performance at school: "they are more distracted because the stomach is not full, they are not well fed. They have a poor retention of information because they quickly forget what they learn". The school wants to change this situation through the Social-Productive Project of the school, which according to the Education Law N° 070, urges schools to develop a project that deals with a specific problem (i.e., social insecurity, pollution, nutrition, domestic violence, etc.) (Bolivia, 2010). Once a Social-Productive Project is defined by the school community it becomes part of all the courses with the main goal of positively impacting the daily lives of students (Ministerio de Educación, 2013). Figure 13 shows the school's entrance wall in the year 2019 with a painting that reads: healthy and nutritional food through the consumption of local products.



Figure 13. School's entrance painting by elementary students "healthy and nutritional food through the consumption of local products"

Note. Source: H. Gruberg

The committee of agroecological farmers in the community of Virvini. In 2018, with the assistance of two local non-governmental organizations, a committee of agroecological farmers was formed in four communities of Tiraque, among them Virvini. In meetings with the research team, some farmers expressed that they wanted to help train other farmers, but mainly they wanted to form a network of agroecological schools in Tiraque. Moreover, in Virvini peasants expressed problems of soil fertility loss and excessive use of agrochemicals among other problems. Illustrative is a farmer explaining that “production is no longer normal. We don't know what is missing [in the soil] because we are not specialists” (Farmer-1). Farmers expressed that despite the different soil studies from the area done by government agencies, the information usually does not reach them. Also, the information generated by these studies is complex and covers larger areas, making its understanding difficult for the local communities: “Soil studies are done. However, there is no space for feedback. Technical language is used that some colleagues do not understand” (Farmer-2). Moreover, the farmers explained that the costs to carry out studies on the health of their soils in laboratories are high and unaffordable. Muñoz (2021) estimated that a complete soil analysis costs approximately 63 euros, which is a high cost for the inhabitants of the area.

5.2.1 Agroecology exchanges

As a starting point, two agroecology exchanges were organized at the end of 2019. The first one was among peasants, where different actors from local social organizations were invited to visit a dynamic agroforestry farm in another municipality in Cochabamba. At the farm, 12 farmers (male and female) were able to share their problems and viable solutions while visiting different plots with a variety of dynamic agroforestry practices. At the end of the visit, they learned how to prepare *terra preta* (Amazonian dark earth) to increase soil fertility and how to incorporate it into a plot. During this visit, farmers expressed repeatedly that soil degradation is one of the main agricultural problems in Tiraque, corroborating the findings from the diagnosis (Figure 14). Likewise, farmers from the Agroecological Committee showed interest in working in conducting research on soil fertility.



Figure 14. Left: A group of visiting women appreciating the trees in an agroforestry plot. Right: Visiting farmers incorporating *terra preta* to improve soil fertility

Note. Source: H. Gruberg

A second exchange was organized between high school students from the local school in Tiraque and a school in Sacaba (another municipality from Cochabamba). In the latter, school staff and parents managed to include agroecology as part of the Social-Productive Project of the school, making agroecology part of all the courses taken by students from pre-school (who are three years old) until graduation. For instance, students learn about geometry by doing math calculations at the food gardens. Socioecological results are significant. Students are not only able to have a production with a surplus for sales after consumption, but they also have a greater sense of responsibility and empathy towards nature (Gruberg, 2019). Moreover, the food gardens became a space for community work and encounters among students, school staff, and parents (Gruberg, 2019). Currently, the school in Sacaba is applying to be accredited for giving a double degree in humanities and technical agroecology to its high school graduates.

At this exchange 25 students, one teacher, and the director from the school from Tiraque visited the school in Sacaba. Also, a partner non-governmental organization that promotes school gardens in peri-urban and rural areas of Cochabamba with a focus on creating community bonds was present. Students from the school in Sacaba prepared a meal and a series of agroecological presentations and practices. Students from Tiraque were able to appreciate the greenhouse, composter, preparation of organic amendments, square-foot gardens, bio-intensive gardens, and a water harvester. They participated in the preparation of a bio-intensive plot (Figure 15). The visit concluded with a soccer game between the students. Students from Tiraque were able to observe and ask their peers about agroecology. Both students and school staff from Tiraque were highly inspired and eager to replicate the experience at their school. At the end of the visit, they asked students from Sacaba to visit them in Tiraque and help them to start their own school garden.



Figure 15. Left. Elementary students sharing their experience with intensive gardens. Right: Preparation of a bio-intensive plot

Note. Source: H. Gruberg

5.2.2 Art sessions

After the agroecology exchanges, we asked other academics from Projects 1, 4, and 6 to join us in a joint effort to carry out a series of art sessions in the local school in Tiraque. Academics were invited based on their experience with Participatory Action Research activities and their interest to work with youth groups around the topic of food sovereignty. Hence, a lawyer from Project 4 who specialized in indigenous rights and theater of the oppressed was invited. She joined with a group of bachelor law students. Two communicators (a master's student and a PhD student) with experience in using art as research tools joined with a bachelor student whose thesis was focused on storytelling. A psychology bachelor student with expertise in storytelling and mural painting also joined. The opportunity of collaboration among researchers from different backgrounds was exciting to all of us and the organization was simple and enjoyable.

These sessions had the goal of inspiring reflexivity about food sovereignty and nutrition in 30 high school students (14 to 15 years old). These sessions were made up of storytelling, drawing and coloring, food sovereignty vs food security game, and graffiti painting.

We started with storytelling¹², which is a research tool “that consists of the construction of a narrative that allows to capture attention and build bonds with audiences. It is used in processes of research, marketing, and teaching-learning” (Rodriguez, 2022, p. 24). Students were asked to share in small groups their most precious story about food. Through their stories, students showed the meaning of food in their life such as in family encounters, soothing effects in difficult times, affection demonstration, and fun, among others. Temporal migration is significant in Tiraque. Usually, parents work in other cities during the week and return to Tiraque during the weekend. For children, meals during the weekend are an important space of encounter and sharing with their family (which is illustrated in Figure 16). The researchers of projects 1, 3, and 6 and students participated in this activity.



Figure 16. Drawing by a student about the significance of meals as spaces of family encounter entitled “weekend”

Note. Source: H. Gruberg

¹² It is a research tool “that consists of the construction of a narrative that allows to capture attention and build bonds with audiences. It is used in processes of research, marketing and teaching-learning” (Rodriguez, 2022, p. 24).

In each group, students were asked to choose their favorite drawing and share it with the rest of the group. Then they voted for one story and drawing that represented a shared memory for the whole group. They chose a story about a field trip they had to a river. On this trip, after having fun swimming and playing, they were hungry. A relative of one of the students helped them to prepare a meal that they all shared together. In the following session, students were asked to write together a sentence about what food represents to them:

“Together. A flavorful and healthy meal makes us happy”

With the help of a creative psychology student, high school students painted a mural at the entrance of their school representing the chosen story and painting. With the above sentence and as a slogan (Figure 17).



Figure 17. Left: Painting process of the mural. Right: Final mural with everyone involved

Note. Source: Courtesy of W. Rocabado from Project 6.

5.2.3 Theater of the oppressed

A PhD student from Project 4 researching indigenous peoples' rights prepared a series of activities with the help of law bachelor students from the Universidad Católica Boliviana “San Pablo”. These activities were aimed at strengthening the students' understanding and differentiation between the concepts of food security and food sovereignty (Figure 18). First, students were asked to draw what they understood of these concepts and shared their thoughts with the class. Then a game was developed, in which students had to allocate the main ideas around these concepts. Finally, a session on the theater of the oppressed was carried out, which is a popular community-based education methodology. Students played the “Landlord’s Monologue”.



Figure 18. Differentiation game between “food security” and “food sovereignty” developed by Project 4

Note. Source: H. Gruberg

Such inspirational moments were key to starting the transdisciplinary agroecology research process. The school director and staff asked us to work together with agroecological school gardens. Likewise, the Agroecological Committee of Tiraque expressed in a meeting that they were eager to create a network of local schools to exchange ideas and experiences on agroecology. They were interested in transmitting their technical expertise to students.

5.3 Negotiations

After these inspirational moments, actors approached us wanting to work on specific research topics such as the recovery of degraded soils and school gardens. Hence, we began to have organization and, above all, negotiation meetings. We attended a meeting of the agricultural union of the community of Virvini to present some possible topics on which we could work. At this meeting, the possibility of exploring a participatory soil health assessment kit¹³ arose, in addition to other topics such as natural indicators for weather forecasting and the installation of weather stations. Farmers were interested in knowing how accurate natural indicators were in comparison to the readings of a weather station. A mixed group of eight men and women were asked to volunteer to be part of the research team and finally, dates were set to start the work. The agreed goal of the research was to develop a soil evaluation participatory kit for land management and soil conservation.

Also, the planning of the school gardens began. Yet, several obstacles appeared. Although the school director, teaching staff, and the parents' association were enthusiastic and eager to start working, the responsible of the education district did not agree. It did not seem right for her to work only in one school, especially that specific school, as she considered other schools to be much more in need. To be able to discuss this situation it was important to have a meeting with the education district. Several meetings didn't reveal a clear explanation, hence months

¹³ The McKnight Foundation developed a participatory soil kit which was implemented in Bolivia by Agrecol Andes (McKnight Foundation, 2018).

passed without a resolution. In a desperate act, the non-governmental organization made use of its good relations with the Municipal Council, which promised to assist us. As a result, in March 2020, just a few days before the beginning of the Covid-19 pandemic, a formal agreement was signed between the University, the education district, the Municipal Council, and the non-governmental organization.

At this point also a series of negotiations arose concerning the PhD study at the local University. The PhD student and Project 3 are part of the Center for Exact Sciences and Engineering. This Center is composed of engineers that conduct mainly disciplinary research. The head of the Center was worried that the PhD study was “too social” to be accepted by the Center. Hence, the PhD student was asked to present her proposal to all the researchers for evaluation. Only if the proposal had their approval, it could continue, although it was already approved at Ghent University. After the presentation, with a deep explanation of transdisciplinarity, it was approved under the condition of making sure that the research included an engineering innovation component and a publication in an engineering journal. This experience shows that there is a clash between the exact and social sciences. Moreover, it shows that the research proposal needed legitimacy and approval by both non-academic and academic stakeholders.

5.4 Action

As the planning and negotiations were easier with the Agrarian Union, only a few weeks after the first joint meeting, research work began. First, a participatory zoning and soil science workshop led by an environmental engineering bachelor student was held. Eight volunteer farmers, a female, and a male between ages 18 and 60 attended the workshop (Figure 19). The non-governmental organization that had experience with the soil kit in Bolivia also participated. At this workshop, farmers explained the local names they use for various kinds of soils and the main problems they are facing regarding soil degradation. After the zoning, they defined a set of criteria for selecting the plots that were going to be sampled. For example, it was important for them to sample at least two plots per zone, each with a different management practice to be able to compare them. For example, they chose plots with different fallow periods to see if soil fertility was different. Subsequently, training days were held in the field and the group of farmers developed the soil evaluation. Halfway through the process, the Covid-19 pandemic began.



Figure 19. From left to right: Participatory community zoning, edaphology workshop, and soil sampling

Note. Source: H. Gruberg

5.5 The Covid-19 pandemic

The Covid-19 pandemic paused everyone's lives in the world. In Bolivia, during the first four months of the pandemic, there was a strict lockdown. As soon as activities could be restarted, we did so. Hence, the soil kit's activities were able to continue. However, it was planned to have farmers carry out soil evaluation at the University's laboratories to compare them with filed results. This activity was canceled because the University remained closed for almost two years.

Activities at the school were paralyzed for a while because in Bolivia schools were closed for even longer periods. At this point, a senior communication researcher from Project 1 from the local university contacted us to collaborate. Project 1 was interested in conducting research with a youth group and asked for our collaboration to work with the school. They already had experience in conducting research through mobile phones. Hence, to continue working with students we collaborated in a joint effort to conduct the research through mobile phones using *WhatsApp*. Two communication bachelor students joined us in this endeavor with the major participation of the junior psychologist. School students were given internet data to be able to participate in group discussions around food sovereignty and water harvesting. They were taught how to film and edit videos with their phones. They were asked to produce short *TikTok* videos about these topics. This collaboration among academics was easy.

5.6 Negotiations

Before the pandemic, the need to build a water harvester was identified by the school staff, academics, and a non-governmental organization. The goal of the water harvester was to conduct research, water the food gardens, and use them as a social and educative space. Before the pandemic, we had bought all the construction materials necessary to build a 52,000-liter water harvester to irrigate the school gardens. Some materials were about to expire, such as concrete. Hence, we needed to resume work at the school. At this point, things got complicated. On the one hand, every authority in the municipality was about to get changed. In other words, all the actors with whom we had worked at the school, in the district, and the municipality would leave their positions and could not hold meetings or make decisions. We needed to wait until new authorities were appointed.

However, the new authorities did not know us, nor did they know about the food gardens project. They thought they were working on a whim project of ours. Moreover, they saw no need to build a water harvester in a region with many natural water resources. They also did not fully understand the role of food gardens. In other words, we were back at zero with a proposal that no longer seemed collective. Slowly we managed to return to the point where we were through meetings and extended discussions and negotiations with school staff and the board of parents.

Then a new actor appeared. It turns out that the land where the food gardens would be does not belong to the school but to a religious educational organization. The owners planned to demolish everything on the site. Hence, we began the task of negotiation with the owners of the land. The school director led the first negotiations and discussions. Then the PhD student and the junior psychologist met on three occasions with the highest authority of the organization in Cochabamba. Finally, the go-ahead was given and off we started the construction of the water harvester.

5.7 Action

Soil evaluations continued and were finalized. At this point, only five of the eight farmers remained in the research group. Three left because they needed to study and work outside of Tiraque. For example, one farmer reflects on his experience: “I have learned and gained great experience as a producer with the soil kits. I have participated in some workshops and others, my wife has gone, because I had a job elsewhere” (Farmer-1). His wife could not attend all the workshops either:

In this experience, I learned to see what kind of worms are in the soil. What are the soils like? What type of soils are they? Whether they are good or not. We have been analyzing all of this. I like it but I haven't been able to attend anymore. (Farmer-3)

The student in charge of this phase processed all the information and presented a soil health traffic light to the farmers (Red: bad, Orange: more or less, and Green: good). With the group of farmers, the results were analyzed and validated. They identified a series of actions to be carried out to improve the health of their soils. A farmer expressed his opinion about the experience as follows: “Regarding the soil kit, the people who know how [to use it], who are producing, have improved our land because we know exactly what it needs” (Farmer-2). Later, the group of farmers shared the results at a Union's meeting for the community to make management decisions.



Figure 20. Left: Water harvester in construction. Right: Water harvester finalized

Note. Source: P. Ávalos

Construction of the water harvester began at the school (Figure 20). For this, a master mason and his two assistants with experience in water harvesters were hired. Also, the involvement of the board of parents was crucial. First, the head of the board used his influence and power at the Peasant Organization since he was also part of that board and got a backhoe to make the hole for the cistern. This endeavor would otherwise have taken weeks to be finalized by hand. The board of parents then organized two daily shifts for a week to help with the construction. Both mothers and fathers participated in the construction. The school had organized to provide food and accommodation to the mason and his assistants. It took a week to complete the water harvester. The municipality brought a cistern to fill the harvester until the rains came. It also gave a water pump to take the water from the harvester to the food gardens. This stage concluded with a big inauguration event for the water harvester with the presence of all the students, professors, authorities, non-governmental organizations, etc. Students organized dances and recited poems written by them. Finally, fruit trees were planted and irrigated with water from the harvester (Figure 21).



Figure 21. Student using the water harvested to irrigate the school garden

Note. Source: P. Ávalos

5.8 Inspiration

At the request of the non-governmental organization working on the implementation of a public water policy in two local communities (see chapter 6), a workshop was organized on a farmer-to-farmer model on soil evaluation. To do so, the most enthusiastic and constant farmers from the research group (one male and one female) from Virvini were asked to go to Carhun Mayu and share their knowledge about the soil kit. Both farmers showed important leadership, curiosity, and creativity. However, only the male farmer attended a reinforcement session to clear some doubts they had regarding the soil evaluations before going to Carhun Mayu. The female farmer was unable to attend because of time limitations. In this session, he gave many insights on how to improve the soil kit. For example, he told us that colleagues want to be able to know the results in the field and not depend on an engineer to know them. Thus, it was decided to develop a traffic light tool in the field. He also explained that chemical parameters are of interest to all farmers. Hence, including such parameters would be of great benefit.

The same farmer went to Carhun Mayu to train other farmers in the use of the soil kit (Figure 22). Hence, a dialogue with another community was opened, ties were forged, and the technology was transmitted and expanded beyond Virvini. But above all, the knowledge took hold in the farmer, who felt more secure and ready to continue doing soil evaluations.



Figure 22. Farmer-to-farmer in Carhun Mayu, Tiraque

Note. Source: Courtesy of P. Andrade

Shortly after, this farmer was invited by the local senior sociologist to share his knowledge in Batallas, a rural municipality in La Paz on the shores of Lake Titicaca (Figure 23). This exchange took place between a Quechua valley and Aymara highlands villagers in a *diálogo de saberes*. From this farmer-to-farmer experience, some farmers from Batallas continued with the soil evaluations. Two highly motivated farmers, again one male and one joined the research team.



Figure 23. Farmer-to-farmer workshop in Batallas, La Paz

Note. Source: J. Benavides

At the school in Tiraque, an 'Edu communication' plan was implemented by one of the bachelor communication students that participated in the *Whatsapp* sessions during the pandemic. The

Edu communication plan was focused on water harvesting and the installation of the gardens in a logic of education, food, and community. Edu communication follows an educational model based on dialogue where all those involved "co-create knowledge by being true interlocutors". In this case, the Edu communicational approach of Kaplún (2002, p. 15) was followed in which messages are produced "so that the recipients become aware of their reality", or "to provoke reflection", or "to generate a discussion". For this, the material was designed, videos were made with 60 high school students from 6th grade (ages 17 to 18) about their perceptions of food, and three workshops were held with guest actors from specialized non-governmental organizations. Likewise, a workshop was given to 30 schoolteachers.

School gardens were already installed. For this, the technicians of a non-governmental organization that works with school gardens provided technical advice to the students, educational staff, and parents. After the implementation of the Edu communicational plan, finally, a research topic to be carried out at the school garden was agreed upon, namely: the improvement of the *biol*¹⁴ recipe given by the local non-governmental organizations. Farmers from the Agroecological Committee shared their knowledge about the production of *biol*, whose recipe is being improved at school in an experimental study between academics, farmers, and students (Figure 24).



Figure 24. *Biol* preparation by the university and school students

Note. Source: A. Ledezma

5.9 Negotiations

On the school grounds, there were two abandoned orchards. The idea was to re-activate both. Once the land-clearing activities began, a new actor appeared claiming one of the orchards. It turned out that another nearby school had the right to use one of the gardens. So, a new round of negotiations began. In this case, the other school was delighted with the project and gave the space for a year and began to get involved in the activities (Figure 25).

¹⁴ Foliar fertilizer is elaborated with fermented local products.



Figure 25. Students working on the school gardens

Note. Source: A. Ledezma

Project 3 was asked by Project 1 to publish the results from the *Whatsapp* sessions and Edu communication plan in their latest book. This situation was carefully analyzed since the data from our project was going to be first published by another Project. This situation shed light on the need to have a clear copyright and publishing protocol when developing transdisciplinary or collaborative research. New questions emerged about transdisciplinarity: who has the copyright? Who is entitled to publish first? Negotiations between senior researchers from both projects were conducted until an agreement was reached. They were allowed to publish those results under the condition of clearly mentioning our participation.

5.10 Action

Based on farmers' appreciation and experience with the soil kit, several amendments were made. First, the protocol for measuring physical parameters was improved and validated. Likewise, a protocol to measure chemical parameters using colorimetry using purple potato peels was compiled and validated. Likewise, farmers asked for a systematization tool that could enable them to get the overall results without depending on academic actors. These improvements were made by two junior environmental engineers and two bachelor environmental students. The new protocols and systematization tool were tested and validated in a meeting of the collaborative group (two academics and three non-academics) in Cochabamba.

5.11 Wrapping up the process

Through “phase 0” we were able to reach the conformation of two transdisciplinary research groups. Although actors from both groups intermingled throughout the process they can be differentiated as 1) participatory soil evaluation for land management decisions and soil conservation, and 2) improvement of the recipe for the preparation of *biol*. In both cases, the different academic and non-academic actors participated with different levels of involvement. A description of the different activities performed, and the actors involved are presented in Appendix 1. Likewise, the intensity of involvement throughout “phase 0” is portrayed in Figure 26 ranging from information, consultation, cooperation, and to collaboration. Empowerment is the ultimate goal of transdisciplinary agroecology research. As appreciated in the next figure, we have not reached this level yet because we are starting to work on phase A.

Returning to the discussion on the integration of Pohl (2011)´s knowledge in chapter 1, we can see that in this continuous study, there is a tendency to follow the line of the definitions of

groups B and C. This is in the sense that it is about reaching the four characteristics of transdisciplinarity: 1) relating to socially relevant issues, 2) transcending and integrating disciplinary paradigms, 3) participatory research, and 4) searching the unity of knowledge. However, it is important to mention that it is an ongoing process, that will go beyond the establishment of collaborative research teams. It is in such a sense that the search for the union of knowledge continues in progress. According to Pimbert (2016, p. 287), it is “the key aim and claim of transdisciplinarity research today [...] this means re-embedding farmers and others citizens in the production of transdisciplinary knowledge in ways that fundamentally democratize research organizations and decolonize research methods in the social and natural sciences as well as humanities”.

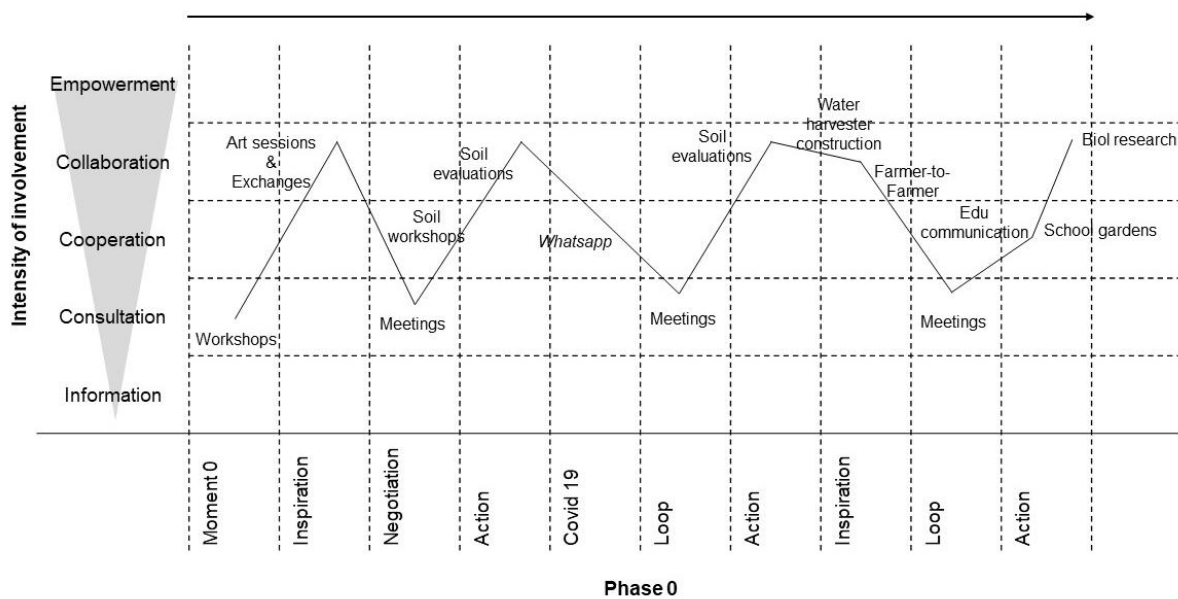


Figure 26. Levels of integration throughout “phase 0”

Note. Source: Authors

The composition of the collaborative team is not static either. The actors that made up the group changed over time according to their possibilities of participation, needs, and socioecological context. For example, in Tiraque some municipal authorities had to leave because their period of command concluded. Also, collaborating actors outside of the team summed up, especially in action moments. Muhar et al. (2006) faced a similar experience of a lack of continuity of political actors. Therefore, they argue that in transdisciplinary research there should always be the option to include new actors, bringing new insights to the team.

We were able to distinguish three moments in the formation of a society-driven collaborative research team for transdisciplinary research: 1) inspiration, 2) negotiation, and 3) action. In between these moments, we identified feedback loops, triggered mainly by negotiations, that made the team reflect on the path forward that can make the moments overlap or intermingle. Figure 27 presents a schematic proposal for society-driven transdisciplinary research (phase 0), based on the described process in Tiraque. In this proposal, the starting point or ‘moment 0’ is the thematic umbrella, in our case defined by the project. At this moment 0, complex sustainability problems are identified through a participatory diagnosis. At this point, the level of involvement is the consultation of cross-sectorial actors. Next ‘moment 1’ of inspiration is carried out through Participatory Action Research activities that can be enriched with the theater of the oppressed and Edu communicational plans. At this point the level of involvement

is cooperation and collaboration, engaging a limited number of actors in each activity. Before reaching the moment of action, negotiations take place because of new actors' interests. At this 'moment 3', the level of involvement is cooperation and consultation with specific actors. In the moment of action, collaboration is the level of involvement with highly committed actors. Between moment 1 and moment 3, feedback loops are generated to enhance the reflexivity about the process that has a level of involvement of cooperation and consultation. Hence, "phase 0" is not linear but follows a more iterative process. This phase overlaps with the initial phase of other transdisciplinary models such as Lang et al. (2012).

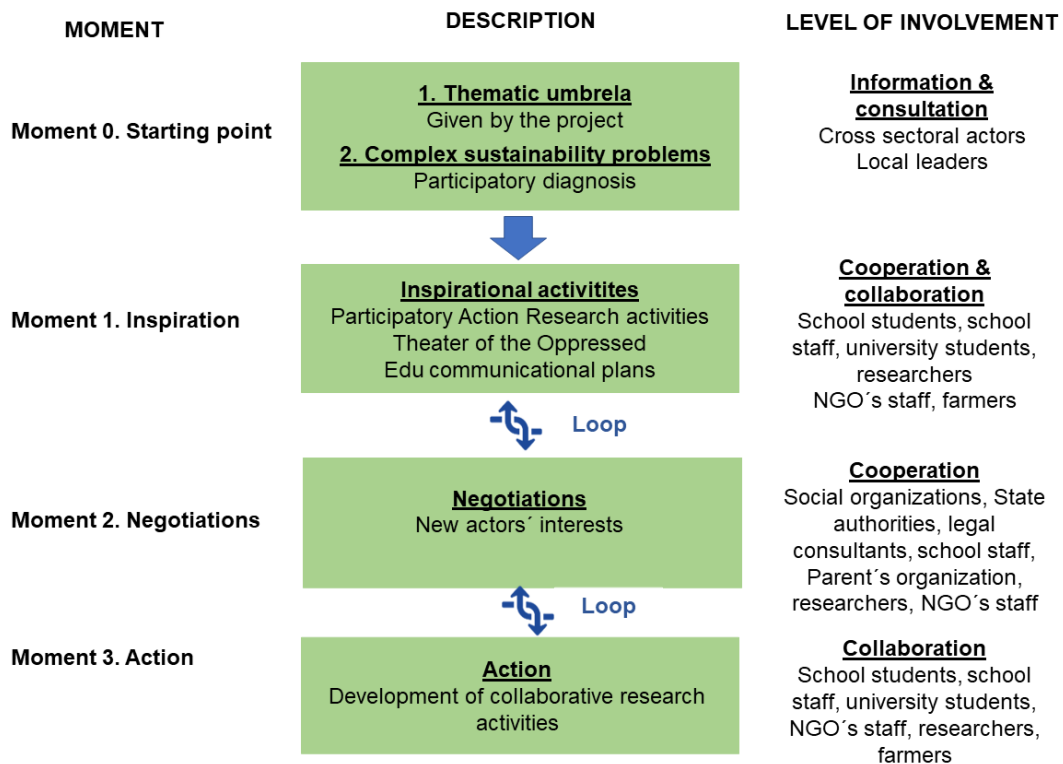


Figure 27. Proposal for "phase 0" in a transdisciplinary agroecology research

Note. Source: Authors

6. Discussion

Recounting what has happened so far in our case studies in Tiraque, we found that the formation of a society-driven collaborative team for transdisciplinary agroecology does not follow a linear sequence. We were able to identify three key aspects for the formation of society-driven collaborative teams: 1) an iterative spiral of inspiration, negotiation, and action moments, 2) the composition of the research groups is not static, and 3) some factors create a window of opportunity.

The process follows an iterative spiral sequence, in which moments of inspiration, negotiation, and action intercalate. Iterative sequences have been identified in other models for transdisciplinary research (Pohl & Hadorn, 2007; Wiek, 2007). In this regard, Wiek and Walter (2009, p. 362) referred to the iterative nature of transdisciplinary research as backward planning and forward operating, in which a past research moment can be modified "on the basis of new insights". Popa et al. (2015) and Enengel et al. (2012) explain that

transdisciplinarity is not linear because it is by definition a highly reflexive and pragmatic process.

Evidence shows that participatory tools generally used in agroecology can also be used in inspirational moments. These inspirational moments are key because they can catalyze action or can reinforce commitment and help in negotiations. They also serve to refresh the group or involve new actors. Both the participatory diagnosis and the inspirational activities are mostly based on Participatory Action Research, which is a methodology developed in the 1990s that does not recognize farmers as objects of study but gives them essential leading roles in the process (Guzmán et al., 2016). Hence, this methodology fosters a *diálogo de saberes* for the co-creation of knowledge to carry out a transformative process. Participatory Action Research presents a series of techniques, which, applied from the Community-based Participatory Approach consider the complex social relations that exist in rural societies around natural resources and agriculture, recognizing that there are power relations that can increase the vulnerability of more marginal actors. Therefore, Villasante (2006) explains that it is more feasible to aim at changing relationships among people than aiming at changing people themselves.

The fundamental principles of Participatory Action Research align with the principles of agroecology and transdisciplinarity:

Participatory Action Research and related approaches seek to involve a diversity of actors as active participants in a cyclical, iterative process that integrates research, reflection, and action, and which seeks to include or amplify those voices that have been traditionally excluded from the research process. (Méndez et al., 2015, p. 5)

In recent years, various combinations of Participatory Action Research and agroecology have been made (Méndez et al., 2015). Such participatory methodologies are used in studies where close collaboration between participants is required (Castleden et al., 2012; Janes, 2016). For example, Guzmán et al. (2016) propose a Participatory Research Framework, based on Participatory Action Research, which mixes participatory methodologies¹⁵ to articulate the dimensions and scales of the agroecological transition (Figure 28) with four functions:

- To generate the data necessary to inform the process
- To facilitate the participation and mobilization of social actors to progress toward the agroecological transition (mainly farmers, but also other social actors with potential to bring about necessary transformations)
- To promote subjective and symbolic transformations in local society
- To monitor the process and evaluate the progress achieved toward sustainability (Guzmán et al., 2016, p. 143)

¹⁵ For more details on the methodologies check (Guzmán et al., 2016).

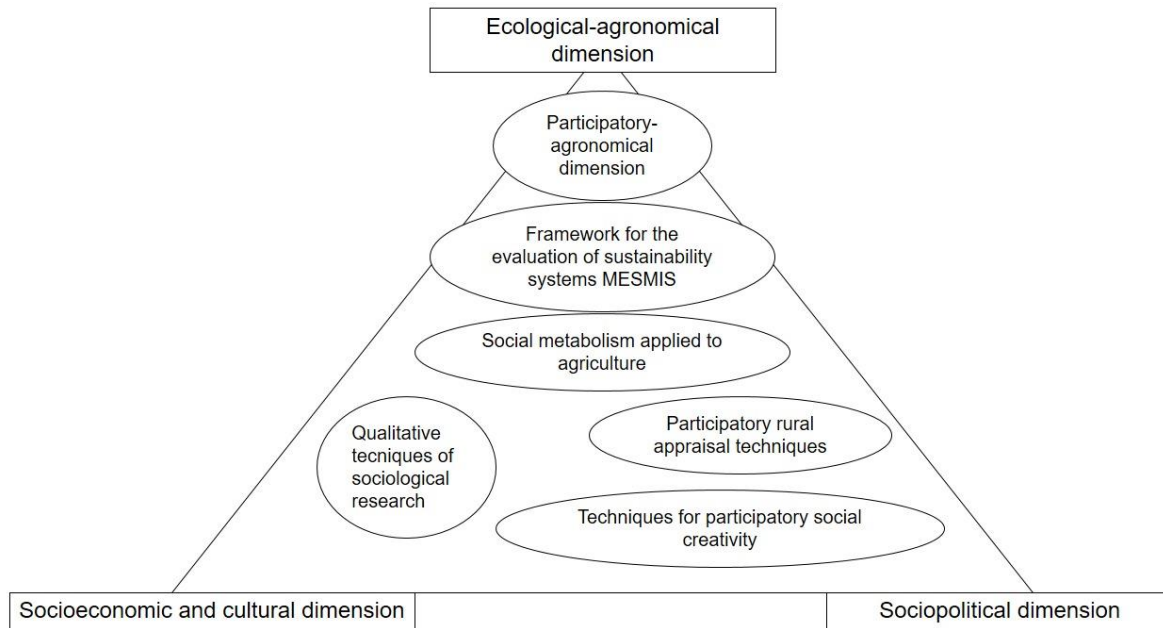


Figure 28. Methodologies for agroecological transition according to the dimensions of agroecology

Note. Source: Guzmán et al. (2016, p. 144)

Boal's (1979) theater of the oppressed has become a tool for critical ethnography, that opens a space for collective and reflexive dialogue for the co-creation of “common scenarios” (Quiroga Eróstegui, 2021, p. 146). Dennis (2009) used theater of the oppressed in a large critical ethnography study about the role of teachers in bullying activities of high school students because this methodology allows for capturing “the complexities and instabilities of participants’ experiences” better than by only using observations, interviews, and focus groups (Dennis, 2009, p. 66). Theater of the oppressed can also be used to explore conflicts over natural resources. Quiroga Eróstegui (2021) used it in a study on the right to land from a gender perspective in Bolivia. This tool “has made it possible to show conflicting situations that identify these women as a group, and symbolically make visible the meaning of the land in their lives” (2021, p. 18). Bezner et al. (2019) used the theater of the oppressed for the participatory design of an agroecological curriculum in Tanzania. These examples show the theater of the oppressed immense potential as a tool for transdisciplinary agroecology.

We propose to consider these techniques and tools for diagnosis and inspirational moments and to include other methodologies of popular education such as the theater of the oppressed and Edu communication plans. It is important to note that there is no fixed set of methodologies and techniques that must be implemented. These can be selected and modified according to the transdisciplinary research needs.

Negotiations were constant throughout the process. Negotiation loops tended to appear just before concrete action was about to happen. Usually, they appeared when permission was required for action and new actors and interests emerged. These loops lead to deep discussions and reflection inside the team since they lead to questioning the proposal and searching for possible alternatives and negotiation resources. In both cases, negotiations ended positively, and new actors became collaborators. Once the moment of negotiation was over, concrete action took place, giving a sense of reward to the actors involved.

Negotiations are also part of other transdisciplinary research models (Klein, 2008). For example, negotiations are present in Horcea-Milcu et al. (2022) recent proposal for a research-driven phase 0. In their experience negotiations were present from sub-phase 0.1 to sub-phase 0.3. In sub-Phase 0.1, negotiations were held among researchers and between researchers and collaborating partners. Then in sub-phase 0.3, negotiations were one of the three pre-conditions required for academics and non-academics to get together: a) managing expectations, b) breaking boundaries, and c) negotiating goals (Horcea-Milcu et al., 2022, p. 192). At this point not only goals are negotiated, but also the roles played by collaborating partners in their societies (Horcea-Milcu et al., 2022). Negotiations are also part of Participatory Action Research.

Social and cultural relations and technological innovation are closely related because of technology. For instance, according to technological determinism, society is shaped by technology (McLuhan et al., 2011). However, technology also answers to social, cultural, economic, and political demands (MacKenzie & Wajcman, 1999). Some authors like Callon and Blackwell (2007) and Latour (2007) posit that there is a reciprocal relationship between society and technology as postulated in the Actor-Network Theory. Tapia (2002, p. 99) explains that: “technology is the most important means to relate society with nature and through this reciprocal relationship to obtain food, clothing, health, distraction and permanently recycled knowledge, recreating their life in the material, social and spiritual aspects”. Hence, society and technological innovation cannot be seen as separate.

Pohl and Hadorn (2007, p. 5) explain that in transdisciplinary research it is important to consider “established technologies, regulations, practices and power relations”. The latter became more evident during the moments of negotiation between different actors. These power relations are intrinsically linked to the interests of the actors. In this regard, Méndez et al. (2015) explain that the participation of actors may be limited if they perceive that their interests are not being fulfilled. Cooperation and collaboration activities between academics flowed well. But negotiations were observed between academics on publication rights since it is in the interest of academics to be able to publish first. Also, power relations were evidenced between academics from the Research Center of the local university, who exercised the power to give legitimacy to the research if it is aligned with the interests of the Center. This exercise puts pressure on the scholars of the transdisciplinary project to meet certain requirements that can influence the course of the research. This problem is partly because there is no clear and agreed definition and methodology of transdisciplinary in the program. This puts academics in a complicated and intermediate situation between the University and the field. Lyall, Meagre, and Bruce (2015) in a study in the United Kingdom also found that a lack of a shared conceptual framework of transdisciplinarity is one of the main obstacles to advancing transdisciplinarity. Likewise, the lack of a shared conceptual transdisciplinary framework limits the monitoring and evaluation of such projects. In this regard, Stokols et al. (2008) explain that is required to have a shared conceptual framework among team members.

Negotiations also took place with the new actors who were appearing as owners of the land or orchards. These negotiations managed to be positive to the extent that the interests of these actors are considered. Another example of the exercise of power is that of a father member of the board, who, being a member of a social organization board, was able to easily access machinery. Many actors used their influences to achieve their goals (i.e., backhoe, water pump, etc.). A crucial aspect of the level of collaboration and reaching the empowerment level is the sharing of power between actors (Sergeant et al., 2021). At the collaboration, actors involved in the research have “equal footing for the progress of the process and output” (Stauffacher et al., 2008, p. 410). As portrayed in Figure 26, during “phase 0” collaboration was reached during

inspiration and action moments. It was observed that moments of action came after negotiations. In these moments of action, different actors collaborated. New actors used to join and become active participants of action moments such as soil evaluation days, the construction of the water harvester or the rehabilitation of the school gardens. These moments were highly rewarding, giving sense to previous moments when everything seemed more unclear.

Another barrier to collaboration among actors could be the perceived legitimacy and validity of others' knowledge. Academics need to overcome the prejudice that their discipline is superior to others (Klein, 2008). Hence, it is important to recognize that other disciplines' methods and results are valid (Max-Neef, 2005). Likewise, although, we did not encounter this situation, academics need to overcome prejudices over non-academics' knowledge. In this regard, an Integrated Pest Management program in Indonesia that included farmer field schools disproved four myths about farmers' knowledge: 1) farmers are ignorant and scientists are experts, 2) farmers cannot train other farmers, 3) farmers cannot do research, and 4) farmers are incapable of strategic planning and organizing complex programs (Pimbert, 2016, p. 273)273. Through our research, we were also able to disprove these myths. However, when conducting transdisciplinary research, especially society-driven, these prejudices need to be overcome.

Lauto and Senguko (2015) identified the main barriers to conducting transdisciplinarity from the academic's point of view in Japan. They found that although transdisciplinarity was highly ranked by all scientists surveyed, only a few of them prioritized participating in transdisciplinary research. According to this study, there are institutional barriers that need to be overcome to foster transdisciplinarity that helps to converge their careers with transdisciplinarity (i.e., research evaluation systems). Results from the field show that to build a society-driven collaborative team for transdisciplinary agroecology research, it is necessary to reach a window of opportunity. A window of opportunity is defined in Oxford Dictionaries as "a period of time when the circumstances are right for doing something" (Oxford University, 2019). Generally, a window of opportunity appears for a short period of time, after which the opportunity is lost (Sull & Wang, 2005). The concept of a window of opportunity is part of various disciplines such as medicine, business, and technological innovation (Clarke et al., 2004; Schmitz et al., 2016; Tyre & Orlikowski, 1994). Furthermore, the emergence of windows of opportunity has been part of studies about triggers for democratic changes. For example, according to the theory of political transition:

Transitory, negative economic shocks give rise to a window of opportunity for citizens to contest power, as the cost of fighting ruling autocratic regimes is relatively low. When citizens reject policy changes that are easy to renege upon once the window closes, autocratic regimes must make democratic concessions to avoid costly repression. (Bruckner & Ciccone, 2008, p. 1)

The Global Landscape Forum works with the notion of windows of opportunity in landscape collaborative governance (Henneman, 2018). This concept is used when there are conflicting policies in one landscape. Generally, the incoherence of public policies is given when a sectorial perspective is followed instead of a landscape one, reason why the policies tend to contradict each other. The theory on windows of opportunity states that policy change can happen when three aspects coincide: 1) there is a practical problem at hand, 2) there is a practical change proposed; and 3) there is a political will to change (Henneman, 2018).

Along similar lines, Olsson et al. (2004) refer to political windows of opportunity in the development of adaptive co-management of ecosystems. A political window or policy window

is a “concept that captures moments in time when it is possible for policy entrepreneurs to couple a policy to a problem and get attention from policy makers” (Knaggård, 2015, p. 460). Olsson et al. (2004) conclude that there are four key factors for this: 1) perception of a crisis in the resource which opens space for action, 2) a steward providing leadership, strategies, vision, and trust, 3) presence of a social and political window of opportunity, and 4) broad support for change among a range of actors at different levels in society.

Similarities can be found between both approaches, identifying three coinciding factors for reaching a window of opportunity (Figure 29):

1. Perception of urgency. There is a perception of crisis or urgency regarding a specific issue among different actors and sectors that leads to collective action (Olsson et al., 2004).
2. Key steward. In literature, key leaders are defined as key stewards and policy entrepreneurs. They are actors with recognized leadership and are trusted by the community (Olsson et al., 2004). A key steward plays a key role in shifting the direction of change and transformation. He or she can identify the perception of urgency, develop proposals, and identify key political and administrative moments for the proposals to be accepted (Kingdon, 1995). His or her proposals can also be used to generate a perception of urgency among different stakeholders (Kingdon, 1995).
3. Institutional will. There is social, administrative, and political support that allows the implementation of the proposal to transform the governance system (Olsson et al., 2004).

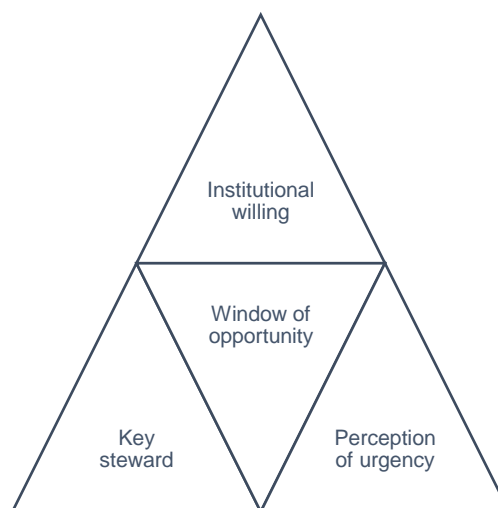


Figure 29. Factors needed for the generation of a window of opportunity

Note. Source: Authors

We include the notion of a window of opportunity in the process of the formation of a society-driven collaborative team for transdisciplinary agroecology research (Figure 30). The starting point (moment 0) is composed of the thematic umbrella and a participatory diagnosis to identify the main complex sustainability problems affecting the population. Based on these problems, a series of inspirational activities can generate a perception of urgency for developing

proposals, establishing research groups, negotiating, and creating a political will. In this way, a window of opportunity is reached that allows the development of a society-driven collaborative team for transdisciplinary agroecology research. As shown in Figure 30, the factors that are aligned to form a window of opportunity do not necessarily have the same weight or proportion. For example, there may be cases where there is more political will than the perception of urgency. Moreover, not only one window of opportunity may appear in the process because it is highly reflexive. The shape of the window of opportunity can also change during the process. Hence, there are constant inspirational activities and negotiation loops.

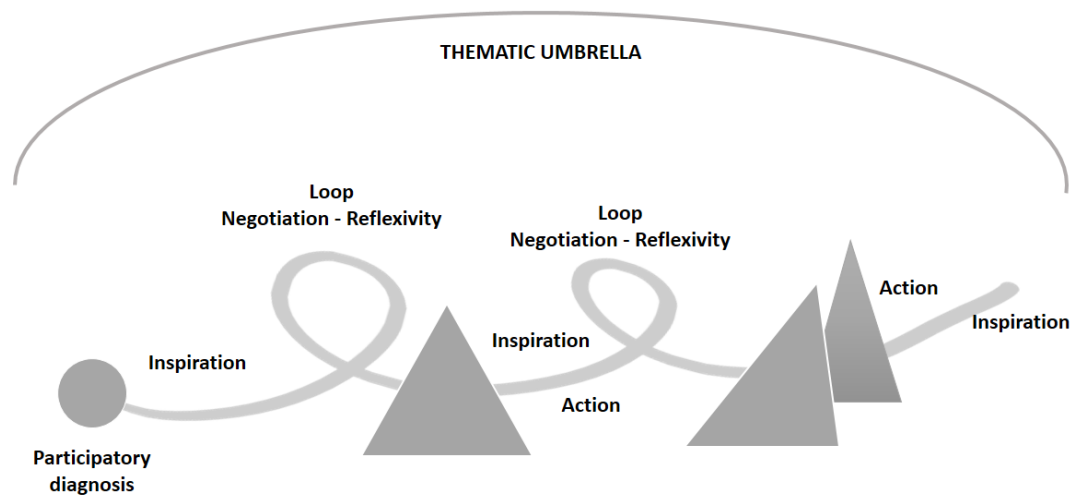


Figure 30. Reaching a window of opportunity. The triangle represents a window of opportunity, that can change its shape during the process.

Note. Source: Authors

Although this “phase 0” is proposed for society-driven transdisciplinary research it could be implemented also in research-driven transdisciplinary research to foster collaboration among the actors involved. Such implementation would require research flexibility, especially regarding time. For example, a research-driven experience in Austria composed of different activities (i.e., stakeholder analysis, network analysis, workshops, and in-depth interviews), took Muhar et al. (2006) approximately one year. We call on the scientific community to implement our proposal in different settings to be able to get feedback and enhance it.

7. Conclusions

Transdisciplinary research is gaining ground because it facilitates the co-creation of knowledge by actively involving different knowledge systems, both academic and non-academic. It also seeks participation and collaboration with marginal groups. Other research approaches seek the integration of non-academic actors but fall short in the sense that they involve non-academic actors only in data collection. Subsequently, the information is taken by the academics who process and analyze the information and then publish it and return it to the non-academic community for dissemination (Rosado-May, 2015).

In recent years, models and guidelines for transdisciplinary research have been developed, such as Lang et al. (2012) which starts from the definition of a problem by a collaborative research team. At this initial point, there is a methodological gap because it is not explained how to form that team from a society-driven approach. Hence, the research could be based on conventional, and top-down processes. To fill this gap, we conducted an exploratory and

critical qualitative study based on the Grounded Theory methodology in the rural municipality of Tiraque. We started from two premises: the thematic umbrella given by the project and a participatory diagnosis that had already been developed in the municipality. From there we continued by developing a series of activities to trigger interest in creating collaborative research groups.

Throughout the transdisciplinary agroecology, we were able to distinguish three moments that are interspersed: 1) inspiration, 2) negotiation, and 3) action. We saw that participatory tools commonly used by Participatory Action Research and aligned with agroecology can be used in inspirational moments. These moments helped to catalyze interest into action. Then, we saw that usually moments of negotiation appeared just before the action was going to take place, with the emergence of new actors and interests. These loops are also reflective and can shift the course of research and change the composition of the teams.

For the formation of society-driven collaborative teams three factors must align to create a window of opportunity: 1) perception of urgency, 2) key steward and 3) institutional will. The balance between these factors is not necessarily proportional and can vary according to the context in which it is immersed, nor is it about a single window of opportunity since transdisciplinary research is an ongoing process where reflexivity is important. Academics must constantly question the role we are playing in the process, being able to act as facilitators at first but passing this role as the research progresses.

The proposed “phase 0” for the society-driven formation of collaborative research teams overlaps partly with other models for transdisciplinarity research such as Lang et al. (2012). Hence, we recommend continuing to use these models once the collaborative team is formed, based on the proposed “phase 0”.

Although this chapter focuses on the agroecological dimension of practices because it aims at the design of agroecological innovation, it also explores the dimension of social movements and science. The social movement is represented by power relations that influence the process of co-creation of knowledge, technologies, and innovations, playing a central role in moments of negotiation. Hence, we recommend considering and reflecting on power relations in transdisciplinary agroecological research.

CHAPTER 5. DIMENSION: SCIENCE

This chapter is based on:

Gruberg, H., Dessein J., D'Haese, M., Alba E., & Benavides, J. (2022). Eroding Traditional Ecological Knowledge. A case study in Bolivia. *Human Ecology*, 50, 1047–1062. <https://doi.org/10.1007/s10745-022-00375-9>

CHAPTER 6. DIMENSION: SOCIAL MOVEMENTS

This chapter is based on:

Gruberg, H., Dessein J., D'Haese, M., & Benavides, J. (2022). Power relations in the co-creation of water policy in Bolivia – beyond the tyranny of participation. *Water Policy Journal*. 24(3), 569–587. <https://doi.org/10.2166/wp.2022.325>

Abstract

Recently, efforts to scale agroecology as an alternative to the dominant corporate food regime are gaining popularity in scientific and political arenas. These efforts embrace the development of policies that regulate property and access rights to natural resources linked to agroecology such as agrobiodiversity, land, water, and energy is being promoted. As well as the integral management of these resources such as integrated water management. Integrated water management is a complex sustainability problem and requires the participation of diverse actors to identify and implement transformative solutions. Recently, transdisciplinarity is being promoted as an ideal approach to empower participants through their meaningful engagement in the process of co-creation of policy. However, power relations can obstruct the more inclusive and equitable experiences of participatory approaches, hence limiting the empowerment of vulnerable groups. It is thus important to study how power relations are influenced by people's interests, socio-political structures, and knowledge in the process of co-creation of water policies. We use an *ex-post* analysis of a case study in a rural municipality in Bolivia to address this issue. Qualitative data was collected between 2017 and 2020 and analyzed using the elements of the Power Cube of Gaventa as the analytical framework. Results confirm that different factors influence power relations in the making of a water policy: interests, access to information, habits, and customs. Actors use different forms, spaces, and levels of power to achieve their interests. Our results show the importance and need to analyze power relations before, during, and after the co-creation of any public policy and to step away from linear and sectoral frameworks of policy development.

Keywords: Governance; water policy; Power Cube; power relations; Bolivia

1. Introduction

Initially, agroecology was understood as the implementation of ecological principles in food production (Méndez et al., 2015). Currently, agroecology is recognized as the integration of science, practice, and social movements (Wezel et al., 2009). Therefore, it has an important political dimension, generally promoted by social movements and peasant organizations around the world (Anderson et al., 2021). Non-governmental organizations also promote the development of policies in favor of agroecology to produce food in an environmentally sustainable and equitable manner, with the empowerment of small farmers (Pimbert, 2009). Thus, efforts to scale agroecology as an alternative to the dominant corporate food regime are gaining popularity in scientific and political arenas (Méndez et al., 2013).

An example of the inclusion of agroecology in these higher policy spaces is the report "Agriculture at a Crossroads" by the International Assessment of Agricultural Knowledge, Science and Technology for Development, where agroecology is recognized as an alternative to integrally deal with poverty and hunger globally (IAASTD, 2009). Another document that has promoted the inclusion of agroecology in the international debate is the Special Rapporteur on Agroecology and the Right to Food presented by De Schutter (2011) at the United Nations Human Rights Council in 2011. This report calls for an urgent shift of the food systems towards more sustainable, productive, and resource-effective systems, positioning agroecology as a promissory alternative to achieve this goal (De Schutter, 2011). Later, between 2014 and 2018, the United Nations Food and Agriculture Organization carried out a series of symposiums with the participation of more than 1,400 participants from 170 countries to discuss the scaling up of agroecology (Anderson et al., 2021). As a result, the United Nations Food and Agriculture Organization has developed a 10-year action plan to scale up agroecology that is made up of

three work areas. From these areas, number two is directly linked to policy to enable agriculture: 2) policy processes for the transformation of agriculture and food systems (FAO, 2019, p. xv). The actions proposed in this area are: “promote markets for agroecologically based products for health, nutrition and sustainability”, and “review institutional policy, legal and financial frameworks to promote agroecology transitions for sustainable food systems” (FAO, 2019, p. xv).

It is important to note that these efforts do not only center on advancing agroecological policies to achieve food sovereignty. It is also about developing policies that regulate property and access rights to natural resources linked to agroecology such as agrobiodiversity, land, water, and energy (Méndez et al., 2013; Pimbert, 2009). Likewise, it is about policies that regulate and promote the sustainable management of these natural resources. In this regard, Keulertz and Allan (2018) explain that there is a tendency among scientists to ignore the inexorable link between the management of water resources and food systems. Because of this inseparable link of water and land to food systems the declaration “Rights to Water and Land. A Common Struggle” was presented by social movements at the World Social Forum in Tunis (World Forum for Alternatives, 2015).

These policies require the effective participation of academics and policymakers. But also, with the participation of small urban and rural farmers, artisanal fishers, dwellers, nomadic pastoralists, indigenous groups, and agro-pastoralists who are often excluded from the decision and policy-making spaces (Chambers, 2008; Cuéllar-Padilla & Calle-Collado, 2011). In general, despite their central role in agriculture (approx. 40% agricultural labor force) women are the most excluded at all levels of policy-making (Pimbert, 2016). Their exclusion from decision-making spaces has often resulted in the imposition of policies that affect the sustainability of the natural resources on which their livelihoods depend, and even limit their access to those resources (Harvey, 2015; Leach & Mearns, 1996). In this regard, social movements such as La Via Campesina “are claiming agroecology as a bottom-up construction of knowledge and practice that needs to be supported – rather than led – by science and policy” (Pimbert, 2016, p. 15). This is related to agroecology’s central values “based on ecological principles and social justice, and honoring the agency of food producers and the important role of social movements in transformational change” (Anderson et al., 2021, p. 5). Thus, to foster public policies linked to agroecology and food sovereignty, dialogue processes between different sectors such as policymakers, scientists and producers must be promoted (Hainzelin, 2019). Both the agroecological and food sovereignty approaches are committed to the *diálogo de saberes* framed in transdisciplinarity. Hence, it is crucial to gain insights for potential transdisciplinary processes regarding the co-creation of policies.

In general, there is a tendency to assume that the construction of a public policy is a linear and straightforward process, which follows a logical sequence of first identifying a need, then formulating a policy, implementing it, and finally concluding with its evaluation (Brock et al., 2001, p. 13). However, in reality, it is a complex process influenced by power relations between different actors (Brock et al., 2001). Ignoring power relations may limit reaching active and meaningful engagements of different stakeholders that are arguably critical in the process of co-creation of a public policy. As a result, the empowerment of vulnerable and marginalized groups does not necessarily occur (Brouwer et al., 2013).

To avoid some stakeholders dominating the process while others end up being “abused, overruled or excluded” (Brouwer et al., 2013, p. 13), it is crucial to recognize and deal with power imbalances from the beginning of, and throughout, the whole process of co-creation of a public policy (Brouwer et al., 2013). Neglecting power imbalances might support more powerful stakeholders rather than benefit the most vulnerable and marginalized (Schiffer,

2007), an outcome often referred to as the tyranny of the participative approach (Boelens & Hoogendam, 2002; Cooke & Kothari, 2001).

Also, in the formulation of public policies related to natural resources, power imbalances may be present. Regarding water rights, López et al. (2019) observe this issue has been analyzed rather “narrowly”, either from a legal, technical, or economic standpoint, even though water rights are embedded in complex socioecological systems. Similarly, Boelens et al. (2007) claim that a water policy can be improved by analyzing and identifying power relations that reinforce both official and customary water rights at a local, national, and international level. Water governance is an interesting arena to explore both power and collaboration because of the complexity of the interactions between different socio-political structures (Brisbois & de Loë, 2016).

Power is defined by Brouwer et al. (2016, p. 73) as “the ability of actors to achieve their goals”. This dynamic interpretation of power allows for different expressions and forms of power, which Green (2016), building on Follet’s (1918) appreciation of power, refers to as power ‘within’, power ‘with’, power ‘to’, and power ‘over’. From these expressions of power, *power over* usually has a negative connotation of domination and/or control exercised by one individual, group, or organization over another one (Brouwer et al., 2016). This expression of power is seen as a potential “obstacle” for agency and collective empowerment because it “undercuts the ability of agents to actualize their own desires” (Pratt, 2011, p. 82).

A more equitable and empowering change may be more viable when these expressions of power and their interrelations are acknowledged (Gaventa, 2021). For the powerless to make a demand, first they need to “develop a sense of self-confidence and a belief in their own rights” (*power within* them) to then get organized as a group and work together (*power with*) (Green, 2016, p. 33). Finally, power transforms into the *power to* act and define “their own futures” (Gaventa, 2021, p. 5). Many scholars refer to *power with* and *power to* as agency (Gaventa et al., 2011; Miller et al., 2006; Whaley & Weatherhead, 2015).

The dynamic character of power is not only reflected in space and time but also at different levels of governance (Green, 2016). Lukes (1974) argued that power needs to be explored and studied outside of decision-making spheres and that more attention should be paid to other aspects such as real and subjective interests, and observable and latent conflict. Building on Lukes’ work, Gaventa (2006, p. 25) claims that power must be studied and understood “in relation to how spaces for engagement are created, and to the levels of power (from local to global), in which they occur”. These forms, spaces, and levels of power have been combined in an analytical approach referred to as the Power Cube, which serves as the analytical framework of our research.

The Power Cube (Gaventa, 2005) emerged from the need to examine explicitly and graphically the interrelations of three aspects of power: forms, levels, and spaces (Figure 39). The model identifies three forms of power: visible, hidden, and invisible (Gaventa, 2005). These forms of power were defined by Gaventa (2005, p. 15):

Visible power: Observable decision-making. This level includes the visible and definable aspects of political power – the formal rules, structures, authorities, institutions, and procedures of decision-making [...]

Invisible power: Shaping meaning and what is acceptable. [...] shapes the psychological and ideological boundaries of participation. Significant problems and issues are not only kept from the decision-making table, but also from the minds and

consciousness of the different players involved, even those directly affected by the problem [...]

Hidden power: Setting the political agenda. Certain powerful people and institutions maintain their influence by controlling who gets to the decision-making table and what gets on the agenda. These dynamics operate on many levels to exclude and devalue the concerns and representation of other less powerful groups [...]

It is important to mention that hidden power also is about who is influencing the process outside the public eye because they have hidden interests (Hunjan & Pettit, 2011). Moreover, it is “about how people affected negatively by [the process] may challenge it, to make their voices more visible” (Gaventa et al., 2011, p. 11).

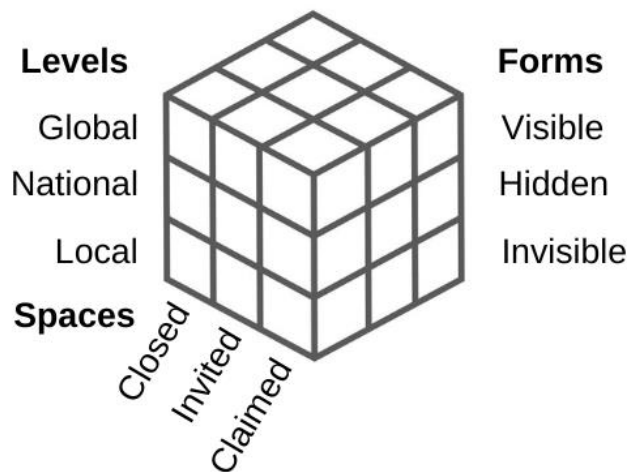


Figure 39. The Power Cube: Levels, spaces, and forms of power

Note. Source: Based on Gaventa (2006)

The Power Cube can be used to explore further the expressions of power mentioned above (Gaventa et al., 2011). For example, *power within*, *with*, and *to* can be linked to hidden and invisible forms of power. Brouwer et al. (2016, p. 81) “[...] can be exercised from below in the form of resistance and as expressions of power to, power with, or power within. Some citizen’s groups may be able to mobilise their own forms of hidden or invisible power as a strategy for empowerment and social change”. Hence, people who are not part of the decision-making but who are affected by those decisions become aware of this situation (*power within*) and organize (*power with*) to contest those decisions and establish a new agenda (hidden power). They can also use the social norms (invisible power) of their communities to confront these decisions (Interpeace-IPAT, 2015).

The forms of power can take place in different spaces or arenas of engagement (Gaventa, 2006):

- Closed spaces: Spaces where only certain “elite” actors make decisions without the inclusion, consultation nor involvement of “the people” (p. 26).
- Invited spaces: Spaces that rise as an attempt to counteract closed spaces by inciting “the people” to participate by state and non-state organizations (p. 26).

- Claimed or created spaces: Spaces created by “less powerful actors for or against the power holders or created more autonomously by them” to deal with common needs or concerns (p. 27). Gaventa (2021, p. 11) adds that in claimed spaces these actors “can shape their own agenda or express their own voices more autonomously”.

Finally, power takes place at different levels of power, usually pre-defined as local (sub-national governments, councils, and associations), national (governments, political parties, and other nation/state authorities) or global levels (formal and informal decision-making beyond the national state) (Gaventa, 2020). However, other levels of power can be defined according to the context and scale of each case.

Although the Power Cube has been used in natural resources and water analysis, most studies focus on only one form of power (Brisbois & de Loë, 2016; Etiegni et al., 2020; Karpouzoglou et al., 2019; Mehta, 2016; Roth et al., 2017; Tantoh et al., 2020; Thompson et al., 2020; Wamuchiru, 2017) or do not explore other dimensions of the model (Rodriguez de Francisco & Boelens, 2014). Although Whaley and Weatherhead (2015) fully implement the Power Cube in a study of water governance in England, they do not study the influence of complex interrelations of various aspects such as interests, socio-political structures, and knowledge in power relations. While in the Bolivian context Jacobi and Llanke (2018) did include all forms of power in their analysis, their study focused on agro-industrial and indigenous food systems. It seems that the Power Cube has not yet been fully implemented in Bolivia in the context of natural resources and water analysis. Therefore, studying the making of a water rights policy from a broader perspective unveils insights for the co-creation of more inclusive, legitimate, and empowering public policies. This chapter tackles this need by analyzing how power relations are influenced by interests, socio-political structures, and knowledge in the context of the co-creation process of a water policy to shed insights into potential transdisciplinary processes. Moreover, this chapter aims at evaluating if the Power Cube in all its aspects allows for such an integrated analysis of water policy, using a case study from Bolivia.

2. Background

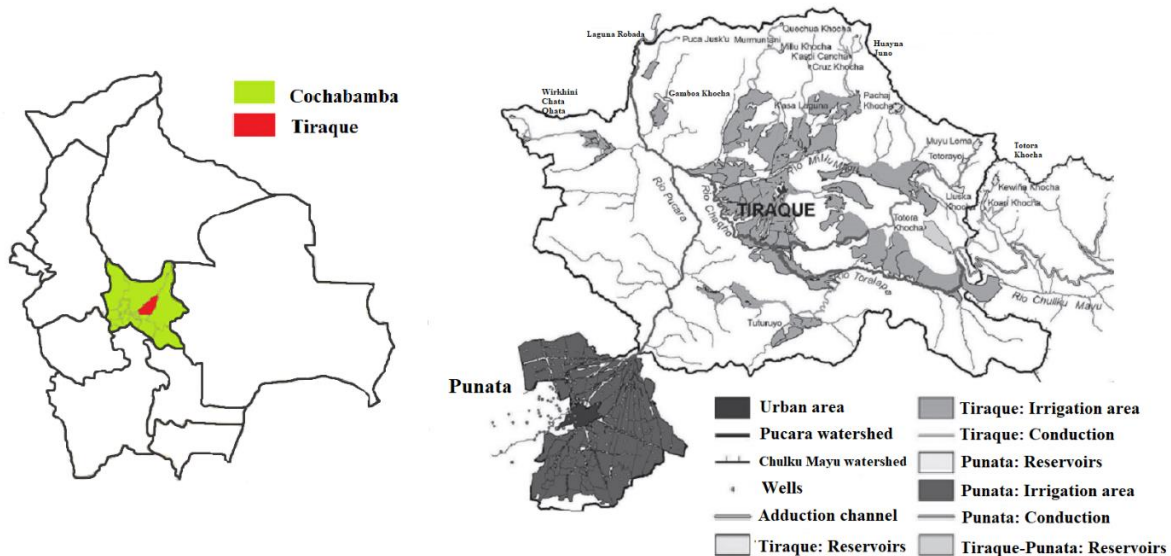


Figure 40. Left: Municipality of Tiraque, Bolivia. Right: Hydrosocial territories formed around reservoirs in the Pucara watershed

Note. Source: Adapted from Tiraque (2003) and Rocha et al. (2016)

The rural municipality of Tiraque, located in Cochabamba - Bolivia, is rich in water resources, with more than twenty lagoons, rivers, and springs belonging to two basins whose flows remain constant throughout the year (Figure 40) (PTDI, 2016). Tiraque is a suitable arena to study power relations in the construction of a public water policy because it is known in Bolivia for external and internal conflicts about access to and control of water (Cossio et al., 2010). Besides these, there are other problems related to water (i.e., distribution, pollution, over-exploitation of groundwater, and limited access to irrigation water) (Rodriguez, 2020). Because of these problems, the need to protect water sources and water recharge areas was identified and included in a municipal planning tool as a measure to secure access to sufficient quantity and quality of water, triggering the need for a specific municipal policy. The design of this water policy was led by a local non-governmental organization, which followed a consultation process established by local social organizations. A draft of the policy was presented to the Municipal Council in October 2019 and the final decision was communicated at the beginning of 2020. The main purpose of this policy is:

[...] to regulate the protection and conservation of water recharge areas and water sources of the municipality of Tiraque, to guarantee and conserve water in quantity and quality destined for its different uses in a sustainable way, considering water as a fundamental human right that guarantees the "good living " of the present and future generations of this municipality. (INCCA, 2019)

The proposal of this policy also seeks to promote food security through integrated water management. Its first article refers to the Political Constitution of the State that seeks to guarantee sovereignty with food security (see Chapter 1) (INCCA, 2019). Article 30 recognizes as rights and obligations of people to "have access to water for their food security" (INCCA, 2019, p. 9). Hence, there is a direct link to food security.

The policy was presented to the Municipal Council for its approval. However, it was contested by some sectors who were afraid of losing not only their water rights but also their land management rights, resulting in the rejection of the policy. The Tiraque irrigators, through their social organizations, wanted proof that the policy would not affect their current rights and asked for the development of pilot projects. Currently, the non-governmental organization is implementing one pilot project to fulfill this requirement.

Different power relations, socio-political structures, interests, and knowledge systems interplay throughout the process of water policy-making, culminating in the social rejection of the policy and the setting of a new agenda in 2020. Given this context, the development of a municipal policy for the protection of water sources and water recharge areas is an arena for internal/external struggles and conflicts, in response to new arrangements of the territory and water management and uses, and for the inclusion and exclusion of actors related to water control (Boelens & Hoogendam, 2002). It can also be a space for confrontation and rejection of external stakeholders, such as non-governmental organizations or international cooperation.

Before the Land Reform in 1953, most of the land and water resources were in the control of wealthy landowners (mostly Spanish descendants) (Antequera, 2018). In return for shelter and food, estates were cultivated by *colonos* (indigenous workers). Outside the estates, small surfaces of land were owned by *piqueros* (mestizo and free indigenous families) (Antequera, 2018). To maintain the water supply for food production, indigenous *colonos* working for estates owners had to build intakes, canals, and dams (Gerbrandy & Hoogendam, 2002). As a result, until 1953, water rights were distributed among all estates' owners who invested in

the construction of hydraulic infrastructure, which could also be located outside their estates (López et al., 2019).

After the Land Reform, estates disappeared and were transformed into peasant communities, and peasant unions started to emerge (Bustamante et al., 2019). López et al. (2019) define the period from 1950's to 1978 as a transition to community control of irrigation water. Through this period, *colonos* and newly established communities claimed the water rights that belonged to their former estate owners, even though such resources could be located outside the community's boundaries (López et al., 2019). A new set of "habits and customs" (*'usos y costumbres'* in Spanish) was established regarding water management and uses (López et al., 2019). Water demand for agricultural production increased after the intensification and expansion of agricultural land by *colonos*. Water rights demands were raised by the *piqueros*. As a result, new hydraulic infrastructure was built, and water rights were given according to families' investments (economic and labor) in these constructions (López et al., 2019, p. 206). Therefore, families who did not participate in this process were not granted water rights.

The period between 1978 and the early 1990's was marked by a major presence of the State with the re-organization of the peasant irrigation systems (López et al., 2019). In the late 1970's agrarian unionism gained strength with the creation of the National Confederation of Peasant Workers of Bolivia and the National Federation of Peasant Women of Bolivia 'Bartolina Sisa' (Costas et al., 2005). These peasant organizations have developed a great capacity to mobilize their grassroots members and/or to physically blockade the country to pressure the government to attend to their demands or to manifest their opposition to certain policies.

The National Confederation of Peasant Workers of Bolivia, the largest organization in the country, counts over 3 million agricultural affiliates (CSUTCB, 2019). It has a hierarchical structure, whose base units are the communities represented by agricultural unions. Associated unions form sub-centrals, which in turn are grouped into *cantonaes*, which grouped make up central provincial representations, in turn, grouped into nine departmental federations. Finally, the latter group collectively makes up the National Confederation.

The Central Provincials level is relevant for the real mobilization of grassroots members since at this level it is possible to coordinate with the smallest and lowest levels of organization (cantonal, sub-central and agricultural unions) (Costas et al., 2005). For example, if a Central Provincial disagrees with a mobilization or blockade defined at a national level, it is difficult for the sub-centrales (the next level of organization) to act against the Central Provincial's decision. Therefore, the Central Provincials are the "fundamental organic nucleus", since no decision to mobilize by the Confederation will be executed without the endorsement of the Central Provincial (Costas et al., 2005, p. 141). Once this endorsement is given, mobilizations will begin from the community level.

The organizational structure of Tiraque's peasants is well-developed. The highest level of social organization is the Central Provincial Peasant Workers Union of Tiraque. From this level down to the agricultural unions, organizations are legally established and have organized and consolidated structures. According to a municipal planning tool, a total of 147 rural communities and 7 Neighborhood Councils are organized in Sub-Centrals (PTDI, 2016). At the same time, the Central of Indigenous Peasant Women 'Bartolina Sisa' has 1,200 affiliates (PTDI, 2016). Specifically, concerning water management, there are the Federation of Indigenous Agricultural Irrigators of Cochabamba, the Tiraque Drinking Water Committees, and the Tiraque Irrigation and Services Association. The Federation of Indigenous Agricultural Irrigators of Cochabamba is composed of eight irrigation associations and was created in 2008

as a strategic instrument during a water conflict with a neighboring municipality (Rocha-López, 2020).

Currently, Tiraque's development is oriented mainly toward agricultural production (potatoes, grains, and fava beans). Agriculture is responsible for nearly 88% of the livelihoods (PTDI, 2016). Families may have access to multiple sources of water and irrigation systems (López et al., 2019). Natural springs are the main sources of the daily water supply to the communities (PTDI, 2016). They are also used for animals and to irrigate different crops. In total, 34 irrigation systems were identified in Tiraque (Viceministerio de Recursos Hídricos y Riego, 2013). Therefore, water control is crucially important in (partly) irrigation-based agricultural systems and is subject to the manifestation of power because of struggles, demands, conflicts, organizational entities, rules, and norms related to water management and use. Throughout history, rural communities have developed *usos y costumbres* regarding water use, dealing with power relations and water conflicts over water rights.

3. Methodology: a qualitative approach to the Power Cube

In recent years, several qualitative tools were designed and tested successfully to conduct power relations analysis throughout the world (Gaventa et al., 2011; Hunjan & Pettit, 2011; Pettit, 2013). This chapter follows a critical qualitative research approach (Merriam & Tisdell, 2015, p. 61) to explore power relations during water policy-making. Different forms (visible, hidden, and invisible), spaces (closed, invited, and created), and levels of power (community, municipal, regional), and their interactions, were analyzed using the Power Cube (Gaventa, 2006) as an analytical framework.

Data was collected through a qualitative methods approach in intensive fieldwork between 2017 and 2020. Primary information was gathered through semi-structured in-depth interviews with key informants, participatory observations, workshops, and transects during and after the construction of the water policy. Information from secondary sources was obtained from an exhaustive bibliographic review.

A total of 25 actors from different sectors were interviewed such as farmers, academia, State, and non-governmental organizations. Some actors were interviewed several times at different stages of the process. Hence a total of 34 interviews were conducted. Prior and informed consent was signed for each interview. In some cases, a local translator helped during the interviews held in *Quechua*.

Farmers were chosen through snowballing based on their involvement with agroecology and/or with peasant social organizations. Academics were directly chosen because of their involvement and participation in the process of construction of the water policy. Representatives from local and international non-governmental organizations were interviewed. We could not interview one of the directors because his contract expired at the end of the process, and he was not willing to grant information. We were able to interview a municipal authority involved in the process, other authorities did not grant interviews because of the political conflicts in the country. Semi-structured questionnaires were designed for each actor, according to the sector they represent and the information requirements of the study. We stopped conducting interviews once we reached a saturation point (Saunders et al., 2018).

Field notes (n=10), field videos (n=31), and workshop audios (n=4) were made through participatory observation at meetings with social organizations and municipality staff members and water policy workshops and transects to identify water sources and recharge areas.

Likewise, meeting audios (n=30) with different stakeholders were collected during coordination, analysis, and/or reflection meetings on the process of construction of the water policy.

Table 9 presents a summary of the different sources, samples, locations, and research tools used.

Table 9. Primary data collection summary

SOURCE	SAMPLE	LOCATION	SAMPLE TECHNIQUE	RESEARCH TOOLS
Female farmers	8	Tiraque	Snowballing	Face-to-face in-depth interviews
Male farmers	4	Tiraque	Snowballing	Face-to-face in-depth interviews
Academics: communicators, chemist, lawyer, psychologist, environmental engineer, and agronomist	9	Cochabamba	Direct invitation	Face-to-face in-depth interviews
Municipality	1	Tiraque	Direct invitation	Face-to-face in-depth interviews
Non-governmental organizations	3	Tiraque and Cochabamba	Direct invitation	Face-to-face in-depth interviews
Field notes	10	Tiraque and Cochabamba	---	Diary
Field videos	31	Tiraque	---	Cameras
Workshop audios	4	Tiraque	---	Cameras
Audio meetings	30	Tiraque and Cochabamba	---	Recorders

Note. Source: Authors

Secondary information about the case was reviewed such as State planning tools, maps, scientific papers, policy drafts, and technical reports from non-governmental organizations and a university among others.

The variety of methods and sources of information was used to gain a deeper understanding of the research questions and corroboration through data triangulation (Schoonenboom & Johnson, 2017). On the one hand, data source triangulation allowed to gather multiple perspectives on power relations in the construction of the water policy. On the other hand, methods triangulation allowed to explore the same issue through in-depth interviews, participatory observations, workshops, and literature review.

All data collected were transcribed and a content analysis was developed following Erlingsson & Brysiewicz (2017). The Power Cube analysis was complemented by an exploration of the interrelations with knowledge, interest, and socio-political structures. These categories were chosen in advance based on the set of guiding questions presented by Hunjan and Pettit (2011, p. 22):

1. Visible power: who are the individuals, and what are the institutions that have the power to change laws, policies, practice on the issue you are interested in? Who are the decision-makers?
2. Hidden power: How are decisions being influenced from behind the scenes? Who sets the agenda? Who is included or excluded from making decisions? Who may have an interest in the issue, but are influencing decisions outside of the public eye (e.g., role of business, banks, special interest groups, etc.)
3. Invisible power: to what extent are those with least power unable to address the issue, simply accepting the situation they find themselves in and why? How is their opinion shaped by society, education, or the media, and internalised?

Quotes were translated from Spanish to English by the first author and are given in italics. The respondent (R) is given between brackets.

4. Results

To unravel the interrelations between power, interests, knowledge, and socio-political structures in the process of construction of a public policy in the municipality of Tiraque, we first present a summary of the process of the making of the public policy, including the main events and actors involved. Next, the different forms of power and their relations with interests and organizational structure are analyzed. This analysis considers different spaces and levels of power. Results provide important lessons for future initiatives for more inclusive and equitable processes of public policy formulation and research.

4.1 Process towards a water policy: a summary

Since the early 2000s, an international non-governmental organization supported local communities with irrigation projects in Tiraque. The need to have a policy for the protection of water sources and water recharge areas was evidenced by the non-governmental organization's personnel because water sources were polluted, eroded, and forested with exotic species. This urgency was also identified in a government planning tool. As a result, in 2018, the international non-governmental organization hired a local non-governmental organization as a consultant to lead the overall process of constructing a public water policy (Figure 41). The local non-governmental organization had the intention of following a transdisciplinary approach with the assistance and participation of academics from the Universidad Católica Boliviana "San Pablo". However, as presented in chapter 4, academics from the university did not have a clear and shared understanding of transdisciplinarity nor methodological guidelines on how to carry it out. Hence, the agreement was to conduct the process as participative as possible within a logic of citizen participation.

The non-governmental organization started the process through a series of meetings and workshops with different sectors and social organizations. By February 2019, the local non-governmental organization facilitated the creation of an Advocacy Group, and the construction of the policy was included in the agenda of the municipality and that of the *Central Provincial*. Members of the Advocacy Group were two executives of the *Central Provincial* of Tiraque, one

from the Federation of Indigenous Agricultural Irrigators of Cochabamba, one executive from the Tiraque Irrigation and Services Association, two Municipal Councilors, and one community communicator. This group was to help set the agenda for the construction of the policy.

Between April and August of 2019, a series of theoretical and practical workshops resulted in the presentation of a draft in Spanish of the public policy, developed by a legal consultant hired by the local non-governmental organization. Next, a series of meetings with municipal technicians as leaders of social organizations were held at the Municipal Council to review the draft and to present it for its approval. The presidential campaign of 2019 played a key role in the process because stakeholders did not want to generate conflicts during this period (as detailed below). Later, in October 2019, the country was paralyzed for 21 days because of the outcomes of the presidential elections. At the beginning of 2020, the public policy was rejected.

In addition to the Advocacy Group, different social and institutional actors were involved throughout the process (Table 10).

Table 10. Actors involved in the co-creation of the public policy

LEVEL	SOCIAL ACTORS	INSTITUTIONAL ACTORS
Departmental	Departmental Federation of Peasant Workers of Cochabamba	Departmental Service Irrigation
Provincial	Central Union of Peasant Workers of the Tiraque province Central Union of Rural Women of the Tiraque Province "Bartolina Sisa"	Tiraque's Municipality (Mayor, directors, and technicians)
Municipal	Federation of Indigenous Agricultural Irrigators of Cochabamba Tiraque Irrigation and Services Association Drinking water committees Agroecological Committee of Tiraque	Municipal Council of Tiraque Drinking Water and Sanitary Sewer Service Association Education councils Local non-governmental organizations
Communal	Micro-irrigation systems Neighborhood councils Community communicators	Municipality technical staff
External	Irrigators from Punata	Private and public universities International non-governmental organization Legal consultant

Note. Source: Authors

Tiraque has a long history of internal and external conflicts related to water access, management, and control. Thus, the making of this policy was practically carried out in a minefield of conflicts and power relations. It is in this context that the actors promoting the formulation of the public policy had to move cautiously to avoid unintentionally stepping on someone's toes. A misunderstood word or technical concept could have unleashed a new

water conflict. For example, when reflecting on a water conflict between Tiraque and a neighboring municipality (Punata), an interviewee mentioned that “*it's like a time bomb ready to explode*” (R1).

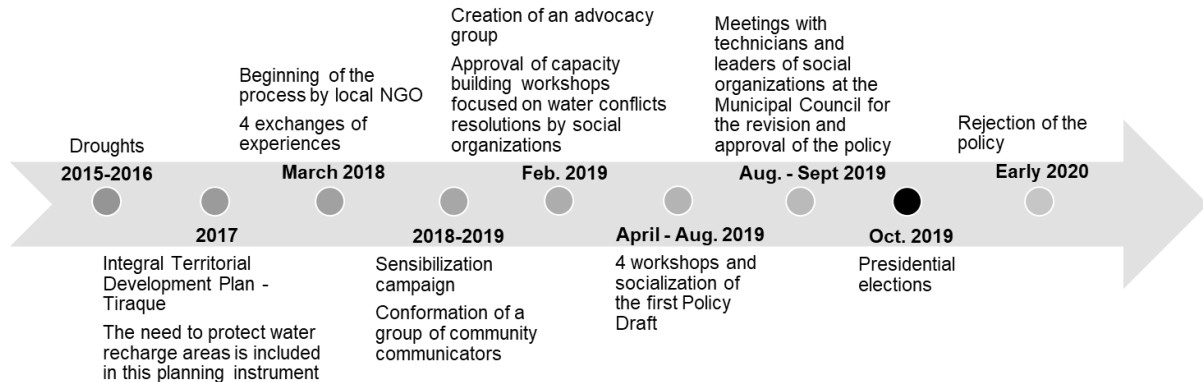


Figure 41. Timeline of the co-creation of the public policy for the protection of water sources and recharge areas

Note. Source: Authors

4.2 Visible power, knowledge, and participation

Visible power is about observable decision-making regarding the construction of public policy. It is mainly in the hands of decision-makers whose interests are to be maintained, hence reducing participation. An objective of social organizations is to influence the construction of public policies in favor of the peasantry, granting them legitimate decision-making power in the country. Although their leaders make decisions in favor of the peasantry at the grassroots, power itself is managed hierarchically and vertically. In Tiraque, the main decision-makers are the *Central Provincial*, the Mayor, and the Municipal Council.

The Central Provincial is identified as the most powerful social organization in Tiraque. For example, the candidates running for Mayor of Tiraque are chosen from the Central Provincial. Hence, political decisions at this level of the organization might allow or block processes. If the Central Provincial asks the Municipal Council to approve a public policy, it will likely be approved. As a municipal authority mentions: “Mostly social organizations exercise power, through the Municipal Council, to ensure that policies are accepted” (R6).

The legal consultant, hired by the local non-governmental organization, developed a draft in Spanish of the public policy, which was made public at the social organizations’ meetings between May and August of 2019. At these meetings, the inclusion and exclusion of actors were based on their decision-making power, resulting in the presence of high-ranking leading figures from social organizations, non-governmental organization staff, Municipal Council representatives, and municipal technicians. Although these meetings are supposed to be invited spaces where public and non-government organizations can freely participate, the invitation of specific actors turned them into closed spaces, characterized by four forms of exclusion: 1) rotating and supplanting leadership, 2) a culture of gendered decision-making, 3) avoiding conflict by not inviting, and 4) flawed transmission of information.

The drafting of the policy was hindered by the inconstancy in the attendance of leaders, due to a two-yearly rotating leadership. As a result, some leaders did not fully understand the

content of the draft and felt that they were being pressured to approve a policy that in their eyes was being imposed on them. This was amplified by leaders being often supplanted by other members of the organization without decision-making power. In this regard, an interviewee who was present throughout the process mentions: "I think that the challenge in our context is that all those who participate, [should have the power to] decide, right? But that really did not happen" (R5).

Likewise, although female leaders were present in these meetings, their voices were not heard, hence not visible. Women's participation was considered important as exemplified by the invitation and participation of the Bartolina Sisa Women's Peasant Unions at the meetings. However, although they presented their policy proposal, it was not even considered by the Central Provincial, because water is thought to be a masculine theme. This can be illustrated by the following comment: "It seems to me that women have had almost no participation in this regard, as Bartolinas have only received a very brief report that the NGO has given them" (R2). Therefore, mere attendance did not guarantee effective and legitimate participation.

Interviews also revealed how communities and landholders with water sources in their properties, were strategically excluded from the process, to avoid conflict. This group is vulnerable because it is not part of the irrigation organizations. In this regard, a farmer mentioned that "many families were not part [of the process]. In the Jatunchinija community alone, there are 174 unaffiliated [families]" (R8). However, organizers of these meetings explained that because these communities were unaffiliated, they could not be identified in time to be invited.

Flawed transmission of information was the fourth form of exclusion. Information was not transmitted to the grassroots because "leaders themselves did not understand the message properly" (R2). Information was not passed to the sub-centrals nor the communities. Reaching the 147 communities individually, considering the large number and the restriction to work during office hours only, was an impossible task for the local non-governmental organization. Therefore, the transmission of information from higher to lower levels of governance was difficult.

Information transmission was also limited due to language barriers. Tiraque's population is mostly *Quechua*-speaking. Men commonly speak Spanish as well, while women mostly speak only *Quechua*. Dealing with quite technical aspects of the conservation of water sources and water recharge, and using Spanish as the main language, the lack of understandable information as input for discussion and debate resulted in confusion, doubts, and distrust about the impacts of the water policy on the management and control of the water supply and recharge areas. In this regard, the following testimony shows how some communities were excluded due to language gaps and legal technicalities:

"The dynamic was that the [local] NGO proposed [the public policy], then the leaders that were present took [the information] to their grassroots and returned with some corrections. Of course, we understand that the grassroots do not have sufficient preparation to understand the methodology to generate a public policy. I have witnessed how community grassroots were not aware and did not understand at all. Hence, their participation was not ideal. It made me feel that the opinion of many of them was not considered because it was not an opinion that was expressed in an equitable and balanced way regarding the conditions that each of these people had" (R7).

This case shows that visible power is about who the decision-makers are. But it also shows that it is about who is present in the process but have little influence, such as women. Finally, it is also about those excluded, for example, because of language gaps. The following section presents how excluded or opposing actors contested the process and how interests influenced it.

4.3 Hidden power, agenda, and interests

Hidden power is concerned with who sets the agenda and how those affected manage to challenge it. Moreover, it focuses on hidden interests that different actors may have and on how decisions are being influenced outside the public eye. Although the construction of this water policy in Tiraque aimed to address a common need identified and prioritized by multiple local actors, its three-year development process was mainly led by a local non-governmental organization. The non-governmental organization managed to put the construction of this policy on the agendas of social organizations and the municipality, through a linear and straightforward advocacy strategy. Therefore, by setting the agenda, the local non-governmental organization exercised hidden power. This is further supported by a municipal authority who mentioned: "the NGO presented the request [for the policy], from there we started" (R6). The municipal authority related to the pressure felt as follows: "[municipal authorities] feel pressured, compelled" (R6). Along the same lines, an academic mentioned that "The agenda is established directly by the NGO. It has been generating the process. It is the driving force behind the public policy process. They are setting the agenda" (R2).

To prepare the ground and to show the importance of the policy, a series of initial meetings, including theoretical and practical workshops, was organized by the local non-governmental organization. Each workshop lasted "one day with the participation of various local actors, irrigators, peasant organization, municipal authorities" (R3). Due to its content and the used "farmer-to-farmer" approach, the first workshop was well-rated by the attendees. In this event, technical aspects of water dynamics were covered, and a local peasant from the area gave legitimacy to the conservation of water sources as he explained how their community changed their *usos y costumbres* to be able to protect water sources.

To "*continue motivating local actors*" (R3), in another workshop an authority from a municipality in a lower region was invited to explain his region's experience with the Reciprocal Water Agreements for "water planting" (*siembra de agua*), a commonly used term to refer to groundwater recharge fostered by human interventions for infiltration, retention, and regulation of runoff waters (i.e., conservation of recharge areas, reforestation, artificial lakes, etc.). As we will see later, this workshop had a major impact on the approval of the policy. Due to the cultural differences with higher located lands, regarding water rights, confusion was generated with the concept of "water planting". From the point of view of the attendees, those who "plant water" would have complete ownership of the water harvested. Because these events were open and included the participation of different actors, they were identified as *invited spaces*, where "social institutions took a leading role" (R5). A university supported this process with a communication campaign that included a "micro-documentary and booklets designed to sensitize organizations", which according to some researchers helped to "*open the field*" for the policy construction (R2). Although these workshops were focused on water management facilitators continuously linked its importance to food sovereignty.

Although the draft of the public policy was written, the Municipal Council did not grant its approval. This can be explained by several forms of hidden power such as the distancing of the leaders, questioning the legitimacy of the process, the deliberate obstruction of the process, information transmission flaws, and actors avoiding being involved. While initially the

meetings and workshops were well-attended (up to 40 attendees), the attendance declined gradually. By the end of the process, barely seven people were present. In addition, some leaders had distanced themselves from the process. This context of a weakening leadership, a reduced willingness to participate, and an increasing pressure to conclude the processes urged the local non-governmental organization and social organizations leaders to take it to the next level (Municipal Council). Although they were aware of the lack of empowerment, understanding, or open dialogue, the legitimacy derived from the successful start of the entire process and from the mere authority of the local non-governmental organization itself allowed for this move. Secondly, several actors questioned the legitimacy of the process and condemned the pressure exerted by the local non-governmental organization to carry out the process without the effective participation of key actors: "There has been participation, yes, but it seems to me that it has not been very legitimate" (R7). Another informant links the weakening of the process with the lack of coordination, the unclear division of roles, and a resulting lack of responsibility among the actors involved (R2).

Others actively and consciously obstructed the process in several ways. For instance, several leaders expressed that they could not participate in the decision-making since they first had to consult their communities. Such a process usually takes a month, and did not happen:

"It was not a fully participatory process of what should be a public policy because it has been largely developed by the NGO. That has been a very repetitive criticism in the meetings by the representatives of the unions. These unions were, in addition to that, putting obstacles in the matter so as, logically, to lower the proposal directly to the grassroots, and that takes about 1 month." (R7)

A third example of conscious obstruction is provided by the actions of the irrigators, the group most affected by water policies. The Federation of Indigenous Agricultural Irrigators of Cochabamba is an important actor because although its members do not manage all the water sources of Tiraque, they do have the biggest ones. They were not against the idea of the water policy as such, but they were afraid of its content, as it might affect their control over and management of water as well as land sources. Therefore, they took a series of actions that ended in the rejection of the policy. For example, identifying water sources is a key factor in developing water policy. Therefore, a technical advisor attempted to make an inventory of water sources in support of the policy. The irrigation organizations "have not endorsed this information, they have not accepted that it is valid information" (R2).

Three forms of hidden power triggered the fears of the Federation of Indigenous Agricultural Irrigators of Cochabamba for the new policy, urging them to act against it. The first form relates to the specific context of the gatherings. There is the issue of language, combining Spanish with a technical-legal jargon, and the deliberate choice by the *Central Provincial* to organize the meetings in their own venues, hence giving the irrigators a secondary position in the room. The second form relates to the misinterpretation of the "water planting" concept and "water harvesting" rights explained before. An informant explained "that the concept has been misinterpreted because harvesting water is about collecting water: when it rains, you harvest it, store it and that's it and it's for your consumption and they can't claim rainwater" (R2). Therefore, irrigators were afraid that by "planting water" other people would gain access and control of water resources. Thirdly, historical conflicts with the municipality of Punata created the fear that this policy of conservation of water sources and recharge areas would be beneficial for Punata as well, a perspective that was not appealing, as detailed later.

As a result, the Federation of Indigenous Agricultural Irrigators of Cochabamba preferred not to enact the policy. Other irrigation organizations and the *Central Provincial*, decided to reject

it as well for political interests (see below). As an alternative, the Federation of Indigenous Agricultural Irrigators of Cochabamba successfully requested a pilot case to be developed to show them the real impacts of the policy, which is currently being implemented through a Declaration of Protected Area in a community that supports the policy. In this way, irrigators have successfully managed to obstruct the approval of this water policy and negotiated an alternative, setting a new agenda as a true representation of their *power with* and *power to*. This contestation was organized at *claimed spaces* at the Federation of Indigenous Agricultural Irrigators of Cochabamba's own meetings. Then Federation of Indigenous Agricultural Irrigators of Cochabamba's representatives met with different social leaders in *closed spaces* to express their concern, which was finally taken to the Municipal Council where the policy has been evaluated.

Actors used different spaces and levels of power to reach their interests: neighboring municipal water interests, political interests related to presidential elections, non-governmental organizations' institutional interests, and the mayor's office interests. The institutional regulation of water in Tiraque is a common interest among surrounding municipalities that benefit from Tiraque's water. They have a long history of municipal conflicts around water access with Tiraque. A particular conflict arose when the municipality of Punata tried to expand a water catchment in Tiraque (Titora Khocha) only to benefit its own communities (40). After several years of negotiations, an agreement was reached giving Punata 60% of the rights and 40% to Tiraque (Saldías, 2009). Since then, irrigators from Tiraque are very suspicious and cautious regarding any water policy that could also benefit Punata. Currently, "Punata and Tiraque do not get along, although water belongs to everybody. They understand that it does, but it does not suit their interests" (R4). The surrounding municipalities' interests in the water policy are part of the hidden power since they are shaping the process outside of the public eye.

Political interests have influenced the process in Tiraque because, during the final period of the construction of the public policy, there were many interests related to the presidential elections. During this period the priorities of social organizations were influenced by the political interests of Morales' Movimiento al Socialismo campaign. On the one hand, social organization leaders were busy campaigning for Movimiento al Socialismo and did not spare time to lobby for new projects¹⁷. On the other hand, leaders aimed to avoid any conflict that could jeopardize the political campaign such as losing the support of a highly influential sector such as the irrigators. The elections were followed by a period of great political unrest where social organizations did not want to trigger any conflict. Therefore, when the Federation of Indigenous Agricultural Irrigators of Cochabamba opposed the water policy, social organizations and the Municipal Council rejected it to avoid any conflict.

Institutional interests also affected the process of construction of the policy. For example, the local non-governmental organization was interested in reaching the goals established by the international non-governmental organization and in its institutional planning. Usually, these interests generate pressure on the non-governmental organization's personnel since they must meet the established deadlines and outcomes of their funding organizations. However, in the process of policy construction, they must also consider local dynamics and power relations, which can prolong the time needed to reach the expected goals. This affected the local non-governmental organization promoting the water policy construction: "I believe that the NGO has also felt this pressure because it has not been able to show many results of their project" is mentioned by a Country Officer of the international non-governmental organization

¹⁷ During this period meetings for interviews with the researchers were constantly cancelled because leaders were campaigning.

(R3). Hence, the interests of the international non-governmental organization influenced the interests of the local non-governmental organization and directed its course of action in the overall process. This is a representation of hidden power.

On their side, the Mayor's office is also interested in the policy because it could open doors to develop new sectors. For example, an interviewee mentioned that "this would lead to training in the management of irrigation systems, opening new doors for production development" (R1). This shows that although pursuing the achievement of institutional interests may open possibilities to develop a policy, it may also generate unfavorable pressure on different actors.

Within the hidden form of power, the participation and influence, behind the public eye, of the corporate food regime was expected. However, due to the characteristics of the region where the study was carried out, the exercise of power by this corporate regime was not evidenced, since it is an area dedicated to family farming and local commerce.

4.4 Invisible power and socio-political structures

Invisible power concerns social norms and values that shape what is accepted as normal by society (Brouwer et al., 2016). Therefore, invisible power, represented by *usos y costumbres* in Tiraque, shape the process of decision-making by defining spaces, protocols, leaders, and participation. *Usos y costumbres* were respected by the non-governmental organization and the municipality, by the Mayor and the Municipal Council. It is the *usos y costumbres* that can make decisions accepted as legitimate when they are made by authorities. *Usos y costumbres* were used to establish the non-governmental organization's strategy to set the agenda, the meetings at the *Central Provincial*, only leaders' participation, and the top-down flow of information.

The non-governmental organization abided by the local *usos y costumbres* to define its strategy to include the construction of public policy in the agendas of the municipality and social organizations. For example, the *Central Provincial* asked to have the meetings and workshops as part of their own meetings. Likewise, at the beginning of the process, the non-governmental organization identified the need to engage strategically and separately with irrigator's organizations to avoid conflict. However, the *Central Provincial* asked to have general joint meetings, a request that was accepted by the non-governmental organization following the authority level:

"The Central Provincial is the one that defines these issues. So, we followed what they say, and the order established in the municipality, which is through the Central Provincial. We do what they tell us" (R1).

Although according to the *usos y costumbres* the information shared and generated at the *Central Provincial* meeting should flow down to the grassroots, this transmission of information was limited. A municipal authority mentioned that: "it is not possible to reach the totality of the grassroots and there may be a dissatisfied minority, but they abide by what has been decided" (R6). This shows that communities will usually abide by the decisions made even if they do not agree with them. Therefore, the non-governmental organization initially tried to show in a workshop how some *usos y costumbres* can be changed to protect water sources and water recharge areas. In fact, to implement this water policy, some social structures would have needed to be adapted. Although this case shows how actors challenged the water policy through their *power with* and *power to*, it also shows how socio-political structures affect the process of decision-making and how certain groups will abide by the decisions made by their leaders. Moreover, as mentioned, some communities were afraid that their *usos y costumbres*

were challenged by the new policy, opening space to the State to access and control their resources.

5. Discussion

Integrated water management is an inseparable part of food systems whose policies are being promoted by agroecology, especially by peasant organizations and social movements. The proposed water policy in Tiraque links the integrated management of water resources to people's food security as a right and duty (INCCA, 2019). Although, the process of co-creation of the water policy was intended to follow a transdisciplinary approach, because of the lack of a shared conceptual and methodological framework it followed a citizen participation approach. However, it brings insights into potential transdisciplinary processes.

Power relations can shape the construction and implementation of policies through the interaction of various actors (Anderson et al., 2021). Taking to Giraldo and Rosset (2018) water management is itself a "territory of disputes". This *ex-post* analysis of a case study illustrates that the Power Cube can be fully implemented for an integrated analysis of how power interrelates with actors' interests, knowledge, and socio-political structures in the co-creation of a water policy. These interrelations define the course and result of the process and thus should be considered in future implementations of the Power Cube to enrich the analysis. Furthermore, through the implementation of this tool and Hunjan and Pettit (2011) guiding questions, the dynamics and characteristics of hidden and invisible power became observable, evidencing that the Power Cube is a promising tool for the analysis of power relations to unveil insights for the co-creation of more inclusive, legitimate, and empowering natural resources and water policies. However, it is important to recall that power relations are not static, they are highly dynamic in space, time, and levels of governance (Green, 2016). In this regard, Gaventa (2005, p. 19) explains that the Power Cube cannot be used as a "set of fixed boxes" or project indicators. Instead, it should be understood "as an illustration of concepts and sets of relationships that are constantly dynamic and changing" that should be analyzed and reflected continually.

Visible power is an exercise by decision-makers, in this case, the Central Provincial. Actors who exercise visible power usually make decisions in closed spaces and, most importantly, decide who can participate and who is excluded. In this case, some vulnerable groups were left out of the process and others, such as women groups, were part of the process, but their participation remained low. This indicates that attendance does not guarantee participation. Moreover, it shows that women's knowledge is still not considered valuable. Similarly, Seemann (2016) found in one community of Tiraque that in the Water Users Registries, only 56 out of 200 entries belonged to women even though women are involved in the daily chores of water management. By being left out of these registries, women have limited access to meetings. Therefore, women continue to be invisible in water-related decision-making arenas.

Along the same lines, access to timely and adequate information was a key to the exclusion of lower levels of governance actors. As long as communities do not have access to timely and adequate information (i.e., due to language barriers), they cannot achieve "participation and autonomy" (Chávez & Rojas, 2011, p. 174). If they are not informed, they will not be able to build their own speech and make their voices heard. A similar case was observed in the process of the Commission on the Legal Empowerment of the Poor from Peru. This process was criticized for excluding vulnerable groups such as "the poor, women, indigenous peoples, the landless, and ethnic minorities" (Seemann, 2016, p. 194). Moreover, visible power can be linked to knowledge because by defining who can participate, it also defines whose knowledge

is considered valuable and can come to the decision-making table. This aspect should be considered in transdisciplinary settings where different knowledge systems may be confronted.

Although certain actors exercise visible power, irrigators managed to challenge the process through their power with and power to and stopped the approval of the process, setting a new agenda by asking for a pilot project. Indeed, by following the strategies and tactics of various actors, it is possible to see how the direction of a policy is changing (Brock et al., 2001). This was seen in studies carried out by Geng (2016) and by De la Cruz and Dessein (2021) in Peru, where groups of villagers managed to challenge the decision-making power through interactive networks of actors. Such 'intertwining relations' (De La Cruz & Dessein, 2021) demonstrate that policy-making can take the form of bricolage - where actors participate throughout the whole process as "doers" -, or even of sabotage - where other actors oppose and sabotage the process as "stoppers" (Paquet, 2001, p. 14).

Moreover, throughout the process, there were closed, invited, and claimed spaces. However, spaces interact with different forms and levels of power, changing from one type of space to another (Gaventa, 2006). For example, participation was still limited at invited spaces because hidden forms of power defined what issues and whose voices were valid. When the Federation of Indigenous Agricultural Irrigators of Cochabamba contested the public policy and managed to set a new agenda, their contestation was organized in claimed spaces (the federation's meetings) and taken to higher levels of decision-making in closed spaces (meetings with social leaders). Similar observations were made in Asian cities and in Rwanda, where vulnerable people excluded from closed and invited spaces of participation mobilized to create claimed spaces for contestation (Nikuze et al., 2020; Patel et al., 2016). This evidence indicates that in policy-making dynamics, different spaces are used or created by actors at different levels to achieve their goals. Thus, levels of governance also interact with forms and spaces of power in different and varying ways.

The corporate food regime is powerful in the lowlands of Bolivia. Where there is a strong agro-industrial sector (i.e., soybean production and sorghum). Jacobi and Llanque (2018) analyzed the power relations in the agro-industrial sector the lowlands of Bolivia and found that through hidden power that sector "undermines the visible legislative power" of the State. For example, they found that landholdings exceed the surface regulated by the State (up to 5,000 ha). Moreover, most of the land belongs to a few private owners. However, in Tiraque we did not find participation outside the public eye of the corporate regime because it does not have a presence in the region. Tiraque is still characterized by small-holding and family production, mainly destined for local markets. However, it is important to consciously explore the corporate regime's hidden power and its influence in the process. It is important to mention that there is not much literature on the hidden power of corporate regime using the Power Cube. Hence, it is important to explore power relations through the Power Cube in diverse contextual settings.

Invisible power can be difficult to explore since it concerns social norms and values related to socio-political structures which require longer periods in the field to be able to identify and study them. Because of the socio-political unrest after the presidential elections of 2019, it was difficult to reach leaders of social organizations to achieve deeper interviews after the final rejection of the policy. Moreover, in Bolivia, *usos y costumbres* are important aspects of rural communities and are guaranteed by the Political Constitution of the State through Article 374 (Bolivia, 2009). A threat to local *usos y costumbres* can spark conflict. Saldías (2009) in a study on Tiraque and Punata found that irrigation associations of high-altitude communities negotiate water control based on their territoriality and their *usos y costumbres*. Therefore, to create changes through policy, either the policy must conform with local water *usos y costumbres* or there must be an adaptation or transformation of them. In this line, the rejection of the policy

and the requirement to establish pilot projects can be seen in the long term as an opportunity because these interventions could provoke generational and lasting changes to the invisible power, required for sustainable water management. Therefore, we recommend promoting small-scale interventions to provoke changes in *usos y costumbres* and generate a sense of ownership and earn the required legitimacy for the development of water resources policies.

This case study shows that the attempts to implement a highly participatory process in the co-creation of public policies eventually conformed with the traditional linear, silo thinking (sectoral vision) and top-down schemes in which vulnerable groups continue to be excluded. It is important to step away from a silo thinking approach and foster a system one in the development of agroecology-related policies. A systems view “maximizes synergies within the food system, mitigates negative externalities, and minimizes harmful competition between agricultural sectors” (Anderson et al., 2021, p. 137). To create a more participatory process, a change must be achieved that allows actors to be given a voice in effective participation that takes them from “access, to presence, to influence” (Gaventa, 2006, p. 24). Therefore, more collaborative governance approaches should be developed that conform to Latin-American contexts.

In this case, we implemented the Power Cube *ex post* the construction of a water policy. However, it can be implemented before, during, and after a transdisciplinary research process. We recommend using the Power Cube with other power relations analysis tools (Brouwer et al., 2016; Bryson, 2004; DfID, 2003; Hunjan & Pettit, 2011). The Power - Interest Matrix, is a stakeholder management tool designed to identify actors according to their level of interest in the (no-)realization of a project and the level of power that they have (

Figure 42) (Oguz, 2022). Based on the position of a stakeholder, management decisions and strategies can be developed. For example, actors with low interest and low power are categorized as “monitor” (Oguz, 2022). Strategies regarding those actors involve monitoring, keeping them updated, and trying to increase their interest. Actors with high interest but low power are categorized as “keep informed” (Oguz, 2022). Strategies regarding these groups include making use of interest through involvement and consulting on their area of interest (Oguz, 2022). They can be supporters or ambassadors. Actors with low interest and high power are categorized as “keep satisfied” (Oguz, 2022). This group requires attention because actors could either foster or limit the process. Hence, strategies are designed to increase their positive interest in the process (Oguz, 2022). They need to become engaged. Finally, actors with a high interest and high power are categorized as “manage closely” (Oguz, 2022). They should become our allies in the process and need to be managed closely. They need to be involved actively in the process and the decision-making. It is not recommended to use this matrix by itself, since key actors may be left out or omit other power dynamics that the cube would allow us to visualize (Horton & Pilkington, 2014). We recommend carrying out studies that integrate these tools throughout the life cycle of a transdisciplinary process.

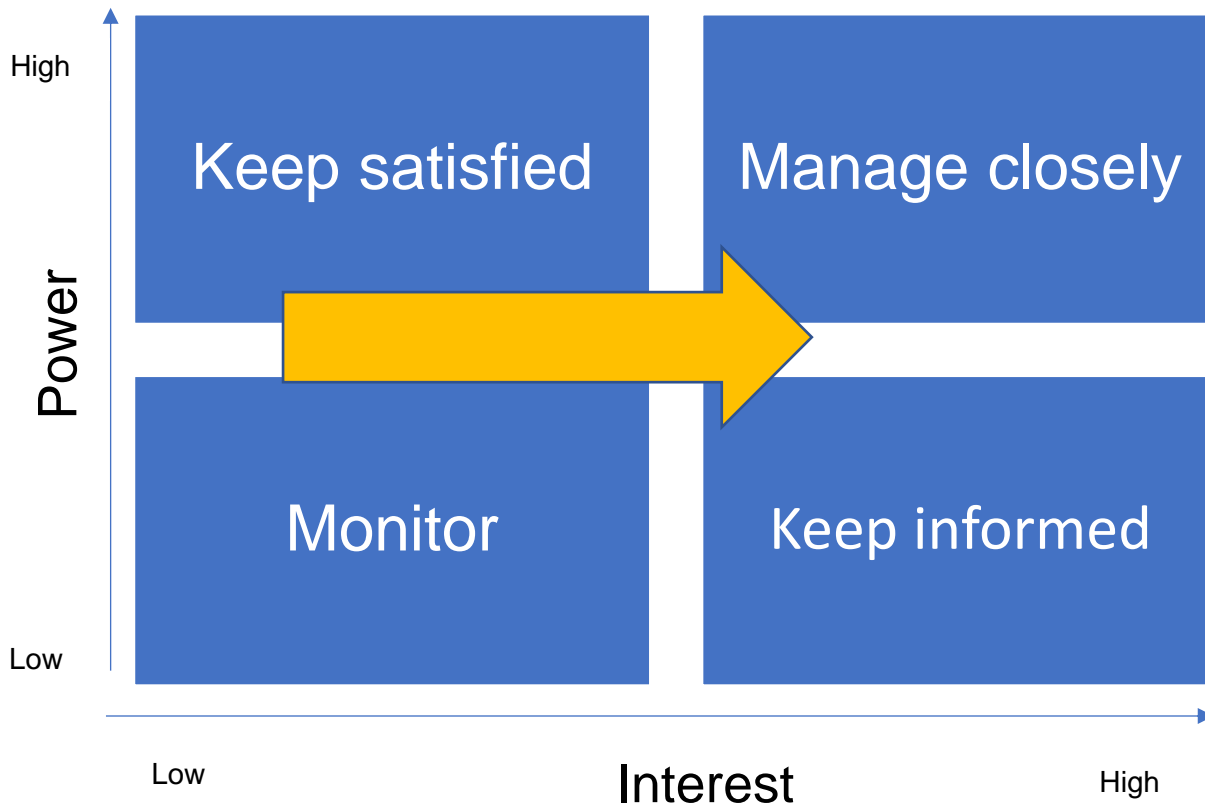


Figure 42. Power-Interest Matrix

Note. Source: Based on Oguz (2022, p. 126)

We found that it is important for funding organizations to recognize the importance of flexibility and realism in terms of time and products demanded from non-governmental organizations, public officials, and academics. Due to pressure exerted by the financial organization, a chain of pressure was given, from the local non-governmental organization to the social organizations and the municipality. This pressure did allow for the hasty drafting of the policy proposal, but due to its many shortcomings, it was finally rejected. This consideration must be considered in transdisciplinary initiatives, since they require flexibility, especially in terms of timing (see chapter 4).

6. Conclusions

The design of a water policy in Tiraque presents evidence that the co-creation of such a policy is not a linear process because of the complex intertwining of power relations from the beginning until the end. Therefore, to foster more inclusive, equitable, empowering, and legitimate policies, it is crucial to analyze power relations throughout the whole process.

This chapter shows that the Power Cube (Gaventa, 2005) is a very useful approach to unveiling complex power dynamics and having a close understanding of the different forms, levels, and spaces of power in natural resources and water issues. Moreover, it demonstrates that it can be expanded to study how power interrelates with actors' interests, knowledge, and socio-political structures. It is highly recommended to include these interrelations in future implementations of the Power Cube.

Our study shows that social organizations in the municipality of Tiraque exercise more visible power than the mayor and the Municipal Council. Although the meetings organized for the construction of the public policy are expected to be invited spaces, they became closed spaces because only specific actors were invited. We identified four forms of exclusion: 1) rotating and supplanting leadership, 2) a culture of gendered decision-making, 3) avoiding conflict by not inviting, and 4) flawed transmission of information. Through these forms of exclusion, vulnerable and marginalized groups were excluded. Women groups, for example, were present but their effective and meaningful participation was not guaranteed. Moreover, language barriers hindered the participation of different actors, especially from the grassroots.

The study shows that both actors in favor and against the public policy exercised hidden power by setting the agenda. On the one hand, the non-governmental organization managed to get the construction of the public policy on the agenda of social organizations and the municipality. To do so, the non-governmental organization abided by the local *usos y costumbres* regarding decision-making and developed a series of workshops and meetings at invited spaces for participation. On the other hand, the Federation of Indigenous Agricultural Irrigators of Cochabamba was afraid of the possible impact of the policy and managed to have the policy rejected, asking for the development of pilot cases; therefore, setting a new agenda. Their contestation was organized in a claimed space. This shows that intertwined relations in processes of bricolage and sabotage shape the policy-making process.

Usos y costumbres were followed by the non-governmental organization and defined the protocol for the construction of the policy. However, *usos y costumbres* in Tiraque are also closely linked to invisible power because they define what is accepted as normal by society regarding decision-making. Even if some people or families do not agree with the decisions made, they usually will abide by them, seeing them as mandatory.

Different forms, levels, and spaces of power were used by actors to reach their interests. Many actors had political interests at the time, either for the presidential elections or to open new spaces for water management projects. The local non-governmental organization had institutional interests, forcing it to achieve the expected results set by its funding organization. Interests of other actors were also present outside of the public eye, such as the interest of the neighboring municipality that benefits from the water from Tiraque.

Although the study focused on Bolivia for an in-depth case study, the findings are globally relevant for collaborative approaches in the co-creation of natural resources and water policies. Hence, we suggest developing a power analysis before and during the co-creation of a public policy to achieve true empowerment. Otherwise, vulnerable, and marginalized groups might be excluded which might generate obstacles to achieving the expected result.

CHAPTER 7. GENERAL DISCUSSIONS AND CONCLUSIONS

1. Introduction

This chapter presents a general discussion of the overall findings of the PhD dissertation. First, a synthesis of the main findings for each research question is presented. Then, the general conclusions and theoretical methodological contribution of the dissertation are presented. Closing with some final remarks on the study.

2. Synthesis of the main findings

Transdisciplinary agroecology has been proposed as a path to achieve food sovereignty. It is understood as a triad of practices, science, and social movements. Although there are many advances to demonstrate its social and environmental contributions for the development of more sustainable and equitable food systems, no research has been found on how to operationalize it from a society-driven approach. To fill this knowledge gap, this study had the overall aim of exploring how in future research designs transdisciplinary agroecology can be organized to achieve food sovereignty. For this purpose, the agroecological triad was used as an entry point, studying in each dimension a knowledge gap that could contribute to fulfilling the main objective. In the following sections, a summary of the main findings and conclusions reached for each research question is provided.

2.1 Dimension: Practices - How can a collaborative research team be built for society-driven transdisciplinary agroecology research?

The dimension of practices was explored through two case studies of agroecological innovation. An exploratory and critical qualitative study using Grounded Theory methodology was developed to study the methodological gap found in transdisciplinary research models and guidelines: How can a collaborative research team be built for society-driven transdisciplinary agroecology research (cf. chapter 4). Three key aspects were identified for the formation of society-driven collaborative teams: 1) an iterative spiral sequence of inspiration, negotiation, and action moments, 2) the composition of the research groups is not static, and 3) some factors constellate in a window of opportunity.

Moreover, three factors instigate the creation of a window of opportunity for this formation of society-driven collaborative teams: 1) a perception of urgency, 2) a key steward, and 3) institutional will. Finally, reflectivity is highly important in this process both as a research team and individually. Academics must constantly question the role they are playing in the process, being able to act as facilitators at first but also passing this role as the research progresses. This proposal of a “phase 0” overlaps with phase A or 1 of other transdisciplinary models. Hence, it is recommended that after reaching the formation of the collaborative research team continue with the phases proposed by other models such as Lang et al. (2012).

2.2 Dimension: Science - What are the main socioecological factors that impact the transmission of traditional ecological knowledge within and across generations?

Transdisciplinary agroecology as a science aims at the integration of different knowledge systems, including traditional ecological knowledge. To operationalize transdisciplinary agroecology and integrate knowledge, it is important to study the state of traditional ecological knowledge. This dissertation contributed to this broader question by identifying the main socioecological factors that impact the transmission of traditional ecological knowledge within

and across generations (cf. chapter 5). To do so, a mixed methods approach was developed in a case study about the traditional ecological knowledge of weather forecasting was developed in Tiraque. The knowledge-practice-belief complex developed by Berkes et al. (2000) was used as an analytical framework. Four factors affecting the transmission of traditional ecological knowledge were identified: formal education, migration, a new religion, and the politicization of rural unions. It was found that interest in traditional ecological knowledge, especially among younger generations, can be refreshed through the co-creation of hybrid knowledge.

2.3 Dimension: Social movements - How do power relations influence the process of co-creation of food sovereignty?

Agroecology as a social movement seeks the empowerment of grassroots in decision-making processes regarding agri-food systems and recognition of the rights of small-scale farmers, indigenous communities, and consumers. It also challenges the dominant corporate regime. Hence, this dimension is highly political. Therefore, it is related to the development of policies related to agroecology, and the integrated management of natural resources linked to food production. Agroecology uses transdisciplinarity, Community-based Participatory research and Participatory Action Research as tools for participation. However, power relations can affect the participation of various actors in transdisciplinary research, limiting the empowerment of vulnerable groups (Pohl & Hadorn, 2007). Therefore, it was important to explore power relations in transdisciplinary processes in general and in the co-creation of food sovereignty in specific to gain insights into how true empowerment can be achieved. Hence, the third research question of the dissertation was: How do people's interests, socio-political structures, and knowledge influence power relations in the process of co-creation of food sovereignty? (cf. chapter 6). This question was addressed through a case study in the co-creation of a water policy in Tiraque. Results confirm that different factors influence power relations: interests, access to information, habits, and customs. Actors use different forms, spaces, and levels of power to achieve their interests. Hence, it is crucial to analyze power relations before, during, and after the co-creation of any public policy and to step away from linear and sectoral frameworks of policy development.

3. General conclusions and contributions

Although transdisciplinarity has already been proposed in the 1970s there are still some methodological gaps on how to pursue it in practice. Likewise, agroecology has been related to transdisciplinarity by practitioners and academics as a path to achieving food sovereignty. However, the proposal of "transdisciplinary agroecology" has little been conceptualized and studied. It is in this sense, that this PhD thesis ventured to study how transdisciplinary agroecology can be organized to achieve food sovereignty. In the process of achieving this knowledge gap, a series of theoretical and methodological insights have been delivered answering the general objective of the dissertation. Below the main findings, lessons learnt, challenges and contributions to developing transdisciplinary agroecology are detailed.

3.1 Following a socioecological system approach

Transdisciplinary agroecology and food sovereignty cannot be approximated from a monodisciplinary and mono-sectoral approach because they are immersed in complex relationships between individuals, societies, and their environment (Anderson et al., 2021). This integrative perspective allows communities to adapt more easily and, in the best of cases, co-evolve with their socioecological systems (cf. chapter 5). In the PhD study, multi-level

information was gathered and analyzed. The study included actors from various academic sectors, non-governmental organizations, municipalities, social organizations, and students. Also, it considered different levels of governance from the local communities to the municipality and regional levels. Even during the farmer-to-farmer exchanges, another municipality on the shores of Titicaca Lake in La Paz was involved. Opportunities are opened to develop transdisciplinary research from the local culture and its historical and social context when considering the complexity of the socioecological system (Löwy, 1991; Pohl et al., 2020). For example, by venturing to follow a socioecological system approach it was possible to take a broader view of the complex problem. This approach allowed having a wealth of social interactions. It also made it possible to explore some phenomena from different perspectives, allowing information to be crossed and validated. Therefore, it is highly suggested to follow a socioecological system approach from the beginning of the research.

3.2 Implementing “phase 0” for the formation of collaborative research teams

An important lesson from this study is the need to have a shared understanding of transdisciplinarity and a methodological framework. Without these core elements it is difficult to implement transdisciplinary agroecology, to monitor the progress and to evaluate the outcomes. One of the main methodological contributions made by this doctoral thesis is the filling of a methodological gap on how to form society-driven collaborative research teams for transdisciplinary agroecology (cf. chapter 4). The study identified three moments for achieving the formation of society-driven collaborative teams: 1) inspiration, 2) negotiation, and 3) action. In the beginning, inspirational moments are required. Then negotiation moments usually come before action. However, after the first inspirational moment, there is no specific order of moments to follow since it will depend on the specific context.

Likewise, three factors that must be aligned to achieve a window of opportunity have also been identified: 1) perception of urgency, 2) key steward, and 3) institutional will. The latter came as a combination of the notions presented by Henneman (2018) and by Olsson et al. (2004). However, this concept of windows of opportunity for reaching a society-driven collaborative team is novel to transdisciplinary agroecology. Hence, it is highly recommended to carry out similar studies to test it further and to gain feedback to make it more robust. Moreover, this proposal of a “phase 0” overlaps with phase A or 1 of other transdisciplinary models. Hence, it is recommended that after reaching the formation of the collaborative research team to continue with the phases proposed by other models such as Lang et al. (2012).

It was found that participatory and popular education methodologies could be implemented in “phase 0” to foster the integration of knowledge. The difference between participatory research methodologies such as Participatory Action Research and transdisciplinarity is often almost imperceptible to many. Although there are differences among them, this does not make them mutually exclusive. Participatory Action Research seeks to empower farmers as fundamental actors in research, but in many cases, the integration of other knowledge systems such as the academic is neglected (Tress et al., 2005). In other cases, Participatory Action Research does not necessarily amount to research and tends to lean more toward action or activism (Agramont et al., 2019). For its part, transdisciplinarity seeks the integration of different knowledge systems, academic and non-academic. However, there was a methodological gap on how to form society-driven collaborative teams for transdisciplinary agroecology research (cf. chapter 4). This study found that participatory methodologies such as Participatory Action Research and popular education are a perfect fit as they are inclusive and reflexive. Agroecology has been implementing some of these methodologies to foster the transition of agri-food systems (Guzmán et al., 2016). Therefore, the implementation of these

methodologies is highly recommended in inspirational moments for the formation of a society-driven collaborative team (cf. chapter 4).

However, it is also important to acknowledge that the implementation of the proposed “phase 0” requires more time and resources than other transdisciplinary models that follow a research-driven approach (Horcea-Milcu et al., 2022). Some projects may have strict financial and time frames. In those cases, a research-driven approach is more suited (Horcea-Milcu et al., 2022).

3.3 Considering power relations

Power relations have drawn people's attention throughout human history. When we do a simple search on Google Scholar about “power relations”, a total of 2,440,000 results appear only for the English language (checked 03/11/2022). However, we tend to give power a negative connotation. As Liu (2017, pp. 00:23-00:40) mentioned in his TED Talk about power, although we daily navigate through systems of power, it is “something we are often uncomfortable talking about [...] any further talk about power and who has it seems a little dirty, maybe even evil”. However, power does not have to be evil. As discussed in chapter 6, from all the expressions of power, *power over* usually has a negative connotation of domination and/or control exercised by one individual, group, or organization over another one (Brouwer et al., 2016). But we can't turn a blind eye. Power relations are present and by not taking them into account we run the risk of leaving the most vulnerable people aside. Hence, it is vitally important to take them into account from the beginning to the end of the process. There are several tools for power relations analysis. In this study, we saw that the Power Cube can help us to carry out this analysis¹⁸.

In the PhD it was found that power relations are present in transdisciplinary agroecology. For example, power relations will determine whose knowledge is valid and legitimate, thus affecting the transmission and use of traditional ecological knowledge (cf. chapter 5). Elders in Tiraque are losing the power and legitimacy that used to be associated with them as wise and reliable people in their communities. Hence, their knowledge is undervalued. The quote “when the old men speak, the others laugh” exemplifies this situation. Milton (2001) found a similar situation in the Brazilian Amazon where the leadership that once belonged to the elders of the community, recognized as the wisest, currently belongs to the youth because they can easily negotiate with outsiders. As a result, elders in these communities no longer have power because their knowledge is considered less valuable. In Tiraque it was also found that there is a power struggle between the State authority and the communal authority over education. Likewise, in the exploration of “phase 0” for the formation of society-driven collaborative research teams, power relations between different actors became more evident during the negotiations (cf. chapter 4). Negotiations had to be carried out with new actors who had their own interests and agendas.

González de Molina (2016, p. 59) explains that power relations even transform agroecosystems and impact their sustainability because “an agroecosystem is not, solely only the result of a set of physical and biological properties but, rather, the reflection of certain power relationships”. It is in this understanding that transdisciplinary agroecology, like food sovereignty, is highly political. Hence, to carry out transdisciplinary agroecology we must consider power relations throughout the whole process.

¹⁸ For more practical information on the Power Cube check <https://www.powercube.net/>
For more tools to analyze power relations check (Pettit, 2013).

Gaventa's (2006) Power Cube allows for studying the different forms, spaces, and levels of power. However, until this PhD study, it had not been fully implemented for an integrated analysis of how power interrelates with actors' interests, knowledge, and socio-political structures in the co-creation of food sovereignty (cf. chapter 6). Such integrated study was achieved by combining the Power Cube with Hunjan and Pettit (2011)'s guiding questions to explore different forms of power. This combination made the dynamics and characteristics of hidden and invisible power observable. By being able to make power relations more tangible, actions can be taken to navigate through them and to level up the ground for more inclusive, legitimate, and empowering transdisciplinary agroecology processes.

Of the three forms of power (visible, invisible, and hidden), the visible one may be easier to handle because it is more obvious. While hidden and invisible power requires more care and in-depth analysis. To do so, the following guiding questions proposed by Hunjan and Pettit are recommended (2011, p. 22). Some actors through their hidden power can likely follow strategies and tactics that may change the direction of a process (Brock et al., 2001). Depending on which side we are on in the process, these actions may further the process we seek or may even sabotage it (De La Cruz & Dessein, 2021; Paquet, 2001). Consequently, we must negotiate with these actors and probably redirect our work to be able to continue.

Invisible power is more difficult to study because it is linked to social norms and values related to socio-political structures which require longer periods in the field to be able to identify them. They may become an obstacle to moving forward with transdisciplinary agroecology because they may be fostering a socio-technical lock-in (Pimbert, 2016). As explained by Meynard et al. (2018, p. 54) "the relationships, within a socio-technical system, between values, knowledge, organizations, and technologies can create strong interdependencies and self-reinforcing mechanisms, which lead to a lock-in, and may discourage stakeholders from adopting alternative production systems". They explain that although technological lock-ins are more commonly studied in other sectors, currently some scholars are applying the concept of socio-technical lock-ins to agroecology (Meynard et al., 2018). Thus, to move forward with transdisciplinary agroecology, we must work with social norms and values (*usos y costumbres*). Because as soon as an activity seems to threaten people in the communities, red flags may arise among certain members of the community and the processes can stall. Results show that developing pilot projects might be an ideal approach for incremental transformations in invisible power (cf. chapter 6).

Although the Power Cube was implemented *ex post* the construction of a water policy. However, it can be implemented before, during, and after a transdisciplinary research process. It is recommended to use the Power Cube in combination with other power relations analysis tools such as the Power – Interest Matrix (Brouwer et al., 2016; Bryson, 2004; DfID, 2003; Hunjan & Pettit, 2011). The Power - Interest Matrix, is a stakeholder management tool designed to identify actors according to their level of interest in the (no-)realization of a project and the level of power that they have (Oguz, 2022). Based on the position of a stakeholder, management decisions and strategies can be developed (cf. chapter 6).

Rosendhal et al. (2015) in a transdisciplinarity research project about pro-poor resource governance in six countries (including Bolivia), adopted the Harding (1991) Standpoint Theory and strong objectivity. Adopting Standpoint Theory and strong objectivity rather than a "neutral objectivity", will give researchers a greater reflection on power relations and their influence on the research process (Rolin, 2009; Rosendahl et al., 2015). This will result in a greater contribution to resource governance. Rosendhal et al. (2015) support a "biased selection" of stakeholders with a special focus on marginalized groups because it "allows for a better understanding of social order and of different structures that constrain the expression of their

perspectives, and which impede their concerns from being considered in decision making” (Rosendahl et al., 2015, p. 25). By initiating a study focusing on underprivileged groups it is possible to uncover hidden power relations regarding genders and social institutions (Harding, 1991, p. 127). Finally, according to the Standpoint Theory trust can be gained through collective achievement since it focuses on commitment, both political and moral (Rolin, 2009, p. 224). Hence, we must include the most marginal and vulnerable actors in the process.

3.4 Exploring the state of traditional ecological knowledge

The co-creation of knowledge is the basis of transdisciplinarity and transdisciplinary agroecology. In the *diálogo de saberes* different knowledge systems meet and lead to innovations that adapt to socioecological changes and the current context. It is not new that transdisciplinarity seeks to achieve the co-creation of knowledge. To foster the integration of knowledge it is important to explore the state of traditional ecological knowledge to identify the main factors affecting its transmission and the potentialities for the development of transdisciplinary research processes (Sachs, 1981). This exploration also exposes other important aspects of the socioecological system (i.e., state of natural resources and their management, social institutions, worldview, power relations, etc.). This statement was further supported by the findings in chapter 5 where it was found that the socioecological mechanisms for the transmission of knowledge are disappearing, generating a rupture in the knowledge-practice-belief complex. For this reason, the transmission modes (vertical, oblique, and horizontal) are not working (cf. chapter 5). However, the study shows that the horizontal transmission of knowledge between peers of the same generation can be encouraged through the co-creation of hybrid knowledge (Athayde et al., 2017; Hosen et al., 2020). This is important for transdisciplinary agroecological projects that seek to increase the attention of younger groups and foster the integration of knowledge for agroecological innovation.

3.5 Considering symbolic and physical spaces

The creation, emergence, and use of physical spaces and symbolic spaces such as field work, unions’ meetings, night gatherings for storytelling, rituals, festivities, and sacred sites are important in transdisciplinary agroecology (cf. chapter 5). In this dissertation, spaces of power were studied as closed (where only elite actors participate and make decisions), invited (created by state and non-state organizations who invite “the people” to participate), and claimed (created by fewer power holders to express their voices and shape their own agenda) (cf. chapter 6). Results show that spaces interact with different forms and levels of power, changing from one type of space to another (Gaventa, 2006). This evidence indicates that in policy-making dynamics, different spaces are used or created by actors at different levels to achieve their goals. Thus, levels of governance also interact with forms and spaces of power in varying ways.

Likewise, it was found that vertical and horizontal modes of transmission of knowledge require spaces for socioecological mechanisms to enact. As these spaces disappear it affects the modes and socioecological mechanisms of transmission in the knowledge-practice-belief complex, impacting negatively on the transmission of traditional ecological knowledge (cf. chapter 5). In this scenario the “cultural script” that allows the repetition and retention of traditional ecological knowledge is no longer part of the daily routine of community members, especially younger ones. For instance, the oblique transmission of traditional ecological knowledge, from grandparents to grandchildren, requires the following symbolic and practical spaces to work: worldview as a nest of values and reciprocity among humans and nature, recognition, and legitimacy of elder’s knowledge, and symbolic and practical spaces for

intergenerational transmission of traditional ecological knowledge. Likewise, for the co-creation of knowledge or hybrid knowledge, spaces of encounter are required for academic and non-academic actors to meet (cf. chapter 4). Moreover, this PhD study shows that hybrid technology itself can be understood as a space itself for ongoing *diálogo de saberes*. For example, in addition to being socio-educational spaces, school gardens become spaces for the community to meet, spaces that foster dialogue and reciprocity between students, teachers, and parents (Ruiz & Rodríguez, 2015).

3.6 Constantly reflecting

Reflexivity was a constant throughout the study, as an individual researcher and as a collaborative team. It is recognized as a key aspect in the process of co-creation of knowledge through transdisciplinarity both at a conceptual and practical level (Lang et al., 2012; Rosendahl et al., 2015). According to Agramont et al. (2019, p. 4), reflexivity has the following purposes:

- To develop a shared understanding of a problem,
- To reflect on the social relevance of problem framing,
- To set up joint social experiments and collective learning processes between the involved actors, and
- To create a critical research agenda that can help transform the current governance system into a more sustainable system.

Moreover, in this study it was found that it is important to reflect on the interactions among actors and also, to reflect the different epistemologies and cultural backgrounds of the actors involved (Schmidt et al., 2020). Also, through reflexivity it was possible to evaluate and improve the methodology, tools, and results (Lang et al., 2012). For example, in the exploration of a “phase 0”, right before action, new actors and new interests appeared. At first, these actors were seen as obstacles that hindered the process. However, it was learnt that as a result of the negotiations held with them, strong moments of reflection came to us that modified and strengthened the process, letting newcomers become allies.

Throughout the PhD, as a researcher, I constantly reflected on different issues: what is my role as a researcher? How do I avoid falling into the same tendency to impose my ideas, extract information, take it with me and then publish it? To do so, I strongly held onto Participatory Action Research, agroecology, and popular education. With the premise of letting everything flow and letting research teams be self-formed. In literature, we can be seen as facilitators. For instance, Heleba et al. (2016, p. 180) explain that in participatory methodologies “the researcher–educator is placed on the role of facilitator or catalyst of information transfer”. Under this logic, the academic researcher can also bring knowledge or technological inputs according to the needs of the research team. Hence, under this logic would I be left out of the research? Would I always be a spectator? If so, that would again fall under the Participatory Action Research tendency of having little involvement of academic actors, stepping away from transdisciplinary research. The research process showed that it is a balance. In the beginning, academics can facilitate certain processes. Also, academics can contribute with resources that the community cannot access individually. However, as academics it is important to recognize ourselves as part of the research team to promote a *diálogo de saberes*. Later on, the facilitator role is handed over to other actors in the process such as the key steward (cf. chapter 4).

3.7 Transdisciplinary agroecology is as an ongoing process

This thesis shows that society-driven transdisciplinary agroecology research is a continuous process. An expiration date cannot be given to the process because it is in constant movement and transformation. It is in this sense that all the actors involved must be aware of this situation and be able to define and express how far and how long they want to participate. This acknowledgment is especially required from academic actors and financing agencies since by understanding this longevity of the transdisciplinary agroecological process they will be able to understand that “final products” of research cannot be demanded or processes that must follow their natural course cannot be rushed. Otherwise, ideas may end up being imposed and falling back into instrumentalist processes, which also stresses the others involved. Thus, a lot of institutional flexibility is needed. The preparation phase of a case study reported by Muhar et al. (2006) took a year.

In Tiraque the transdisciplinary agroecology research still has a long way to go. The collaborative teams for the participatory soil evaluation and the school gardens continue to transform as the investigations continue. Non-academic actors still feel that they need to gain legitimacy in their communities when it comes to transmitting their results. For example, farmers from Tiraque and Batallas explained to us that in their communities some people do not believe in the results until an “engineer” or “expert” comes along. This is an aspect that needs to continue to be reinforced not only in the presentation of the results obtained but also in the situated technology developed.

4. Final remarks

When I started this doctorate path in 2019, my colleague Anneline Gansemans¹⁹ was about to defend her doctoral thesis “Empowerment of workers in the Costa Rica-EU pineapple trade”. Anneline used the analogy of the “elephant in the room” referring to power relationships. It refers to a situation where everyone knows the elephant is there, but they pretend not to see it, just like power relations. This strong image stayed with me throughout my doctoral study and became even more vivid when I began to explore transdisciplinary agroecology for the co-creation of food sovereignty. However, when trying to understand the differences between the various levels of disciplinary integration, the Indian parable of “the blind men and the elephant” came to mind:

A group of blind men heard that a strange animal, called an elephant, had been brought to the town, but none of them were aware of its shape and form. So, out of curiosity, they said: “We must inspect and know it by touch, of which we are capable.” So, they sought it out, and when they found it, they groped about it. The first person, whose hand landed on the trunk, said, “this being is like a thick snake.” For another one whose hand reached its ear, it seemed like a fan. Another person, whose hand was upon its leg, said, “the elephant is a pillar like a tree trunk.” The blind man who placed his hand upon its side said, “ the elephant is a wall.” Another who felt its tail described it as a rope. The last felt its tusk, and stated, “the elephant is that which is hard, smooth, and like a spear. (Hirschey, 2022)

This parable exemplifies the limitations that a monodisciplinary perspective can have and the relativity of knowledge. As I delved deeper into transdisciplinary research, I was able to realize

¹⁹ See Gansemans (2019).

that it helps to take off the disciplinary blindfolds and come together in *diálogo de saberes* to study a common problem for the co-creation of situated and hybrid knowledge.

The corporate food regime has shown that it cannot feed the world with respect for nature and human beings it has shown a series of failures throughout history and has become a technological lock-in (cf. chapter 1). To get out of this lock-in, radicalism is required, such as the food sovereignty proposed by La Via Campesina, and transdisciplinary agroecology proves that it is the way to do it.

It is recommended to continue delving into the topics initiated by this thesis in the three dimensions of transdisciplinary agroecology: practices, science, and social movement. For example, I consider it important to study how power relations are leveling out through transdisciplinary research. Also, I consider it important to study the spaces that are being generated and how they are promoting the horizontal transmission of knowledge. An important aspect that came to light in the study is that new remote agriculture is emerging with new needs. It would be important to study what mechanisms and tools can be designed to bring the actors closer to their communities, to traditional ecological knowledge, and agroecology in this context. Finally, I think that the hybrid knowledge of the internet of things and traditional ecological knowledge could be interesting to study and further develop.

REFERENCES

- Agramont, Av ., Craps, M., Balderrama, M., & Huysmans, M. (2019). Transdisciplinary Learning Communities to Involve Vulnerable Social Groups in Solving Complex Water-Related Problems in Bolivia. *Water*, 11(2), 385-385. doi: 10.3390/w11020385
- AGRECOL. (2018). *Diagnóstico de Producción Ecológica en Bolivia e Identificación de Necesidades de Capacitación*. Cochabamba, Bolivia: AGRECOL. Retrieved from https://www.agrecolandes.org/wp-content/uploads/2019/02/diagnostico-produccion-ecologica_final.pdf
- Albuquerque, U. P., Ludwig, D., Feitosa, I. S., de Moura, J. M. B., Gonçalves, P. H. S., da Silva, R. H., . . . Ferreira Junior, W. S. (2021). Integrating traditional ecological knowledge into academic research at local and global scales. *Regional Environmental Change*, 21(2), 1-11. doi: 10.1007/s10113-021-01774-2
- Alkon, A. H. (2014). Food justice and the challenge to neoliberalism. *Gastronomica: The Journal of Food and Culture*, 14(2), 27-40. doi: 10.1525/gfc.2014.14.2.27
- Alkon, A. H., & Norgaard, K. M. (2009). Breaking the food chains: An investigation of food justice activism. *Sociological Inquiry*, 79(3), 289-305. doi: 10.1111/j.1475-682X.2009.00291.x
- Altieri, M. A., Nicholls, C. & Westwood, G. (2015). *Agroecology, key concepts, principles and practices*. Third World Network (TWN)-SOCLA. Penang, Malaysia: Jutaprint.
- Altieri, M. A. (1993). Ethnoscience and biodiversity: key elements in the design of sustainable pest management systems for small farmers in developing countries. *Agriculture, ecosystems & environment*, 46(1-4), 257-272. Retrieved from <http://agroeco.org/wp-content/uploads/2010/11/ethnosciandbiodiv.pdf>
- Altieri, M. A. (2000). Agroecology: principles and strategies for designing sustainable farming systems. *Agroecology in action*. Retrieved from <http://www.researchgate.net>
- Altieri, M. A., & Rosset, P. (2018). *Agroecología: ciencia y política*. Barcelona, Spain: Icaria.
- Altieri, M. A., & Toledo, V. M. (2011). The agroecological revolution in Latin America: rescuing nature, ensuring food sovereignty and empowering peasants. *Journal of peasant studies*, 38(3), 587-612. doi: 10.1080/03066150.2011.582947
- Anderson, C. R., Bruil, J., Chappell, M. J., Kiss, C., & Pimbert, M. P. (2021). *Agroecology now!: Transformations towards more just and sustainable food systems*. Cham, Switzerland: Springer Nature. doi: 10.1007/978-3-030-61315-0
- Antequera, N. (2015). *Usos, costumbres, rituales y normas locales (consuetudinarias) en relación con el uso del agua, el manejo de (eco) sistemas y la gestión organizacional*. Cochabamba, Bolivia: UMSS. Retrieved from <http://www.academia.edu>
- Antequera, N. (2018). *Pachamamawan Parlaspa. Saberes y conocimientos locales sobre el clima*. Cochabamba, Bolivia: PIACC - UMSS.
- AOPEB. (2022). Inicio. Retrieved from <https://www.aopeb.org/>
- Arce, R. (2005). "Vivir para morir y morir para Vivir". *Transformaciones socioculturales y pervivencia de la fiesta de Todos santos. Caso Comunidad de Japo, Ayllu Majasaya Mujlli, provincia Tapacarí, Dpto. de Cochabamba*. Cochabamba, Bolivia: AGRUCO. Retrieved from <http://atlas.umss.edu.bo:8080/xmlui/bitstream/handle/123456789/1232/Tesis-Ramiro-Arce.pdf?sequence=1&isAllowed=y>
- Argueta, A. (2016). Los saberes y las prácticas tradicionales: Conceptos y propuestas para la construcción de un enorme campo transdisciplinario. In: F. Delgado, & Rist, E. (Eds.), *Ciencias, diálogo de saberes y transdiscipliniedad Aportes teórico metodológicos para la sustentabilidad alimentaria y del desarrollo*, 169-190. La Paz, Bolivia: Plural Editores.

- Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners*, 35(4), 216-224. doi: <https://doi.org/10.1080/01944366908977225>
- Athayde, S., Silva-Lugo, J., Schmink, M., & Heckenberger, M. (2017). The same, but different: Indigenous knowledge retention, erosion, and innovation in the Brazilian Amazon. *Human Ecology*, 45(4), 533-544. doi: 10.1007/s10745-017-9919-0
- Atkins, P., & Bowler, I. (2016). *Food in society: economy, culture, geography*. London, England: Routledge. doi: 10.4324/9781315824819
- Attwood, H. (1997). *An overview of issues around the use of participatory approaches by post-graduate students*. IDS Participatory Pack: IDS, Participatory Research.
- Azero, M. (2018). *Diagnóstico socioambiental de Tiraque*. Cochabamba, Bolivia: Project 3.
- Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Chappell, M. J., Aviles-Vazquez, K., . . . Perfecto, I. (2007). Organic agriculture and the global food supply. *Renewable agriculture and food systems*, 22(2), 86-108. doi: 10.1017/S1742170507001640
- Ballivian, D. (2009). *Estructura agraria boliviana*. La Paz, Bolivia: Plural editores.
- Baum, F., MacDougall, C., & Smith, D. (2006). Participatory action research. *Journal of Epidemiology and Community Health*, 60(10), 854-857. doi: 10.1136/jech.2004.028662
- Bergmann, M., Brohmann, B., Hoffmann, E., Loibl, M. C., Rehaag, R., Schramm, E., & Voß, J.-P. (2005). Quality criteria of transdisciplinary research. *A guide for the formative evaluation of research projects*. Frankfurt, Germany: ISOE-Studientexte.
- Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of Traditional Knowledge as Adaptive Management. *Ecological Applications*, 10(5), 1251-1252. doi: 10.1890/1051-0761(2000)010[1251:ROTEKA]2.0.CO;2
- Bernard, B., & Lux, A. (2017). How to feed the world sustainably: an overview of the discourse on agroecology and sustainable intensification. *Regional Environmental Change*, 17(5), 1279-1290. doi: 10.1007/s10113-016-1027-y
- Bezner Kerr, R., Young, S. L., Young, C., Santoso, M. V., Magalasi, M., Entz, M., . . . Wolfe, D. (2019). Farming for change: developing a participatory curriculum on agroecology, nutrition, climate change and social equity in Malawi and Tanzania. *Agriculture and Human Values*, 36(3), 549-566. doi: 10.1007/978-3-031-19400-9_3
- Bhavnani, K.-K., Chua, P., & Collins, D. (2014). Critical approaches to qualitative. In: P. Leavy (Eds), *The Oxford handbook of qualitative research*, 165-178. New York, United States of America: Oxford University Press. Retrieved from <http://www.researchgate.net>
- Bichler, B., Wach, E., & Ripoll, S. (2020). Participatory Analysis and action to promote agroecological food systems—methodological insights from a three-country initiative: Nicaragua, Senegal and England. *Landbauforschung Journal of Sustainable and Organic Agricultural Systems*, 70(2), 157-168. doi: 10.3220/LBF1614324857000
- Blackstock, K. L., Kelly, G. J., & Horsey, B. L. (2007). Developing and applying a framework to evaluate participatory research for sustainability. *Ecological economics*, 60(4), 726-742. doi: 10.1016/j.ecolecon.2006.05.014
- Block, T., Prové, C., Dehaene, M., Abeele, P. V., & Beeckmans, L. (2022). Understanding urban sustainability from Mode 2 Science and transdisciplinary education: how Master Thesis Ateliers of the Ghent Stadsacademie tackle wicked issues. *Environment, Development and Sustainability*, 1-26. doi: 10.1007/s10668-022-02657-0
- Block, T., Van Poeck, K., & Östman, L. (2019). Tackling wicked problems in teaching and learning. Sustainability issues as knowledge, ethical and political challenges. In *Sustainable Development Teaching*, 28-39. London, England: Routledge.

- Boal, A. (1979). Theatre of the Oppressed. In *The Improvisation Studies Reader* (pp. 97-104). London, England: Routledge.
- Boelens, R., Bustamante, R., & de Vos, H. (2007). Legal pluralism and the politics of inclusion, recognition and contestation of local water rights in the Andes. *Community-based water law and water resources management reform in developing countries*, 96-113. Wallingford, England: CABI.
- Boelens, R., & Hoogendam, P. (2002). The Yapa'. Water rights, power and empowerment. *Water rights and empowerment*, 241-241. Assen, The Netherlands: Van Gorcum.
- Bolivia. (2009). *Constitución Política del Estado*. In Gaceta Oficial del Estado Plurinacional de Bolivia (Ed.). La Paz, Bolivia.
- Bolivia. (2010). *Ley de Educación 170*. Avelino Siñani-Elizardo Pérez. In Gaceta Oficial del Estado Plurinacional de Bolivia (Ed.). La Paz, Bolivia.
- Bolivia. (2011). *Ley de Revolución Productiva Comunitaria Agropecuaria - Ley N° 114 del 26 de junio de 2011*. In Gaceta Oficial del Estado Plurinacional de Bolivia (Ed.). La Paz, Bolivia
- Bolivia. (2020) *Decreto Supremo N° 4232 del 7 de mayo de 2020*. In Gaceta Oficial del Estado Plurinacional de Bolivia (Ed.). La Paz, Bolivia.
- Bratspies, R. (2017). Owing all the seeds: consolidation and control in agbiotech. *Environmental Law*, 47, 583. Retrieved from <https://heinonline.org/>
- Breisinger, C., Ecker, O., Al-Riffai, P., & Yu, B. (2012). Beyond the Arab awakening. Washington, United States of America: IFPRI.
- Brink, E., Wamsler, C., Adolfsson, M., Axelsson, M., Beery, T., Björn, H., . . . Thiere, G. (2018). On the road to 'research municipalities': analysing transdisciplinarity in municipal ecosystem services and adaptation planning. In *Sustainability science*, 13, 765-784. doi: 10.1007/s11625-017-0499-0
- Brisbois, M., & de Loë, R. (2016). Power in collaborative approaches to governance for water: a systematic review. *Society & Natural Resources*, 29(7), 775-790. doi: 10.1080/08941920.2015.1080339
- Brock, K., Cornwall, A., & Gaventa, J. (2001). *Power, knowledge and political spaces in the framing of poverty policy*. Sussex, England: Institute of Development Studies. Retrieved from <https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/3908/Wp143.pdf>
- Brooker, R. W., Bennett, A. E., Cong, W. F., Daniell, T. J., George, T. S., Hallett, P. D., . . . Karley, A. J. (2015). Improving intercropping: a synthesis of research in agronomy, plant physiology and ecology. *New Phytologist*, 206(1), 107-117. doi: 10.1111/nph.13132
- Brouwer, H., Hiemstra, W., van Vugt, S., & Walters, H. (2013). Analysing stakeholder power dynamics in multi-stakeholder processes: insights of practice from Africa and Asia. *Knowledge Management for Development Journal*, 9(3), 11-31. Retrieved from <https://km4djournal.org/index.php/km4dj/article/view/153>
- Brouwer, H., Woodhill, J., Hemmati, M., Verhoosel, S., & van Vugt, M. (2016). *The MSP guide: How to design and facilitate multi-stakeholder partnerships*. Wageningen, The Netherlands: Practical Action Publishing Ltd.
- Bruckner, M., & Ciccone, A. (2008). Rain and the democratic window of opportunity. *Econometrica*, 79(3), 923-947. doi: 10.3982/ECTA8183
- Bryson, J. M. (2004). What to do when stakeholders matter: stakeholder identification and analysis techniques. *Public management review*, 6(1), 21-53. Retrieved from

- <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=3aa8cd83844f0e07a93a995317ca2a18d885fb99>
- Bustamante, R., Antequera, N., & Galindo, G. (2019). Comprendiendo la relación con el clima en la zona de Tiraque. Resultados del proyecto Concepción Andina del Clima. In: R. Bustamante & G. Canedo (Eds.), *Visiones sobre el clima y gestión del riesgo climático. Estudios y propuestas de estrategias de adaptación al cambio climático*, 103-130. Cochabamba, Bolivia: UMSS. Retrieved from <http://www.researchgate.net>
- Caballero-Serrano, V., McLaren, B., Carrasco, J., Alday, J., Fiallos, L., Amigo, J., & Onaindia, M. (2019). Traditional ecological knowledge and medicinal plant diversity in Ecuadorian Amazon home gardens. *Global Ecology and Conservation*, 17, 1-26. doi: 10.1016/j.gecco.2019.e00524
- Cabero Villazón, R. C., & Ferreira, W. J. (2022a). *Compendio socioterritorial de municipios de Bolivia: San José de Chiquitos, Batallas, Tiraque y San Lorenzo*. Cochabamba, Bolivia: UCB.
- Cabero Villazón, R. C., & Ferreira, W. J. (2022b). *Documento De Trabajo: Perspectiva Cuantitativa Y Descriptiva De Las Dinámicas Locales En Comunidades Rurales Bolivianas: San José De Chiquitos, Batallas, Tiraque Y San Lorenzo*. Cochabamba, Bolivia: UCB.
- Cafiero, C. (2016). *Sobre el uso de escalas de medición de inseguridad alimentaria basada sobre las experiencias en la medición multidimensional de Pobreza*. CEPAL. Retrieved from <https://www.cepal.org/sites/default/files/presentations/2017-05-carlo-cafiero-fao.pdf>
- Callon, M., & Blackwell, O. (2007). Actor-network theory. *The Politics of Interventions*, 1, 273-286. Oslo, Norway: Oslo Academic Press.
- Campero, S., & Guzmán, G. (2018). Metodología para la articulación de ciencia ancestral y ciencia moderna para la construcción de la modelación climática de la comunidad Condoriri (CEAC-UTO) PIA-ACC UTO-61. Cochabamba, Bolivia: PIACC.
- Camps, E., Parente, A., & Duque, S. (2018). Cambio Climático y desorden social: visiones desde el conocimiento ecológico tradicional tikuna. In: R. Bustamante & G. Canedo (Eds.), *Visiones sobre el clima y gestión del riesgo climático. Estudios y propuestas de estrategias de adaptación al cambio climático*. Cochabamba, Bolivia: UMSS. Retrieved from <http://www.researchgate.net>
- Cartagena, P., & Peralta, C. (2021). Bolivia en llamas: Cómo las políticas agropecuarias impulsan la pérdida de medios de vida de las mujeres rurales. Estudio de caso en profundidad. *Justicia de género y ganadería*. La Paz, Bolivia: CIPCA.
- Cassidy, E. S., West, P. C., Gerber, J. S., & Foley, J. A. (2013). Redefining agricultural yields: from tonnes to people nourished per hectare. *Environmental Research Letters*, 8(3), 034015. doi: 10.1088/1748-9326/8/3/034015
- Castleden, H., Morgan, V. S., & Lamb, C. (2012). "I spent the first year drinking tea": Exploring Canadian university researchers' perspectives on community-based participatory research involving Indigenous peoples. *The Canadian Geographer/Le Géographe canadien*, 56(2), 160-179. doi: 10.1111/j.1541-0064.2012.00432.x
- Catacora-Vargas, G., Piepenstock, A., Sotomayor, C., Cuentas, D., Cruz, A., & Delgado, F. (2017). Brief historical review of agroecology in Bolivia. *Agroecology and Sustainable Food Systems*, 41(3-4), 429-447. doi: 10.1080/21683565.2017.1290732
- Cavalli-Sforza, L. L., & Feldman, M. W. (1981). *Cultural transmission and evolution: A quantitative approach*. New Jersey, United States of America: Princeton University Press.

- Cave, D. (2013). As cost of importing food soars, Jamaica turns to the Earth. *New York Times*, 3. Retrieved from <https://www.nytimes.com/2013/08/04/world/americas/as-cost-of-importing-food-soars-jamaica-turns-to-the-earth.html>
- CEUB. (2011). *Modelo académico del sistema de la Universidad Boliviana 2015-2019*. La Paz, Bolivia: CEUB. Retrieved from <http://www.planificacion.umsa.bo/documents/1778193302/0/CEUB+MODELO+ACAD+EMICO+SUB.pdf>.
- Chambers, R. (1992). *Rural appraisal: rapid, relaxed and participatory*. Discussion paper 311. London, England: Institute of Development Studies.
- Chambers, R. (1994). The origins and practice of participatory rural appraisal. *World Development*, 22(7), 953-969. doi: 10.1016/0305-750X(94)90141-4
- Chambers, R. (2008). *From PRA to PLA and pluralism: Practice and theory*. Working paper 282. 2. London, England: Institute of Development Studies.
- Charmaz, K. X. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. London, England: Sage Publications.
- Chávez, F. P. F., & Rojas, A. M. L. (2011). Una mirada a las raíces de la comunicación para el desarrollo. Entrevista con Luis Ramiro Beltrán Salmón. *Signo y Pensamiento*, 30(58), 170-176. Retrieved from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-48232011000100010
- Chirveches, M., Guarachi, A., & Casilla, O. (2013). *Saberes y tecnologías locales para la adaptación al cambio climático en el cultivo de papa (Solanum sp.)*. Cochabamba, Bolivia: PADIC SRL. Retrieved from https://issuu.com/bioculturabolivia/docs/adaptaci__n_al_cambio_clim__tico_tv
- Clarke, J., Dunbar, C., & Kahle, K. (2004). The long-run performance of secondary equity issues: A test of the windows of opportunity hypothesis. *The Journal of Business*, 77(3), 575-603. Retrieved from <https://www.jstor.org/stable/10.1086/386531>
- Cockburn, J., Rouget, M., Slotow, R., Roberts, D., Boon, R., Douwes, E., . . . Musakwa, W. (2016). How to build science-action partnerships for local land-use planning and management: lessons from Durban, South Africa. *Ecology and Society*, 21(1). Retrieved from <https://www.jstor.org/stable/26270334>
- Consultores, C. (2003). *Ajuste al PDM del Municipio Tiraque Valle. Resumen Ejecutivo- 2003-2007*. Cochabamba, Bolivia. Retrieved from http://vpc.planificacion.gob.bo/uploads/PDM_S/03_COCHABAMBA/031601%20Tiraque.pdf
- Cooke, B., & Kothari, U. (2001). *Participation: The new tyranny?* London, England: Zed books.
- Coolsaet, B. (2016). Towards an agroecology of knowledges: Recognition, cognitive justice and farmers' autonomy in France. *Journal of Rural Studies*, 47, 165-171. doi: 10.1016/J.JRURSTUD.2016.07.012
- Cossio, V., Bustamante, R., & Skielboe, T. (2010). *Conflict and cooperation in local water governance: Inventory of local water-related events in tiraque District, Bolivia*: DIIS Working Paper. Cochabamba, Bolivia: DISS. Retrieved from <https://www.econstor.eu/bitstream/10419/44630/1/630323615.pdf>
- Costas, P., Garcia, A., & Chávez, M. (2005). *Sociología de los movimientos sociales en Bolivia: Estructuras de movilización, repertorios culturales y acción política*. La Paz, Bolivia: Plural Editores.
- Crespo, C., & Frank, F. (2022). De microbios, biofábricas y soberanías. In C. Sarmiento (Ed.), *Agroecología a la carta*. Río Cuarto, Argentina: UnRío Editora. Retrieved from

- <https://www.biodiversidadla.org/Recomendamos/De-microbios-biofabricas-y-soberanias>
- Cruz, P., Joffre, R., Bernard, C., Egan, N., Roux, B., & Winkel, T. (2022). Social adaptive responses to a harsh and unpredictable environment: insights from a pre-Hispanic andean society. *Ecology and Society*, 27(2). doi: 10.5751/ES-13207-270229
- CSUTCB. (2019). Quiénes somos. Retrieved from <http://www.csutcb.org/>
- Cuéllar-Padilla, M., & Calle-Collado, Á. (2011). Can we find solutions with people? Participatory action research with small organic producers in Andalusia. *Journal of Rural Studies*, 27(4), 372-383. doi: 10.1016/j.jrurstud.2011.08.004
- Cummings, S., Regeer, B. J., Ho, W. W. S., & Zweekhorst, M. B. M. (2013). Proposing a fifth generation of knowledge management for development: investigating convergence between knowledge management for development and transdisciplinary research. *Knowledge Management for Development Journal*, 9(2), 10-36. Retrieved from <https://km4djournal.org/index.php/km4dj/article/view/170>
- Czaplicki, S. (2021). *Desmitificando la agricultura familiar en la economía rural boliviana: caracterización, contribución e implicaciones*. La Paz, Bolivia: CIPCA.
- De Almeida, L. F., Sánchez, F. R., & Hallewell, L. (2000). The landless workers' movement and social struggles against neoliberalism. *Latin American Perspectives*, 27(5), 11-32. Retrieved from : <https://www.jstor.org/stable/2634155>
- De La Cruz, M., & Dessen, J. (2021). Beyond institutional bricolage: an'intertwining approach'to understanding the transition towards agroecology in Peru. *Ecological economics*, 187. doi: 10.1016/j.ecolecon.2021.107091
- De Lauwere, C., de Rooij, S., & van der Ploeg, J. D. (2007). Understanding farmers' values. *Sustainable food production and ethics*, 198-203. <https://doi.org/10.3920/978-90-8686-616-8>
- De Schutter, O. (2011). *Agroecology and the right to food*. Retrieved from <http://www.srfood.org/en/report-agroecology-and-the-right-to-food>
- De Sousa Santos, B. (2010). *Descolonizar el saber, reinventar el poder*. Montevideo, Uruguay: Ediciones Trilce.
- Delgado, R. (2010). *Investigación participativa revalorizadora e innovación tecnológica enfoque transdisciplinar en la innovación de saberes agropecuarios, experiencia piloto de producción y mercadeo de pito de cañahua y charque de llama en la comunidad Tallija-Confital*. Cochabamba, Bolivia: AGRUCO.
- Dennis, B. (2009). Acting up: Theater of the oppressed as critical ethnography. *International Journal of Qualitative Methods*, 8(2), 65-96. Retrieved from <https://journals.sagepub.com/doi/pdf/10.1177/160940690900800208>
- DfID. (2003). *Tools for development: a handbook for those engaged in development activity (version 15.1)*. London, England: DFID.
- Díaz, M., & Simmons, R. (1999). When is research participatory? Reflections on a reproductive health project in Brazil. *Journal of women's health*, 8(2), 175-184. Retrieved from <https://www.liebertpub.com>
- Edelman, M. (2009). Synergies and tensions between rural social movements and professional researchers. *The Journal of Peasant Studies*, 36(1), 245-265. doi: 10.1080/03066150902820313
- Enengel, B., Muhar, A., Penker, M., Freyer, B., Drlik, S., & Ritter, F. (2012). Co-production of knowledge in transdisciplinary doctoral theses on landscape development—an

- analysis of actor roles and knowledge types in different research phases. *Landscape and Urban Planning*, 105(1-2), 106-117. doi: 10.1016/j.landurbplan.2011.12.004
- Erlingsson, C., & Brysiewicz, P. (2017). A hands-on guide to doing content analysis. *African Journal of Emergency Medicine*, 7(3), 93-99. doi: 10.1016/j.afjem.2017.08.001
- Estado Plurinacional de Bolivia. (2013). *Agenda Patriótica 2025*. Retrieved from <https://observatorioplanificacion.cepal.org>
- Estado Plurinacional de Bolivia. (2021). *Informe Nacional Voluntario de Bolivia 2021*. Retrieved from https://sustainabledevelopment.un.org/content/documents/28230Bolivias_VNR_Report.pdf
- Etiegni, C. A., Irvine, K., & Kooy, M. (2020). Participatory governance in Lake Victoria (Kenya) fisheries: whose voices are heard? *Maritime Studies*, 9, 489-507. doi:10.1007/s40152-020-00195-x
- Evenson, R. E., & Gollin, D. (2003). Assessing the Impact of the Green Revolution, 1960 to 2000. *Science*, 300(5620), 758-762. doi: 10.1126/science.1078710
- FAO. (1975). World Food and Agriculture Situation. Rome, Italy. Retrieved from <https://www.fao.org/3/h3100e/h3100e.pdf>
- FAO. (2015). Coordinadora de Integración de Organizaciones Económicas Campesinas, Indígenas y Originarias de Bolivia (CIOEC-BOLIVIA). In *Family Knowledge Platform*. Retrieved from <https://www.fao.org/family-farming/detail/es/c/325599/>
- FAO. (2018). *Modelo Yapuchiri. Estado Plurinacional de Bolivia*. Paper presented at the Second International Symposium on Agroecology. Rome, Italy: FAO. Retrieved from <https://www.fao.org/3/BU697EN/bu697en.pdf>
- FAO. (2019). *Scaling up agroecology to achieve the sustainable development goals*. Paper presented at the Proceedings of The Second FAO International Symposium. Rome, Italy: FAO Retrieved from <https://www.fao.org/partnerships/civil-society/events/details-events/en/c/1073831/>
- FAO. (2022). Agroecology & Family Farming. *Family Farming Knowledge Platform*. Retrieved from <https://www.fao.org/family-farming/themes/agroecology/en/>
- FAO. (2023). *Indicator 2.1.1 - Prevalence of undernourishment. Sustainable Development Goals*. Retrieved from <https://www.fao.org/sustainable-development-goals/indicators/211/en/>
- FAO, IFAD, UNICEF, WFP, & WHO. (2022). The State of Food Security and Nutrition in the World 2022. Rome, Italy: FAO. doi: 10.4060/cc0639en
- FAO, IFAD, UNICEF, & WHO. (2021). *The State of Food Security and Nutrition in the World 2021: Transforming food systems for food security, improved nutrition and affordable healthy diets for all*. Retrieved from <https://www.fao.org/publications/sofi/2021/en/>
- Fausto, C., & de Vienne, E. (2014). Acting translation: ritual and prophetism in twenty-first-century indigenous Amazonia. *Hau: Journal of Ethnographic Theory*, 4(2), 161-191. doi: 10.14318/hau4.2.008
- Feder, G., Murgai, R., & Quizon, J. B. (2004). Sending farmers back to school: The impact of farmer field schools in Indonesia. *Applied Economic Perspectives and Policy*, 26(1), 45-62. doi: 10.1111/j.1467-9353.2003.00161.x
- Feola, G. (2015). Societal transformation in response to global environmental change: A review of emerging concepts. *Ambio*, 44(5), 376-390. doi:10.1007/s13280-014-0582-z
- Fernandes, I. F., Barbosa, L. P., Dos Santos Damasceno, C., & Rosset, P. M. (2021). Inventory of Agroecological Practices as part of the Peasant to Peasant Methodology in Ceará:

- An instrument to decolonize a territory and (re) value peasant knowledge. *Desenvolvimento e Meio Ambiente*, 551-578. doi: 10.5380/dma.v58i0.77777
- Fliert, E. v. d. (1993). Integrated pest management : farmer field schools generate sustainable practices : a case study in Central Java evaluating IPM training. Wageningen, The Netherlands: Wageningen University. Retrieved from <https://library.wur.nl/WebQuery/wurpubs/fulltext/133364>
- Folke, C. (2004). Traditional knowledge in social–ecological systems. *Ecology and Society*, 9(3). Retrieved from : <https://www.jstor.org/stable/26267675>
- Follet, M. P. (1918). *The New State: Group Organization the Solution of Popular Government*, New York, United States of America: Longmans.
- Freire, P. (1982). *La educación como práctica de la libertad*. Buenos Aires, Argentina: Siglo XXI editores.
- Gansemans, A. (2019). *Beyond the low-hanging fruit: Worker empowerment in Costa Rica-EU pineapple trade*. (Doctor of Applied Biological Sciences & Rural Development and Doctor of Political Sciences). Ghent, Belgium: Ghent University.
- García López, V., Pertierra Lazo, R., Torres Romero, M. C., Pengue, W. A., Rosset, P. M., Martínez Torres, M. E., . . . Casimiro Rodríguez, L. (2020). *Agroecología: ciencia, práctica y movimientos para alcanzar la Soberanía Alimentaria*. Cuenca, Ecuador: SOCLA.
- Gaventa, J. (2005). Reflections on the uses of the ‘power cube’ approach for analyzing the spaces, places and dynamics of civil society participation and engagement. *Prepared for Dutch CFA Evaluation ‘Assessing Civil Society Participation as Supported In-Country by Cordaid, Hivos, Novib and Plan Netherlands*. Sussex, England: University of Sussex.
- Gaventa, J. (2006). Finding the spaces for change: a power analysis. *IDS bulletin*, 37(6), 23-33. doi: 10.1111/j.1759-5436.2006.tb00320.x
- Gaventa, J. (2020). Applying Power Analysis: Using the ‘Powercube’ to explore forms, levels and spaces. *Power, Empowerment and Social Change*, 117-138. Retrieved from https://www.unescochair-cbrsr.org/wp-content/uploads/2020/08/Uses_of_the_powercube.pdf
- Gaventa, J. (2021). Linking the prepositions: using power analysis to inform strategies for social action. *Journal of Political Power*, 14(1), 109-130. doi: : 10.1080/2158379X.2021.1878409
- Gaventa, J., Pettit, J., & Cornish, L. (2011). *Power pack, understanding power for social change*. Sussex, England: Institute for Developmental Studies. Retrieved from www.powercube.net
- Geng, D. (2016). *Reformas institucionales del agua en la costa peruana: análisis de la gobernanza del agua en la cuenca Ica-Alto Pampas*. (Master). Lima, Peru: Pontificia Universidad Católica del Perú.
- Gerbrandy, G., & Hoogendam, P. (2002). Materialising rights: hydraulic property in the extension and rehabilitation of two irrigation. In: R. Boelens & P. Hoogendam (Eds.), *Water rights and empowerment*, 36-51. Assen, The Netherlands: Van Gorcum.
- Gibbons, M., Limoges, C., Scott, P., Schwartzman, S., & Nowotny, H. (1994). The new production of knowledge: The dynamics of science and research in contemporary societies. *The New Production of Knowledge*, 1-192. London, England: Sage Publications.
- Gibbs, G. R. (2012). Grounded theory, coding and computer-assisted analysis. In: *Understanding Research for Social Policy and Social Work: Themes, Methods and*

- Approaches. Understanding Welfare: Social Issues, Policy and Practice series*, 337-343. Bristol, England: Policy Press.
- Giraldo, O. F., & Rosset, P. M. (2018). Agroecology as a territory in dispute: Between institutionality and social movements. *The Journal of Peasant Studies*, 45(3), 545-564. doi: 10.1080/03066150.2017.1353496
- Glaser, B., & Strauss, A. (1967). *The Discovery of Grounded Theory*. New York, United States of America: Routledge. doi: <https://doi.org/10.4324/9780203793206>
- Gliessman, S. (2018). Defining Agroecology. *Agroecology and Sustainable Food Systems*, 42(6), 599-600. doi: 10.1080/21683565.2018.1432329
- Gliessman, S. (2019). Scaling agroecology through policy change. *Agroecology and Sustainable Food Systems*. 43(4), 361-361. doi: 10.1080/21683565.2019.1578468
- Gliessman, S. (2022). How do knowledge systems shape agroecology transitions? In *Agroecology and Sustainable Food Systems*, 46(8), 1115-1117. doi: 10.1080/21683565.2022.2108213
- Gliessman, S. R. (2020). Transforming food and agriculture systems with agroecology. *Agriculture and Human Values*, 37(3), 547-548. doi: 10.1007/s10460-020-10058-0
- Gómez-Baggethun, E., Corbera, E., & Reyes-García, V. (2013). Traditional ecological knowledge and global environmental change: research findings and policy implications. *Ecology and society: a journal of integrative science for resilience and sustainability*, 18(4). doi: 10.5751/ES-06288-180472
- Gong, T., Minett, J. W., & Wang, W. S. Y. (2010). A simulation study exploring the role of cultural transmission in language evolution. *Connection Science*, 22(1), 69-85. doi: 10.1080/09540090903198819
- González de Molina, M. (2016). Political Agroecology: An essential tool to promote agrarian sustainability. In: Méndez, VE, Bacon, CM, Cohen, R., Gliessman, S.R. (Eds). *Agroecology: A Transdisciplinary, Participatory and Action-Oriented Approach*; 55-72. Retrieved from <http://www.researchgate.net>
- Gottlieb, R., & Joshi, A. (2010). *Food justice*. Massachusetts, United States of America: Massachusetts Institute of Technology.
- Green, D. (2016). *How change happens*. Oxford, England: Oxford University Press.
- Gruberg, H. (2019). *Sistematización de la experiencia "sembrando vida, cosechando conocimiento"*. Cochabamba, Bolivia: Fundación Abril.
- Gruberg, H., Meldrum, G., Padulosi, S., Rojas, W., Pinto, M., & Crane, T. A. (2013). *Hacia un mejor entendimiento sobre los agricultores custodios y sus roles: percepciones de un estudio de caso en Cachilaya, Bolivia*. Rome, Italy: Bioversity International.
- Guerrero, O. M. B. (2005). *El diálogo de saberes y la educación ambiental*. 7. Bogotá, Colombia: Universidad Nacional de Colombia.
- Gumucio, A. (2019). Conocimiento rural y sostenibilidad alimentaria en el altiplano boliviano. In: K. Herrera & A. Gumucio (Eds.), *Sabores, saberes. Comunicación y conocimientos en la cultura andina*. La Paz, Bolivia: Plural editores.
- Guzmán, G. I., López, D., Román, L., & Alonso, A. M. (2016). Chapter 9. Participatory action research for an agroecological transition in Spain. In: *Agroecology. A Transdisciplinary, Participatory and Action-oriented Approach*, 139-159. Boca Raton, United States of America: Taylor & Francis Group.
- Hainzelin, E. (2015). *Enhancing the function and provisioning of ecosystem services in agriculture: agroecological principles*. Rome, Italy: FAO.

- Hainzelin, E. (2019). *Interactive panel: Common challenges and achievements from the regional dialogues. Chapter 2. Regional Synthesis Taking Stock of FAO's Global Dialogue in Agroecology*. Paper presented at the Scaling up agroecology to achieve the sustainable development goals, Rome, Italy: FAO.
- Harding, S. (1991). *Whose science? whose knowledge? thinking from women*. New York, United States of America: Cornell University Press.
- Harvey, D. (2015). *Seventeen Contradictions and the End of Capitalism*. Oxford, England: Oxford University Press.
- Hasell, J., & Roser, M. (2017). Famines. In: *Our World in Data*. Retrieved from <https://ourworldindata.org/famin>
- Heinzmann, J., Simonson, A., & Kenyon, D. B. (2019). A transdisciplinary approach is essential to community-based research with American Indian populations. *American Indian and Alaska native mental health research (Online)*, 26(2), 15. doi: 10.5820/aian.2602.2019.15
- Heleba, D., Grubinger, V., & Darby, H. (2016). On the ground. Putting agroecology to work through applied research and extension in Vermont. In: *Agroecology: A transdisciplinary, participatory and action-oriented approach*, 177-192. Boca Raton, United States of America: Taylor & Francis Group.
- Helvetas. (2020). *Yapuchiris: Un legado para afrontar los impactos del cambio climático*. La Paz, Bolivia: Helvetas. Retrieved <https://prosuco.org/wp-content/uploads/2020/09/Yapuchiris-un-legado.pdf>
- Henneman, I. (2018). Policy Integration. *Landscape Governance: Collaborating Across Sectors and Scales*: WageningenX. Wageningen, The Netherlands: Wageningen University.
- High, C., & Nemes, G. (2007). Social learning in LEADER: Exogenous, endogenous and hybrid evaluation in rural development. *Sociologia ruralis*, 47(2), 103-119. doi: 10.1111/j.1467-9523.2007.00430.x
- Hirschey, M. (Producer). (2022). Dynamic range. In: *Thinking*. Retrieved from <https://www.heurekalabs.org/dynamic-range/>
- Hisschemöller, M., & Hoppe, R. (2018). Coping with intractable controversies: the case for problem structuring in policy design and analysis 1. In: *Knowledge, power, and participation in environmental policy analysis*, 47-72, London, England: Routledge.
- HLPE. (2020). *Food security and nutrition: building a global narrative towards 2030*. Retrieved from <https://www.fao.org/3/ca9731en/ca9731en.pdf>
- Hoffmann, N. (2022). *Determinación de zonas vulnerables a la contaminación por nutrientes, en la microcuenca Virvini*. Cochabamba, Bolivia: UCB.
- Holt-Giménez, E. (2006). *Campesino a campesino: voices from Latin America's farmer to farmer movement for sustainable agriculture*. California, United States of America: Food first books.
- Holt-Gimenez, E., Altieri, M. A., & Rosset, P. (2008). Diez razones por las que una nueva Revolución Verde promovida por la alianza de las fundaciones Rockefeller y Bill y Melinda Gates no resolverá los problemas de la pobreza y el hambre en el África subsahariana. *Mientras tanto*. (106), 67-82. Retrieved from <https://www.jstor.org/stable/27821278>
- Holt-Gimenez, E., & Patel, R. (2012). *Food rebellions: Crisis and the hunger for justice*. California, United States of America: Food First Books.

- Holt Giménez, E., & Shattuck, A. (2011). Food crises, food regimes and food movements: rumblings of reform or tides of transformation? *The Journal of Peasant Studies*, 38(1), 109-144. doi: 10.1080/03066150.2010.538578
- Horcea-Milcu, A.-I., Leventon, J., & Lang, D. J. (2022). Making transdisciplinarity happen: Phase 0, or before the beginning. *Environmental science & policy*, 136, 187-197. doi: 10.1016/j.envsci.2022.05.019
- Horton, L., & Pilkington, A. (2014). Rolling back from the power/interest matrix: a new approach for role based stakeholder engagement in projects. *PM World*, 3(5), 1-5. Retrieved from www.pmworljournal.net
- Hosen, N., Nakamura, H., & Hamzah, A. (2020). Adaptation to climate change: Does traditional ecological knowledge hold the key? *Sustainability*, 12(2), 676. doi: 10.3390/su12020676
- Houde, N. (2007). The six faces of traditional ecological knowledge: challenges and opportunities for Canadian co-management arrangements. *Ecology and Society*, 12(2), 17. Retrieved from <https://www.jstor.org/stable/26267900>
- Howard, D. J. (2017). *The food sovereignty challenge to the corporate food regime: Food for thought*. (Master of Social Sciences in Sociology), Waikato, New Zealand: University of Waikato.
- Huberman, A. M., & Miles, J. S. M. B. X. (2019). *Qualitative data analysis: A methods sourcebook*. Thousand Oaks, United States of America: Sage Publications.
- Hunjan, R., & Pettit, J. (2011). *Power: A practical guide for facilitating social change*. Dunfermline: Carnegie United Kingdom Trust Dunfermline.
- Hussain, S., Miller, D., Gemmill-Herren, B., & Bogdanski, A. (2014). *Agroecology and economics of ecosystems and biodiversity: The devil is in the detail*. Paper presented at the Proceedings of the FAO international symposium, Rome, Italy: FAO.
- IAASTD. (2009). *Agriculture at a Crossroads. Global report*. Retrieved from <https://wedocs.unep.org/handle/20.500.11822/8590>
- Ianni, E., Geneletti, D., & Ciolli, M. (2015). Revitalizing traditional ecological knowledge: A study in an alpine rural community. *Environmental management*, 56(1), 144-156. doi: 10.1007/s00267-015-0479-z
- INCCA. (2019). *Protección y conservación de zonas de recarga hídrica y fuentes de agua del municipio de Tiraque. Draft*. Cochabamba, Bolivia: INCCA.
- INE. (2012a). *Bolivia: Indicadores de población, según departamento y municipio, Censo 2012*. La Paz, Bolivia: INE.
- INE. (2012b). *Censo de Población y Vivienda*. La Paz, Bolivia: INE.
- INE. (2012c). *Cochabamba. Grupos de edades quinquenales, según provincia, municipio y ciudad/comunidad. Censo 2012*. La Paz, Bolivia: INE. Retrieved from: <https://www.ine.gob.bo>
- INE. (2018). *Migración interna en Bolivia*. La Paz, Bolivia: INE. Retrieved from https://www.udape.gob.bo/portales_html/docsociales/MIGRA.pdf.
- Interpeace-IPAT. (2015). *Effective Advising in Statebuilding and Peacebuilding: How: Understanding and working with power*. Geneva, Switzerland: Interpeace. Retrieved from <https://www.interpeace.org/resource/understanding-and-working-with-power-effective-advising-in-statebuilding-and-peacebuilding-contexts/>
- Jacobi, J., & Llanque, A. (2018). "When We Stand up, They Have to Negotiate with Us": Power Relations in and between an Agroindustrial and an Indigenous Food System in Bolivia. *Sustainability*, 10(11), 4001. doi: 10.3390/su10114001

- Jacobi, J., Mathez-Stiefel, S.-L., Gambon, H., Rist, S., & Altieri, M. (2017). Whose knowledge, whose development? Use and role of local and external knowledge in agroforestry projects in Bolivia. *Environmental management*, 59(3), 464-476. doi: 10.1007/s00267-016-0805-0
- Jacobs, S. (2016). The Use of Participatory Action Research within Education--Benefits to Stakeholders. *World Journal of Education*(6(3)), 48-55. Retrieved from <https://eric.ed.gov/?id=EJ1158288>
- Jahn, T. (2008). *Transdisziplinarität in der Forschungspraxis*. Retrieved from <http://www.researchgate.net>
- Jalongo, M. R., & Saracho, O. N. (2016). *Writing for Publication: Transitions and Tools That Support Scholars' Success*. Springer Nature. doi: 10.1007/978-3-319-31650-5
- Janes, J. E. (2016). Democratic encounters? Epistemic privilege, power, and community-based participatory action research. *Action Research*, 14(1), 72-87. doi: 10.1177/1476750315579129
- Jimenez, S. (2020). *Lineamientos para una política de soberanía alimentaria en el municipio de Tiraque*. (Bachelor in law). Cochabamba, Bolivia: UCB.
- Kaplún, M. (2002). *Una Pedagogía de la comunicación (el comunicador popular)*. La Habana, Cuba: Editorial Caminos.
- Karpouzoglou, T., Tri, V. A. N. P. D., Ahmed, F., Warner, J., Hoang, L., Nguyen, T. B., & Dewulf, A. (2019). Unearthing the ripple effects of power and resilience in large river deltas. *Environmental science & policy*, 98, 1-10. doi: 10.1016/j.envsci.2019.04.011
- Kawulich, B. B. (2005). Participant observation as a data collection method. *FQS*, 6(2), doi: 10.17169/fqs-6.2.466
- Keulertz, M., & Allan, T. (2018). What Is Food-water and Why Do We not Account for It? Chapter 10. In: Conca, K. & Weinthal, E. (Eds). *The Oxford Handbook of Water Politics and Policy*, 227-247. Oxford, England: Oxford Press. doi: doi.org/10.1093/oxfordhb/9780199335084.013.1
- Khush, G. S. (1999). Green revolution: preparing for the 21st century. *Genome*, 42(4), 646-655. doi: 10.1139/g99-044
- Kingdon, J. W. (1995). *Agendas, Alternatives and public policies*. New York, United States of America: Harper Collins. Retrieved from <https://pdfs.semanticscholar.org/b601/985c67970ba87d79fabf6160ca91b1933003.pdf>
- Klein, J. (2008). Evaluation of interdisciplinary and transdisciplinary research: a literature review. *American journal of preventive medicine*, 35(2), S116-S123. doi: 10.1016/j.amepre.2008.05.010
- Klein, J. (2004). Prospects for transdisciplinarity. *Futures*, 36(4), 515-526. doi: 10.1016/j.futures.2003.10.007
- Knaggård, Å. (2015). The multiple streams framework and the problem broker. *European Journal of Political Research*, 54(3), 450-465. doi: 10.1111/1475-6765.12097
- Krueger, A. O. (1996). Political economy of agricultural policy. *Public Choice*, 87(1-2), 163-175. doi: 10.1016/S1574-0072(02)10023-5
- La Razón. (2014). Agricultura, el soporte de Santa Cruz, el líder de la economía nacional. *La Razón*. Retrieved from <https://www.la-razon.com/especiales/2014/09/24/agricultura-el-soporte-de-santa-cruz-el-lider-de-la-economia-nacional/>
- Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., . . . Thomas, C. J. (2012). Transdisciplinary research in sustainability science: practice, principles, and challenges. *Sustainability science*, 7(1), 25-43. doi: 10.1007/s11625-011-0149-x

- Latinobarómetro, C. (2014). Las religiones en tiempos del Papa Francisco. *Santiago de Chile, Chile: Latinobarómetro*. Retrieved from www.latinobarometro.org
- Latour, B. (2007). *Reassembling the social: An introduction to actor-network-theory*. Oxford, England: Oxford University Press.
- Leach, M., & Mearns, R. (1996). *The lie of the land: challenging received wisdom on the African environment*. Suffolk, England: James Currey Ltd. Retrieved from <https://agris.fao.org/agris-search/search.do?recordID=GB9701963>
- Leeuwis, C., & Ban, A. (2004). *Communication for rural innovation*. Oxford, England: Blackwell Publishing.
- Leventon, J., Suchá, L., Nohlová, B., Vaňo, S., & Harmáčková, Z. V. (2022). Participation as a pathway to pluralism: A critical view over diverse disciplines. In: *Pluralism in Ecosystem Governance*, 175. London, England: Academic Press.
- Liebman, M., & Paulston, R. G. (1994). Social cartography: A new methodology for comparative studies. *Compare*, 24(3), 233-245. doi: 10.1080/0305792940240304
- Lilja, N., Ashby, J., & Johnson, N. (2004). Scaling up and out the impact of agricultural research with farmer participatory research. *Scaling up and out: achieving widespread impact through agricultural research*. 25-36. Cali, Colombia: CIAT.
- Liu, E. (Producer). (2017). *Transcript. How to understand power*. TED Talk. Retrieved from <https://www.arenablock.com/block/2204853>
- López, R. R., Hoogendam, P., Vos, J., & Boelens, R. (2019). Transforming hydrosocial territories and changing languages of water rights legitimation: Irrigation development in Bolivia's Pucara watershed. *Geoforum*, 102, 202-213. doi: 10.1016/j.geoforum.2019.04.012
- Löwy, M. (1991). La crítica marxista de la modernidad. *Ecología política*. (1), 87-94. Retrieved from www.unirioja.es
- Ludwig, K. A. (2018). *Is our environment ready for Roundup? Investigation of Genetically Modified Organisms (GMOs) and their indirect effects on the environment*. New York, United States of America: Alfred University. Retrieved from <http://hdl.handle.net/10829/10832>
- Lukes, S. (1974). *A radical view*. London, England: Macmillan.
- Mackenzie, D., & Wajcman, J. (1999). The social shaping of technology. *Research Policy*, 25(6), 865-899. doi: 10.1016/0048-7333(96)00885-2
- Magdoff, F., Foster, J. B., & Buttel, F. H. (2000). *Hungry for profit: The agribusiness threat to farmers, food, and the environment*. New York: United States of America. NYU Press. Retrieved from <https://www.jstor.org/stable/j.ctt9qfp9p>
- Mamani, E. H., & Pimentel, F. L. (2019). Predicción climática local basada en indicadores naturales en la comunidad de Cutusuma. In: R. Bustamante & G. Canedo (Eds.), *Visiones sobre el clima y gestión del riesgo climático. Estudios y propuestas de estrategias de adaptación al cambio climático*, 85-102. Cochabamba, Bolivia: UMSS. Retrieved from <http://www.researchgate.net>
- Mansilla, M. Á., Orellana Urtubia, L., & Panott, N. S. (2020). El pentecostalismo chileno en los espacios Aymara y Quechua de Bolivia (1938-1960). *Secuencia*(107). doi: 10.18234/secuencia.v0i107.1746
- Marin, A., Ely, A., & van Zwanenberg, P. (2016). Co-design with aligned and non-aligned knowledge partners: implications for research and coproduction of sustainable food systems. *Current Opinion in Environmental Sustainability*, 20, 93-98. doi: 10.1016/J.COSUST.2016.09.003

- Martínez-Torres, M. E., & Rosset, P. M. (2014). Diálogo de saberes in La Vía Campesina: food sovereignty and agroecology. *Journal of Peasant Studies*, 41(6), 979-997. doi: 10.1080/03066150.2013.872632
- Masson, J. E., Soustre-Gacougnolle, I., Perrin, M., Schmitt, C., Henaux, M., Jaugey, C., . . . Schermesser, F. (2021). Transdisciplinary participatory-action-research from questions to actionable knowledge for sustainable viticulture development. *Humanities and Social Sciences Communications*, 8(1), 1-9. doi: /10.1057/s41599-020-00693-7 O
- Mausser, W., Klepper, G., Rice, M., Schmalzbauer, B. S., Hackmann, H., Leemans, R., & Moore, H. (2013). Transdisciplinary global change research: the co-creation of knowledge for sustainability. *Current Opinion in Environmental Sustainability*, 5(3-4), 420-431. doi: 10.1016/j.cosust.2013.07.001
- Maweu, J. M. (2011). Indigenous ecological knowledge and modern western ecological knowledge: Complementary, not contradictory. *Thought and Practice*, 3(2), 35-47. Retrieved from <https://www.ajol.info/index.php/tp/article/view/74874>
- Max-Neef, M. A. (2005). Foundations of transdisciplinarity. *Ecological economics*, 53(1), 5-16. doi: 10.1016/j.ecolecon.2005.01.014
- McElreath, R., & Strimling, P. (2008). When natural selection favors imitation of parents. *Current Anthropology*, 49(2), 307-316. doi: 10.1086/524364
- McIntyre, A. (2007). *Participatory action research*. Thousand Oaks, United States of America: Sage Publications.
- McKay, B., Nehring, R., & Walsh-Dille, M. (2014). The 'state' of food sovereignty in Latin America: political projects and alternative pathways in Venezuela, Ecuador and Bolivia. *Journal of peasant studies*, 41(6), 1175-1200. doi: 10.1080/03066150.2014.964217
- McKnight Foundation. (2018). *Cómo Evaluar la Salud del Suelo: Manual de Protocolos*. Ecuador: McKinght Foundation.
- McLuhan, M., Gordon, W. T., Lamberti, E., & Scheffel-Dunand, D. (2011). *The Gutenberg galaxy: The making of typographic man*. Toronto, Canada: University of Toronto Press.
- McMichael, P. (2005). Global development and the corporate food regime. In: F. Buttel, & McMichael, P. (Eds.), *New directions in the sociology of global development*. New Mildford, United States of America. Emerald Group Publishing Limited. doi: 10.1016/S1057-1922(05)11010-5
- McMichael, P. (2012). The land grab and corporate food regime restructuring. *The Journal of Peasant Studies*, 39(3-4), 681-701. doi: 10.1080/03066150.2012.661369
- McMichael, P. (2014). Historicizing food sovereignty. *Journal of peasant studies*, 41(6), 933-957. doi: 10.1080/03066150.2013.876999
- Mehta, L. (2016). Why invisible power and structural violence persist in the water domain. *IDS bulletin*, 47, 31-42. doi: 10.19088/1968-2016.165
- Méndez, V. E., Bacon, C. M., & Cohen, R. (2013). Agroecology as a transdisciplinary, participatory, and action-oriented approach. *Agroecology and Sustainable Food Systems*, 37(1), 3-18. doi: 10.1080/10440046.2012.736926
- Méndez, V. E., Bacon, C. M., Cohen, R., & Gliessman, S. R. (2015). *Agroecology: A transdisciplinary, participatory and action-oriented approach*. Boca Raton: CRC Press. <https://doi.org/10.1201/b19500-9>.
- Méndez, V. E., Caswell, M., Gliessman, S. R., & Cohen, R. (2017). Integrating agroecology and participatory action research (PAR): Lessons from Central America. *Sustainability*, 9(5), 705. doi: 10.3390/su9050705
- Mentschel, S. (2019). *Can Hunger be Defeated?* New Delhi, India: Yoda Press.

- Merriam, S. B., & Tisdell, E. J. X. (2015). *Qualitative research: A guide to design and implementation*. New York, United States of America: John Wiley & Sons.
- Mertens, D. M. (2007). Transformative paradigm: Mixed methods and social justice. *Journal of mixed methods research*, 1(3), 212-225. doi: 10.1177/1558689807302811
- Meynard, J.-M., Charrier, F., Le Bail, M., Magrini, M.-B., Charlier, A., & Messéan, A. (2018). Socio-technical lock-in hinders crop diversification in France. *Agronomy for Sustainable Development*, 38(5), 1-13. doi: 10.1007/s13593-018-0535-1
- Miller, V., VeneKlasen, L., Reilly, M., & Clark, C. (2006). *Power: Concepts for revisioning power for justice, equality and peace*. Washington, United States of America: Just Associates.
- Milton, K. (2001). Aspects and implications of ecological diversity in forest societies of the Brazilian Amazon. *On Biocultural Diversity: linking language and the environment*, Luisa Maffi (editora). 282-297. Washington, United States of America: Smithsonian Institution Press.
- Ministerio de Desarrollo Rural y Tierras. (2017). *Plan del Sector Agropecuario y Rural con Desarrollo Integral para Vivir Bien 2016-2020*. La Paz, Bolivia: MDRyT.
- Ministerio de Economía y Finanzas Públicas. (2011). *El Nuevo Modelo Económico, Social, Comunitario y Productivo*. La Paz, Bolivia: MEFP. Retrieved from https://medios.economiayfinanzas.gob.bo/MH/documentos/Materiales_UCS/Revistas/Revista_01.pdf.
- Ministerio de Educación. (2013). Unidad de Formación Nro. 3 "Proyecto Sociocomunitario Inclusivo de Transformación Educativa I". In *Cuadernos de Formación Continua*. La Paz, Bolivia: ME.
- Ministerio de Educación. (2014). *Indicadores educativos comparados Bolivia, Latinoamérica y El Caribe*. La Paz, Bolivia: ME. Retrieved from <http://urhh.minedu.gob.bo/biblio/book/58507>.
- Minkler, M. (2004). Ethical challenges for the "outside" researcher in community-based participatory research. *Health Education & Behavior*, 31(6), 684-697. doi: 10.1177/1090198104269566
- Mitchell, C., Cordell, D., & Fam, D. (2015). Beginning at the end: The outcome spaces framework to guide purposive transdisciplinary research. *Futures*, 65, 86-96. Doi: 10.1016/j.futures.2014.10.007
- Morlon, P. (1992). De las relaciones del clima de altura y la agricultura de la Sierra del Peru en los textos en los siglos XVI y XVII. *Bull. Inst. fr. études andines*, 21(3), 929-959. Retrieved from https://www.persee.fr/doc/bifea_0303-7495_1992_num_21_3_1093
- Muhar, A., Vilsmaier, U., Glanzer, M., & Freyer, B. (2006). Initiating transdisciplinarity in academic case study teaching: experiences from a regional development project in Salzburg, Austria. *International Journal of Sustainability in Higher Education*. doi: 10.1108/14676370610677856
- Muñoz, D. (2021). *Gestión participativa de evaluación de suelos, mediante la implementación de un kit de evaluación de suelos adaptado para la comunidad de Virvini – Tiraque*. (Ingeniería Ambiental). Cochabamba; Bolivia: UCB.
- Murra, J. V. (1988). El aymara libre de ayer. In: Albó, X. (Ed.). *Raíces de América: el mundo aymara*. Madrid, España: Alianza.
- Nadasdy, P. (1999). The politics of TEK: Power and the "integration" of knowledge. *Arctic Anthropology*, 1-18. Retrieved from <https://www.jstor.org/stable/40316502>

- Nawn, N., Vasan, S., & Kothari, A. (2018). Situating Agroecology in the Environment–Development Matrix. *Economic and Political Weekly*, 53(41), 50-98. Retrieved from <http://www.researchgate.net>
- Nelson, N., & Wright, S. (1995). *Power and participatory development: Theory and practice*: ITDG Publishing. Retrieved from <https://research.gold.ac.uk/id/eprint/11803>
- New Commitment, A. (1999). Declaration on science and the use of scientific knowledge. *Science*. Budapest, Hungary: UNESCO. Retrieved from https://www.jstage.jst.go.jp/article/tits/24/1/24_1_58/_pdf
- Nicholls, C., & Altieri, M. (2014). *Agroecology: designing climate change resilient small farming systems in the developing world*. Paper presented at the Agroecology for food security and nutrition, Proceedings of the FAO International Symposium, Rome, Italy: FAO.
- Nicolescu, B. X. (1996). *La transdisciplinarietà: manifiesto*. Monaco: Ediciones Du Rocher. Retrieved from <http://www.ceuarkos.edu.mx/wp-content/uploads/2019/10/manifiesto.pdf>
- Nikuze, A., Sliuzas, R., & Flacke, J. (2020). From Closed to Claimed Spaces for Participation: Contestation in Urban Redevelopment Induced-Displacements and Resettlement in Kigali, Rwanda. *Land*, 9(7), 212. doi: /10.3390/land9070212
- Nix, E., Paulose, J., Shrubsole, C., Altamirano-Medina, H., Belesova, K., Davies, M., . . . Wilkinson, P. (2019). Participatory Action Research as a Framework for Transdisciplinary Collaboration: A Pilot Study on Healthy, Sustainable, Low-Income Housing in Delhi, India. *Global Challenges*, 3(4), 180054-180064. doi: 10.1002/gch2.201800054
- Noble, H., & Mitchell, G. (2016). What is grounded theory? *Evidence-based nursing*, 19(2), 34-35. doi: 10.1136/eb-2016-102306
- Norgaard, R. B., & Sikor, T. (1999). Metodología y práctica de la agroecología. *Agroecología. Bases científicas para una agricultura sustentable*, 27-42. La Habana, Cuba: CLADES.
- Nyeleni. (2015). *Declaration of the International Forum for Agroecology*. Retrieved from www.foodsovereignty.org
- OECD. (1972). *Interdisciplinarity Problems of Teaching and Research in Universities*. Paris, France: Centre for Educational Research and Innovation.
- OECD. (2006). *Promoting pro-poor growth: agriculture. DAC Guidelines and Reference Series*, Paris, France: Centre for Educational Research and Innovation.
- Oguz, A. (2022). *Project Management: Navigating the Complexity with a Systematic Approach*. Ohio, United States of America: MSL Academic Endeavors.
- OHCHR. (2022). Universal Declaration on the Eradication of hunger and Malnutrition. *Human rights instruments*. Retrieved from <https://www.ohchr.org/en/instruments-mechanisms/instruments/universal-declaration-eradication-hunger-and-malnutrition#:~:text=1.,competence%20to%20achieve%20this%20objective>.
- Olsson, P., Folke, C., & Hahn, T. (2004). Social-ecological transformation for ecosystem management: the development of adaptive co-management of a wetland landscape in southern Sweden. *Ecology and Society*, 9(4). Retrieved from <https://www.jstor.org/stable/26267691>
- Overton, M. (1996). *Agricultural revolution in England: the transformation of the agrarian economy 1500-1850*. England: Cambridge University Press.
- Oxford University, P. (2019). [Oxford Dictionaries]. Discipline. Retrieved from <https://www.oxfordlearnersdictionaries.com/us/>

- Oya, C. (2009). *La crisis alimentaria mundial y sus implicaciones para África* [The world food crisis and its implications for Africa]. Retrieved from https://eprints.soas.ac.uk/11794/1/Claves_2009_Africa1_Oya.pdf
- Paarlberg, R. L. (1996). Rice bowls and dust bowls: Africa, not China, faces a food crisis. *Foreign Affairs*, 75, 127. Retrieved from https://heinonline.org/HOL/Page?collection=journals&handle=hein.journals/fora75&id=512&men_tab=srchresults
- Paquet, G. (2001). La gouvernance face au sabotage et au bricolage. *Canadian Parliamentary Review*. Retrieved from http://www.revparl.ca/24/3/24n3_01e_Paquet.pdf
- PAR. (2018). *Assessing Agrobiodiversity: A Compendium of Methods*. Platform for Agrobiodiversity Research. Rome, Italy: PAR.
- Pardo, R. (2018). *Elementos constitutivos de las prácticas del modelo yapuchiri: estudio de caso de un yapuchiri en la comunidad de Cutusuma, provincia Los Andes del departamento de La Paz*. La Paz, Bolivia: UMSA.
- Parmentier, S. (2014). Scaling-up agroecological approaches: What, why and how. *Oxfam-Solidarity, Brussels*, 472-480. Brussels, Belgium: OXFAM.
- Patel, S., Sliuzas, R., & Georgiadou, Y. (2016). Participatory local governance in Asian cities: Invited, closed or claimed spaces for urban poor? *Environment and urbanization Asia*, 7(1), 1-21. doi: 10.1177/0975425315619044
- Pellegrini, P., & Fernández, R. J. (2018). Crop intensification, land use, and on-farm energy-use efficiency during the worldwide spread of the green revolution. *Proceedings of the National Academy of Sciences*, 115(10), 2335-2340. doi: 10.1073/pnas.1717072115
- Pérez Neira, D., & Soler Montiel, M. (2013). Agroecology and ecofeminism to decolonize and depatriarchalize global food. *Revista Internacional Pensamiento Político*, 8, 95. Retrieved from https://heinonline.org/HOL/Page?collection=journals&handle=hein.journals/rvinpenso8&id=95&men_tab=srchresults
- Peters, I. (2014). Too abstract to be feasible? Applying the grounded theory method in social movement research. Giga Working Paper N° 247. Retrieved from : <http://www.jstor.com/stable/resrep07564>
- Petrosillo, I., Aretano, R., & Zurlini, G. (2015). Socioecological systems. *Reference Module in Earth Systems and Environmental Sciences*, 1-7. Retrieved from <http://www.researchgate.net>
- Pettit, J. (2013). *Power analysis: a practical guide*. Sweden: Swedish International Development Cooperation Agency (SIDA).
- Pfeiffer, J. M., & Butz, R. J. (2005). Assessing cultural and ecological variation in ethnobiological research: the importance of gender. *Journal of Ethnobiology*, 25(2), 240-278. doi: 10.2993/0278-0771(2005)25[240:ACAEVI]2.0.CO;2
- Pielke, R., & Linnér, B.-O. (2019). From Green Revolution to Green Evolution: A Critique of the Political Myth of Averted Famine. *Minerva*, 57, 265-291. doi:10.1007/s11024-019-09372-7
- Pilgrim, S., Cullen, L., Smith, D., & Pretty, J. (2008). Ecological knowledge is lost in wealthier communities and countries. *Environmental Science Technology*, 42(4), 1004-1009. doi:10.1021/es070837v
- Pilgrim, S., Samson, C., & Pretty, J. (2010). Ecocultural revitalization: replenishing community connections to the land. In: *Nature and culture: Rebuilding lost connections*. 235-256. London, England: Routledge.

- Pimbert, M. (2009). *Towards food sovereignty*. London; England: International Institute for Environment and Development.
- Pimbert, M. (2015). Agroecology as an alternative vision to conventional development and climate-smart agriculture. *Development*, 58, 286–298 doi: 10.1057/s41301-016-0013-5
- Pimbert, M. (2016). *Food sovereignty, agroecology and biocultural diversity*. London, England: Routledge.
- Pohl, C. (2011). What is progress in transdisciplinary research? *Futures*, 43(6), 618-626. doi: 10.1016/j.futures.2011.03.001
- Pohl, C., & Hadorn, G. H. (2007). *Principles for designing transdisciplinary research*. Munich, Germany: Oekom Munich.
- Pohl, C., Pearce, B., Mader, M., Senn, L., & Krütli, P. (2020). Integrating systems and design thinking in transdisciplinary case studies. *GAIA-Ecological Perspectives for Science and Society*, 29(4), 258-266. doi: 10.14512/gaia.29.4.11
- Popa, F., Guillermin, M., & Dedeurwaerdere, T. (2015). A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science. *Futures*, 65, 45-56. doi: 10.1016/j.futures.2014.02.002
- Pratt, S. L. (2011). American Power: Mary Parker Follett and Michel Foucault. *Foucault Studies*, 76-91. doi: 10.22439/fs.v0i11.3207
- Pretty, J., & Hine, R. (2000). Feeding the world with sustainable agriculture. *A Summary of New Evidence*. Colchester, UK: University of Essex.
- PROFOCOM. (2017). *Unidad de Formación No. 9. Proyecto Socioproductivo*. La Paz, Bolivia: PROFOCOM. Retrieved from <https://edufisicaesfmms.files.wordpress.com/2017/03/uf9.pdf>.
- PTDI. (2016). *Plan Territorial de Desarrollo Integral 2016 -2020*. La Paz, Bolivia. MDRyT.
- Pusch, J. (2018). *Un giro ontológico en la cosmovisión de la naturaleza: El papel del capitalismo y otras influencias en el cambio de las percepciones tradicionales de la naturaleza en la comunidad Quechua de Paru Paru*. Retrieved from https://digitalcollections.sit.edu/isp_collection/2792
- Quiroga Eróstegui, C. (2021). Aproximaciones al derecho a la tierra desde un enfoque de género: un espacio de resistencia, cuidado y aprendizaje colaborativo en Valle Alto, Cochabamba. *Perfiles latinoamericanos*, 29(57), 143-166. doi: 10.18504/pl2957-006-2021
- Quispe, M. (2011). Reducción de riesgos climáticos en la producción agrícola a través de una construcción de conocimientos compartida en Bolivia. *Experto en Gestión del Riesgo de Desastres, Adaptación al cambio climático y Desarrollo Dirección de Prevención y Reconstrucción Defensa Civil-Bolivia*, 5, 31. Retrieved from http://www.revistasbolivianas.ciencia.bo/scielo.php?pid=S1995-10782011000200005&script=sci_arttext&tlng=es
- Quispe, M. (2019). Yapuchiris y estrategias locales para la gestión de riesgos agropecuarios. In *Sabores, saberes. Comunicación y conocimientos en la cultura alimentaria*. La Paz, Bolivia: Plural editores.
- Raghavan, B., Nardi, B., Lovell, S. T., Norton, J., Tomlinson, B., & Patterson, D. J. (2016). *Computational agroecology: Sustainable food ecosystem design*. Paper presented at the Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems. doi: 10.1145/2851581.2892577

- Ramadier, T. (2004). Transdisciplinarity and its challenges: the case of urban studies. *Futures*, 36(4), 423-439. doi: /10.1016/j.futures.2003.10.009
- Ramankutty, N., Mehrabi, Z., Waha, K., Jarvis, L., Kremen, C., Herrero, M., & Rieseberg, L. H. (2018). Trends in global agricultural land use: implications for environmental health and food security. *Annual review of plant biology*, 69(1), 789-815. doi: 10.1146/annurev-arplant-042817-040256
- Reason, P. E. (1994). *Participation in human inquiry*. United States of America: Sage Publications.
- Redman, C. L., Grove, J. M., & Kuby, L. H. (2004). Integrating social science into the long-term ecological research (LTER) network: social dimensions of ecological change and ecological dimensions of social change. *Ecosystems*, 7(2), 161-171. doi: 10.1007/s10021-003-0215-z
- Regalsky, P., & Quisbert, F. (2008). Bolivia indígena: de gobiernos comunitarios en busca de autonomía a la lucha por la hegemonía. *Gobernar (en) la diversidad: experiencias indígenas desde América Latina. Hacia la investigación de co-labor*. Retrieved from www.academia.edu
- Regeer, B. J., Hoes, A.-C., van Amstel-van Saane, M., Caron-Flinterman, F. F., & Bunders, J. F. G. (2009). Six guiding principles for evaluating mode-2 strategies for sustainable development. *American Journal of Evaluation*, 30(4), 515-537. doi: 10.1177/1098214009344618
- Resler, M. L., & Hagolani-Albov, S. E. (2021). Augmenting agroecological urbanism: the intersection of food sovereignty and food democracy. *Agroecology and Sustainable Food Systems*, 45(3), 320-343. doi: 10.1080/21683565.2020.1811829
- Reyes-García, V., Broesch, J., Calvet-Mir, L., Fuentes-Peláez, N., McDade, T. W., Parsa, S., . . . Martínez-Rodríguez, M. R. (2009). Cultural transmission of ethnobotanical knowledge and skills: an empirical analysis from an Amerindian society. *Evolution and human behavior*, 30(4), 274-285. doi:10.1016/j.evolhumbehav.2009.02.001
- Ricaldi Arévalo, T., & Aguilar, L. (2014). How Yapuchiris build climate resilience. *Farming Matters*, 30(2), 20-23. Retrieved from <http://www.agriculturesnetwork.org>
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences*, 4(2), 155-169. doi: 10.1007/BF01405730
- Rivière, G. (2007). Bolivia: el pentecostalismo en la sociedad aimara del Altiplano. *Nuevo Mundo Mundos Nuevos. Nouveaux mondes mondes nouveaux-Novo Mundo Mundos Novos-New world New worlds*. Retrieved from <http://journals.openedition.org/nuevomundo/6661>
- Rocha-López, R. g. (2020). *Hydrosocio-territorial struggles: Shifting of water rights frameworks in Bolivia*. Wageningen, The Netherlands: Wageningen University.
- Rocha, R., & Solivia, P. (2004). La tecnología de Suka Kollus en el manejo y producción de cultivos en el altiplano boliviano. In: A. Restrepo (Ed.), *Saberes de Vida. Por el bienestar de las Nuevas Generaciones*, 200-211. Quito, Ecuador: UNESCO. Retrieved from <https://unesdoc.unesco.org/ark:/48223/pf0000136715>
- Rocha, R., Vos, J., & Boelens, R. (2016). Territorios hidrosociales y valoración del agua: Perspectivas divergentes sobre los derechos de agua en la Cuenca Pucara, Bolivia. Wageningen, The Netherlands: Wageningen University.
- Rockstrom, J., Hatlbu, N., Owels, T., & Wani, S. P. (2007). Managing water in rainfed agriculture. In: *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*. 315-352, London, England: International Water Management Institute.

- Rodriguez, I. (2020). *Water accounting and model development for a sustainable management of water resources in Tiraque, Bolivia*. National PhD Progress Presentations. Cochabamba, Bolivia: UCB:
- Rodriguez, R. (2022). *Documento de sistematización. Proyecto 3 "Promover la soberanía alimentaria y las innovaciones nutricionales en comunidades vulnerables de Bolivia" Sede Cochabamba (2017-2021)*. Cochabamba, Bolivia: UCB.
- Rodriguez de Francisco, J.-C., & Boelens, R. (2014). Payment for environmental services and power in the Chamachán watershed, Ecuador. *Human Organization*, 73(4), 351-362. doi: 10.17730/humo.73.4.b680w75u27527061
- Rogge, E., & Dessenin, J. (2015). Perceptions of a small farming community on land use change and a changing countryside: A case-study from Flanders. *European Urban and Regional Studies*, 22(3), 300-315. doi: 10.1177/0969776412474664
- Rogge, E., Dessenin, J., & Verhoeve, A. (2013). The organisation of complexity: A set of five components to organise the social interface of rural policy making. *Land use policy*, 35, 329-340. doi: 10.1016/j.landusepol.2013.06.006
- Rolin, K. (2009). Standpoint theory as a methodology for the study of power relations. *Hypatia*, 24(4), 218-226. doi: 10.1111/j.1527-2001.2009.01070.x
- Rosado-May, F. J. (2015). *The intercultural origin of agroecology: contributions from México. Agroecology, a transdisciplinary, participatory and action oriented approach*. Boca Raton, United States of America: Taylor & Francis Group.
- Rosenberg, D. (2011). Food and the Arab Spring. *Gloria center*. Retrieved from https://ciaotest.cc.columbia.edu/journals/meria/v15i3/f_0029750_24069.pdf
- Rosendahl, J., Zanella, M. A., Rist, S., & Weigelt, J. (2015). Scientists' situated knowledge: Strong objectivity in transdisciplinarity. In: *Futures*, 65, 17-27. doi: 10.1016/j.futures.2014.10.011
- Roser, R., & Ortiz-Ospina, M. (2018). *Measuring progress towards the Sustainable Development Goals*. Retrieved from: <https://sdg-tracker.org/zero-hunger>
- Rosset, P. (2000). The multiple functions and benefits of small farm agriculture in the context of global trade negotiations. *Development*, 43(2), 77-82. doi:<https://doi.org/10.1057/palgrave.development.1110149>
- Rosset, P. M., Barbosa, L. P., Val, V., & McCune, N. (2022). Critical Latin American agroecology as a regionalism from below. *Globalizations*, 19(4), 635-652. doi: 10.1080/14747731.2021.1923353
- Roth, D., Vink, M., Warner, J., & Winnubst, M. (2017). Watered-down politics? Inclusive water governance in the Netherlands. *Ocean & Coastal Management*, 150, 51-61. doi: 10.1016/j.ocecoaman.2017.02.020
- Ruiz, Á. B., & Rodríguez, J. M. M. (2015). Los huertos escolares comunitarios: fraguando espacios socioeducativos en y para la sostenibilidad. *Foro de educación*, 13(19), 213-239. Retrieved from <https://www.forodeeducacion.com/ojs/index.php/fde/article/view/380>
- Sachs, I. (1981). Ecodesarrollo: concepto, aplicación, beneficios y riesgos. *Agricultura y sociedad*, (18), 9-32. Retrieved from https://www.mapa.gob.es/ministerio/pags/biblioteca/revistas/pdf_ays/a018_01.pdf
- Saldías, C. (2009). *Revelando la distribución del agua. Abanico Punata, área de influencia de la cuenca Pucara, Bolivia*. Wageningen, The Netherlands: Wageningen University.
- Sánchez Canedo, W. (2008). *Inkas, "flecheros" y mitmaquna: Cambio social y paisajes culturales en los Valles y en los Yungas de Inkachaca/Paracti y Tablas Monte*

- (Cochabamba-Bolivia, siglos XV-XVI). Upsala, Sweden: Institutionen för arkeologi och antik historia, Uppsala University. Retrieved from <http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-9207>
- Sasson, A. (2012). Food security for Africa: an urgent global challenge. *Agriculture & Food Security*, 1(1), 1-16. doi: 10.1186/2048-7010-1-2
- Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., . . . Jinks, C. (2018). Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & quantity*, 52(4), 1893-1907. doi: 10.1007/s11135-017-0574-8
- Saylor, C. R., Alsharif, K. A., & Torres, H. (2017). The importance of traditional ecological knowledge in agroecological systems in Peru. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 13(1), 150-161. doi: 10.1080/21513732.2017.1285814
- Schavelzon, S. (2012). *El nacimiento del Estado Plurinacional de Bolivia, etnografía de una asamblea constituyente*: Fondo de las Naciones Unidas para la Democracia. La paz, Bolivia: Plural editores.
- Schiffer, E. (2007). *The power mapping tool: A method for the empirical research of power relations*. United States of America. doi: 10.22004/ag.econ.42410
- Schmidt, L., Falk, T., Siegmund-Schultze, M., & Spangenberg, J. H. (2020). The objectives of stakeholder involvement in transdisciplinary research. A conceptual framework for a reflective and reflexive practise. *Ecological Economics*, 176, 106751. doi: 10.1016/j.ecolecon.2020.106751
- Schmitz, S., Duhoux, F., & Machiels, J.-P. (2016). Window of opportunity studies: do they fulfil our expectations? *Cancer treatment reviews*, 43, 50-57. doi: 10.1016/j.ctrv.2015.12.005
- Schneidewind, U. (2001). Mobilizing the intellectual capital of universities. In *Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society*. 94-100. doi: 10.1007/978-3-0348-8419-8_9
- Scholz, R. W., & Binder, C. R. (2011). *Environmental literacy in science and society: from knowledge to decisions*. Cambridge, Uk: Cambridge University Press.
- Scholz, R. W., & Tietje, O. (2002). *Embedded case study methods: Integrating quantitative and qualitative knowledge*. United States of America: Sage Publications.
- Schoonenboom, J., & Johnson, R. B. (2017). How to Construct a Mixed Methods Research Design. *Kolner Z Soz Sozpsychol*, 69(Suppl 2), 107-131. doi: 10.1007/s11577-017-0454-1
- Scoville-Simonds, M. (2018). Climate, the Earth, and God—entangled narratives of cultural and climatic change in the Peruvian Andes. *World Development*, 110, 345-359. doi: 10.1016/j.worlddev.2018.06.012
- Seemann, M. (2016). *Water security, justice and the politics of water rights in Peru and Bolivia*. Hampshire, England: Palgrave Mcmillan.
- Segall Corrêa, A. M., Álvarez Uribe, M. C., Melgar Quiñonez, H., & Pérez Escamilla, R. (2012). *Escala latinoamericana y caribeña de seguridad alimentaria (ELCSA): Manual de uso y aplicaciones*. Rome, Italy: FAO. Retrieved from <https://bibliotecadigital.udea.edu.co/handle/10495/25324>
- Sélingué. (2007). *Nyeléni 2007 - Forum for Food Sovereignty. Synthesis Report*. Retrieved from <https://nyeleni-eca.net/food-sovereignty>

- Sergeant, S., Schippers, A. P., Sandvoort, H., Duijf, S., Mostert, R., Embregts, P. J., & Van Hove, G. (2021). Co-designing the Cabriotraining: A training for transdisciplinary teams. *British Journal of Learning Disabilities*, 49(2), 230-246. doi: 10.1111/bld.12357
- Simon, D., & Schiemer, F. (2015). Crossing boundaries: complex systems, transdisciplinarity and applied impact agendas. *Current Opinion in Environmental Sustainability*, 12, 6-11. doi: 10.1016/j.cosust.2014.08.007
- Sole, D., & Edmondson, A. (2002). Situated knowledge and learning in dispersed teams. *British Journal of Management*, 13(S2), S17-S34. doi: 10.1111/1467-8551.13.s2.3
- Soto, C. (1994). *Historia del pacto militar campesino*. La Paz, Bolivia: Ediciones CERES.
- Spangenberg, J. H. (2011). Sustainability science: a review, an analysis and some empirical lessons. *Environmental Conservation*, 38(3), 275-287. doi: 10.1017/S0376892911000270
- Spreitzer, G. M., & Sonenshein, S. (2004). Toward the construct definition of positive deviance. *American Behavioral Scientist*, 47(6), 828-847. doi: 10.1177/0002764203260212
- Stauffacher, M., Flüeler, T., Krütli, P., & Scholz, R. W. (2008). Analytic and dynamic approach to collaboration: a transdisciplinary case study on sustainable landscape development in a Swiss prealpine region. *Systemic Practice and Action Research*, 21(6), 409-422. doi: 10.1007/s11213-008-9107-7
- Steger, C., Klein, J. A., Reid, R. S., Lavorel, S., Tucker, C., Hopping, K. A., . . . Dorji, T. (2021). Science with society: Evidence-based guidance for best practices in environmental transdisciplinary work. *Global environmental change*, 68, 102240. doi: 10.1016/j.gloenvcha.2021.102240
- Sull, D. N., & Wang, Y. (2005). *Made in China: What Western managers can learn from trailblazing Chinese entrepreneurs*. United States of America: Harvard Business Press.
- Tang, R. (2012). An analysis of traditional ecological knowledge's status and its conservation options. New Zealand: Victoria University of Wellington. Retrieved from <http://hdl.handle.net/10063/2785>
- Tantoh, H. B., Simatele, M. D., & Ebhuoma, E. E. (2020). Shifting the paradigm in community-based water resource management in North-West Cameroon: A search for an alternative management approach. *Community Development*, 51(2), 172-191. doi: 10.1080/15575330.2019.1659382
- Tapia, N. (2002). *Agroecología y agricultura campesina sostenible en los Andes Bolivianos*. Cochabamba; Bolivia: AGRUCO.
- Tapia, N. (2016). El diálogo de saberes y la investigación participativa revalorizadora. *Ciencias, diálogo de saberes y la transdisciplinariedad*, 89-118. Cochabamba, Bolivia: AGRUCO.
- Thompson, I., Shrestha, M., Chhetri, N., & Agusdinata, D. B. (2020). An institutional analysis of glacial floods and disaster risk management in the Nepal Himalaya. *International Journal of Disaster Risk Reduction*, 101567. doi: 10.1016/j.ijdr.2020.101567
- Thompson, J., & Scoones, I. (2009). Addressing the dynamics of agri-food systems: an emerging agenda for social science research. *Environmental Science & Policy*, 12(4), 386-397. doi: /10.1016/j.envsci.2009.03.001
- Timmer, C. P. (2009). Do Supermarkets Change the Food Policy Agenda? *World Development*. 37(11), 1812-1819. doi:10.1016/j.worlddev.2008.08.022
- Tiraque. (2003). *Plan de Desarrollo Municipal - Resumen*. Cochabamba, Bolivia: Tiraque.
- TLC Cochabamba. (2018). Gráficos vinculación problemas regionales P3. Cochabamba, Bolivia: UCB.

- Trauger, A. (2014). Toward a political geography of food sovereignty: transforming territory, exchange and power in the liberal sovereign state. *Journal of Peasant Studies*, 41(6), 1131-1152. doi: 10.1080/03066150.2014.937339
- Tress, G., Tress, B., & Fry, G. (2005). Clarifying Integrative Research Concepts in Landscape Ecology. *Landscape Ecology*, 20(4), 479-493. doi: 10.1007/s10980-004-3290-4
- Trimarco, J. S. (2016). *Formal education and traditional ecological knowledge transmission in Samburu, Kenya: research and revitalization*. United States of America: Colorado State University.
- Tyre, M. J., & Orlikowski, W. J. (1994). Windows of opportunity: Temporal patterns of technological adaptation in organizations. *Organization science*, 5(1), 98-118. doi: 10.1287/orsc.5.1.98
- Convocatoria para seleccionar a un@ candidat@ beneficiario de la beca de doctorado en el marco del programa VLIR UOS, (2018). La Paz, Bolivia: UCB.
- UCB, & VLIR-UOS. (2016). *Format for an IUC Partner Programme (PP). Phase 1*. La Paz, Bolivia: UCB.
- UDAPE. (2017). *Diagnóstico Agropecuario*. La Paz, Bolivia: UDAPE. Retrieved from <https://www.udape.gob.bo>
- UN. (2022). Food Security and nutrition and sustainable agriculture. *Sustainable Development Goals*. Retrieved from <https://sustainabledevelopment.un.org/topics/foodagriculture>
- Vargas, A. G., M., Navarro, J. M., Cabrera, J. M., Rodríguez, I., d'Abzac, P., Gruberg, H., . . . Antezana, P. (2019). *Generación de planes transdisciplinarios a partir de la pregunta compleja de la CTA Cochabamba*. Cochabamba, Bolivia: UCB.
- Velarde, C. T., Wanderley, F., Cartagena, P., Rivero, C. P., & Carrasco, C. S. (2021). *Contribución de la agricultura familiar campesina indígena a la producción y consumo de alimentos en Bolivia*. La Paz, Bolivia: CIPCA.
- Via Campesina. (2010). *Sustainable peasant and small family farm agriculture can feed the world*. Retrieved from <https://viacampesina.org/en/wp-content/uploads/sites/2/2011/04/paper6-EN-FINAL.pdf>
- Vía Campesina. (1996). *La Vía Campesina: Proceedings from the II International Conference of the Vía Campesina*. Tlaxcala, Mexico: Via Campesina.
- Viceministerio de Recursos Hídricos y Riego. (2013). *Inventario Nacional de Sistemas de Riego 2012*. La Paz, Bolivia: GIZ PROAGRO.
- Villasante, T. (2006). *Desbordes creativos. Estilos y estrategias para la transformación social*. Madrid, Spain: Los Libros de la Catarata. Retrieved from <https://core.ac.uk/download/pdf/38818802.pdf>
- VLIR-UOS (2017). [IUC 2017 Phase 1 UCB-B].
- VLIR-UOS. (2021). *Comunidades Transdisciplinarias de Aprendizaje*. La Paz, Bolivia: UCB. Retrieved from <https://www.vliruos.ucb.edu.bo/>
- Vorley, B. (2002). *Sustaining agriculture: policy, governance, and the future of family-based farming. A synthesis report of the collaborative research project 'policies that work for sustainable agriculture and regenerating rural livelihoods'*. London England: International Institute for Environment and Development.
- Vorley, B. (2003). *Food, Inc. Corporate concentration from farm to consumer*. London, England Food Group.
- Walsh-Dilley, M. (2019). Religious Fragmentation, Social Disintegration? Social Networks and Evangelical Protestantism in Rural Andean Bolivia. *Qualitative Sociology*, 42(3), 499-520.

- Wamsler, C. (2017). Stakeholder involvement in strategic adaptation planning: Transdisciplinarity and co-production at stake? *Environmental Science & Policy*, 75, 148-157. doi: 10.1016/J.ENVSCI.2017.03.016
- Wamuchiru, E. (2017). Beyond the networked city: situated practices of citizenship and grassroots agency in water infrastructure provision in the Chamazi settlement, Dar es Salaam. *Environment and Urbanization*, 29(2), 551-566. Doi: 10.1177/0956247817700290
- Warburton, H., & Martin, A. (1999). *Local people's knowledge in natural resources research*. In: Chatham, England: Natural Resources Institute Retrieved from <http://gala.grc.ac.uk/id/eprint/11694>
- Werner, M. (2021). Placing the state in the contemporary food regime: Uneven regulatory development in the Dominican Republic. *The Journal of Peasant Studies*, 48(1), 137-158. doi: 10.1080/03066150.2019.1638367
- Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., & David, C. (2009). Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development*, 29(4), 503-515. doi: 10.1051/agro/2009004
- Whaley, L., & Weatherhead, E. K. (2015). Power-sharing in the English lowlands? The political economy of farmer participation and cooperation in water governance. *Water Alternatives*, 8(1), 820-843. Retrieved from <https://www.water-alternatives.org/index.php/alldoc/articles/vol8/v8issue1/267-a8-1-11/file>
- White, A. C., Faulkner, J. W., Conner, D. S., Méndez, V. E., & Niles, M. T. (2022). "How can you put a price on the environment?" Farmer perspectives on stewardship and payment for ecosystem services. *Journal of Soil and Water Conservation*, 77(3), 270-283. doi: 10.2489/jswc.2022.00041
- Wiek, A. (2007). Challenges of transdisciplinary research as interactive knowledge generation—experiences from transdisciplinary case study research. *GAIA-Ecological Perspectives for Science and Society*, 16(1), 52-57. doi: 10.14512/gaia.16.1.14
- Wiek, A., & Walter, A. I. (2009). A transdisciplinary approach for formalized integrated planning and decision-making in complex systems. *European Journal of Operational Research*, 197(1), 360-370. doi: 10.1016/j.ejor.2008.06.013
- Wiggins, S., & Levy, S. (2008). *Rising food prices: A global crisis*. ODI. Retrieved from https://www.tips.org.za/files/Wiggins_S._Levy_S._2008_Rising_food_prices_-_a_global_crisis_-_Action_needed_now_to_avert_poverty_and_hunger.pdf
- Williams, J. J., Gosling, W. D., Coe, A. L., Brooks, S. J., & Gulliver, P. (2011). Four thousand years of environmental change and human activity in the Cochabamba Basin, Bolivia. *Quaternary Research*, 76(1), 58-68. doi: 10.1016/j.yqres.2011.03.004
- Winder, N. P. (2003). Successes and problems when conducting interdisciplinary or transdisciplinary research. In: B. Tress, Tress, G., van der Valk, A., & Fry, G (Eds.), *Interdisciplinary and transdisciplinary landscape studies: Potential and limitations*. 74-79. Wageningen: The Netherlands: Wageningen University.
- World Bank. (2005). *Agricultural Growth and the Poor. An agenda for Development, Directions in Development*. Washington: United States of America: World Bank. doi: 10.1596/0-8213-6067-1
- World Forum for Alternatives. (2015). *Rights to Water and Land, a Common Struggle*. Retrieved from <https://www.tni.org/en/article/rights-to-water-and-land-a-common-struggle>

-
- World Future Council. (2018). *Scaling Up Agroecology. Future Policy Award*. Retrieved from <https://www.worldfuturecouncil.org/wp-content/uploads/2018/10/FPA-2018-Brochure-for-web.pdf>
- WTO. (2016). *Agriculture*. Geneva, Switzerland: WTO Retrieved from https://www.wto.org/english/tratop_e/agric_e/agric_e.htm
- Yin, R. K. (2009). *Case study research: Design and methods*. United States of America: Sage Publications.
- Yuan, Z., Lun, F., He, L., Cao, Z., Min, Q., Bai, Y., . . . Fuller, A. M. (2014). Exploring the State of Retention of Traditional Ecological Knowledge (TEK) in a Hani Rice Terrace Village, Southwest China. *Sustainability*, 6(7), 4497-4513. doi:10.3390/su6074497
- Zent, S. (2013). Processual perspectives on traditional environmental knowledge. *Understanding cultural transmission in anthropology*, 213-265. New York and Oxford: Berghahn Books.

Appendix 1. Moments in the process of transdisciplinary research between 2018 and 2022

Yr.	2018	2019	2020				2021			2022					
Activity	Moment	1. Inspiration	2. Negotiation	3. Action			Loop.	4. Inspiration	Loop. Negotiation	5. Action	6. Inspiration	7. Action	8. Inspiration	Loop. Negotiation	9. Action
General diagnosis	Starting point														
Highschool students exchange															
First art session: Storytelling, drawing and selection of ...															
Meeting with Peasant Union in Virvini															
Meeting with NGO-2															
Trying to get the District' s approval															
Zoning workshop															
First soil workshop															
First soil evaluation set															
Second															
Third soil evaluation															
Formal agreement with Education District															
Delivery of soil results and validation with farmers															
Design of an Action Plan to improve soils health															
Reinforcement capacity building workshop with key															
Farmer-to-farmer in Caribun Mayu															
Negotiations with Direction, Parents Committee and Fe y Alegría															
Construction of the water harvester															
Water harvester inauguration ceremony															
Farmers exchange															
Edu communication plan implementation															
Inclusion of new chemical soil parameters															
Farmers exchange between Batallas and Tiraque in															
Farmer-to-farmer in Tiraque about new soil															
Farmer-to-farmer in Batallas about the new															
With other school for orchards															
Establishment of food gardens and Biol research															

Yr.	2018	2019	2020			2021			2022				
Actors	Projects from TLC Cochabamba	Students from school in Tiraque	Peasants NGO-2 staff NGO-2 director P3 Researchers	Volunteer farmers NGO3 technician NGO 4 technician NGO-2 technician P3 researchers	Education District Volunteer farmers Key farmer School Director NGO-2 technician Municipal Council P3 researchers Carbun Mayu farmers	New school director New parents school committee New teachers Owner of the land P3 researchers	Two daily shifts of parents School parents committee President of parents school committee Owner of the land Municipal staff Students' parents Central Peasant Union P3 resea	Key farmer from Tiraque School director Farmers from Batallas School teachers P3 researchers Students	P3 researchers	Key farmers from Batallas and Tiraque Key farmers from Tiraque Farmers from Virvini 13 Farmers from Batallas 28 P3 researchers	School Director Director from other school P3 researchers	School director School teachers Students P3 researchers	
	Farmers Authority from social organizations Municipal Staff	Farmers from Tiraque 12 Students from Sacaba Projects 1, 3, 4, 6 from TLC Cochabamba Owner of dynamic agroforestry plots 1 Cochabamba School Directors University psycholo	Consultant lawyers Municipality Council Farmers from the agroecological committee Projects 3,4 from TLC Cochabamba Education district authority School director										

Yr.	2018	2019	2020			2021			2022			
	NGOs	gy, law, and communication Farmers from the Agroecological Committee School Staff NGO-1 technicians					rchers NGO-2 NGO-1					

Appendix 2. Indicators, festivities, and rituals

GROUP	ELEMENT	DESCRIPTION	GEN 1		GEN 2		GEN 3		TOTAL
			W	M	W	M	W	M	
Earth, soil, rocks	Soils	Soil moisture defines the start of sowing	1		1	1	1		4
	Rocks	Between August 1 and 6 at dawn, it is checked if there is moisture under the stones to know if it will be a good year. It is one day per month. If the surface is wet, it will be a good year. If it is dry, it will be a dry year.	1		1	2	2	2	8
	Earth	Cracks announces drought			1				1
Meteorologic	Cold	When the cold ends Indicates the beginning of sowing			1	1		1	3
	Wind	If its cold wind announces frost					2		2
		In the sowing season it announces rain				1			1
		In August heralds a rainy year				1			1
Skye	Sky	Black announces rain	2	2	2	1		2	9
		First cloudy, it clears, cold wind runs means that the frost is coming						1	1
		Black with lightning and thunder announces hail	2	3	1	2	4	1	13
		Clear and no wind announces frost			3	2			5
		Clear and yellow announces frost			1				1
		Clear in the rainy season warns the start of sowing		1					1

GROUP	ELEMENT	DESCRIPTION	GEN 1		GEN 2		GEN 3		TOTAL
			W	M	W	M	W	M	
	Clouds	Towards Punata (southwest) and red twilight announces frost					2		2
		Loaded to the west they announce rain						1	1
		Black and fast announces hail				2		1	3
		Blues announce hail						1	1
Astronomical	Moon	If it has a little house, it announces rain			1				1
		On a full moon it is not sown			1	1		1	3
		New moon			1		1	1	3
		Turned west						1	1
	Sun	Sun with thunder and few clouds announces hail				1			1
	Stars	If they formed a plow, they announced rain				1			1
Zoo indicators	Fox	His full howl announces rain. His cut howl heralds drought	1		2	1	1	1	6
	Leke leke	His song tells that we are in cold time	1				1		2
	Frogs	His croaking announces rain	1	1		1	1		4
	Chickens	If it lies on the ground flapping it announces rain	1						1

GROUP	ELEMENT	DESCRIPTION	GEN 1		GEN 2		GEN 3		TOTAL
			W	M	W	M	W	M	
	Chickens	If fleas are removed, it announces rain					1		1
	Crickets	They announce rain	1						1
	Ants with White wings	They announce hail	1	1		1		2	5
	White butterflies Paramonja	They announce rain				1			1
	Kewiña birds	Announces that the rain comes					1		1
	Chiwalo birds	Early August at dawn announces rain					1	1	2
	Virgen birds	If they flutter in groups, it announces rain					1		1
	Seagull	His cry announces wind			1				1
	Pichikanta birds	I sing early in the morning and in the afternoon heralds the start of sowing				1			1
		If you lay your egg in the air it announces little rain. If you put your egg in low and protected areas, it is a good year.						1	1
	Hawks	Hawk fight announces storm						1	1
Phyto indicators	Eucalyptus leaves	If they wither, they announce rain						1	1

GROUP	ELEMENT	DESCRIPTION	GEN 1		GEN 2		GEN 3		TOTAL
			W	M	W	M	W	M	
	Maize	If he becomes dehydrated, he announces that it will rain in the following days			1				1
	Wild plants	The sprouting of the plants indicates for the beginning of the sowing	1	1	3	3			8
		Loss of hard old leaves and branches herald fall planting				1			1
	Plants in general	Dehydrates announce rain	1	1	1			1	4
	Fava	Dehydrates announce rain	1				1		2
		Flower changes colour when it's going to rain					2		2
	Potato	If the plant withers it announces rain				1			1
Rituals and festivities	Verónicas	Veronica and smoke to chase away the hail				1			1
	Black flags and ashes	They are used as defence against hailstorms					1	1	1
	August	If it snowed in August, it was a good year					1	1	2
		Day 1 represents January and day 2 represents February. If it is cloudy those days, it will rain in those months				1			1
		It must be sown on August 6						1	1
Absence of clouds announces frost in January							1	1	

GROUP	ELEMENT	DESCRIPTION	GEN 1		GEN 2		GEN 3		TOTAL
			W	M	W	M	W	M	
	Firecrackers	To ward off the hailstorm							0
	Hailstorm	It is given by the bad behaviour of a neighbour with nature					1		1
	Glass with water	Ask for rain			1				1
	Smoke	To prevent frost from damaging the crop	2	1	2	2	4	4	15
	Irrigation	To mitigate frost damage and prevent	4	4	2	3	2	1	16
	Plastic bottles	To prevent frost from damaging the crop		1	1		1	1	4
	Pleadings	Various prayers are made for the recovery of the crops, avoid hailstorms, ask for rain, etc. Images are taken to the hills, masses are held, the image of the Virgin is taken to the plots, it is requested on its knees, it is invoked.		1	1		2	1	5
	Pal bouquets and ashes	To face the hailstorm					1		1
	K'oa	Thanks to Pachamama for planting	1	3	2				6
		For the recovery of crops		1					1
	San Isidro	It is asked to be a good agricultural year	1		1		1		3

ACADEMIC CURRICULUM VITAE

1. Education

- 2019 - Present **PhD in Bioscience Engineering: Socioeconomics**
Ghent University, Belgium
- 2021- Present **Postgraduate Diploma in Higher Education Teaching**
Universidad Católica Boliviana "San Pablo", Bolivia
- 2014 **Postgraduate Diploma Landscape Analysis: Tool for Management and Territorial Planning**
Fondo Verde, Spain
- 2010 - 2012 **Master of Science in Development and Rural Innovation**
Wageningen University and Research Centre, Netherlands
- 2001 - 2004 **Bachelor in Environmental Engineering**
Universidad Católica Boliviana "San Pablo", Bolivia

2. Academic experience

- 2019 - Present **Full time professor and researcher**
Universidad Católica Boliviana "San Pablo"
Department of Exact Sciences and Engineering
- 2022 **Guest lecturer**
Universidad de Córdoba, Spain
Fundamentals of Urban Agriculture
- 2021 **Graduate lecturer**
Universidad Católica Boliviana "San Pablo".
Communication Applied to Children's Rights and Corporate Restoration.
Sustainability Reports
- 2021 **Guest lecturer**
IMPROMO Latinoamericano
Management of Socio-Ecosystems in the Andes course
- 2013 – 2017 **Agrobiodiversity research consultant**
Bioversity International
Data validation in La Paz, Bolivia
Supporting agrobiodiversity maintenance and use in the context of land management decisions. For the Bolivian and Cuban case study
Provision of information on agro-biodiversity concepts and methods in Bolivia

- Linking ex-situ with on-farm conservation in Bolivia.
- Linking farmland Biodiversity to Ecosystem services for effective ecofunctional Intensification: A database and glossary. Agrobiodiversity and Ecosystem Services Programme in Bolivia
- 2017 **Ministry of Health of the Plurinational State of Bolivia**
- Led the diagnostic evaluation for the use and management of pesticides in agriculture in Bolivia
- 2017 **Instituto de Formación Femenino Integral**
- Economic valorization of housework in the municipalities of Colcapirhua and Quillacollo in Bolivia
- 2014 - 2015 **Research assistant**
- Universitat Autònoma de Barcelona, Institute for Environmental Science and Technology*
- Socio environmental management of the mining sector in Bolivia
- 2013 - 2013 **Research Advisor**
- Gaia Pacha & PROSUCO*
- Citizens' actions for climate change adaptation in Villa Coronilla in Bolivia
- 2012 - 2013 **Research fellow**
- Biodiversity International*
- Landscape, climate change and agro-biodiversity in Bolivia
- 2012 - 2012 **Research Intern**
- Biodiversity International*
- Roles and responsibilities of custodian farmers in communities near Lake Titicaca
- 2011 **Researcher**
- Gaia Pacha & Fundación para la Investigación Estratégica de Bolivia*
- Impact on municipal policies of climate change adaptation actions developed by communities in three regions of Bolivia: Aiquile, Challapata, and Padcaya in Bolivia
- 2008 - 2009 **Project coordinator**
- COSUDE & Gaia Pacha*
- Conversations that germinate in knowledge. Local management of biodiversity. perceptions of climate change in Bolivia
- 2008 - 2009 **Project coordinator**
- IMO LA, FAUTAPO, & Gaia Pacha*

Economic, socio-cultural, and ecological sustainability of the organic production of quinoa in the Southern Highlands in Potosí in Bolivia

3. Short courses, seminars, and others

Present	Wageningen University and Research Centre. MOC Nutrition and Health: Macronutrients and Overnutrition
2022	Gent University How to Get Published
2022	Universidad Católica Boliviana “San Pablo” Cómo Publicar en Revistas de Alto Impacto
2021	Wageningen University and Research Centre. MOOC Sustainable and Inclusive Landscapes
2020	Academic English Now Academic Writing Mastery
2018	TU Delft, Wageningen University and Research Centre; Amsterdam Institute for Metropolitan Solutions. MOOC Sustainable Urban Development
2017	Helvetas Swiss Intercooperation Training Workshop on Guidelines for Decision Making in Resilient Infrastructure Projects with a Focus on Disaster Risk Reduction and Adaptation to Climate Change. Bolivia
2015	Institute of Fundamental Research in Tropical Agriculture Short Course at the II International Congress of urban, suburban, and family agriculture. Cuba
2014	Natural Capital Project Training in the InVEST/RIOS approach to Natural Capital Project. Costa Rica
2014	FAO Núcleo de Capacitación en Políticas Públicas. Online Urban and Peri – Urban Agriculture as a Tool for Urban Food Security and the Fight Against Hunger at the Municipal Level
2014	Transforum. Michigan State University. MOOC Metropolitan Agriculture
2014	Stanford University. MOOC Introduction to Ecosystem Services
2005	Ecotop SRL.

6th International Workshop in Sucesional Agroforestry Systems.
Bolivia

4. Peer reviewed publications

- Gruberg, H., Dessein J., D'Haese, M., Alba E., & Benavides, J. (2022). Eroding Traditional Ecological Knowledge. A case study in Bolivia. *Human Ecology*, 50, 1047–1062. <https://doi.org/10.1007/s10745-022-00375->
- Gruberg, H., Dessein J., D'Haese, M., & Benavides, J. (2022). Power relations in the co-creation of water policy in Bolivia – beyond the tyranny of participation. *Water Policy Journal*. 24(3), 569–587. <https://doi.org/10.2166/wp.2022.325>
- Gruberg, H. (2019). Una revisión de los enfoques transdisciplinarios para la co-creación de la soberanía alimentaria. *Acta Nova*, 9(3), 329-356. Available at http://scielo.org.bo/pdf/ran/v9n3/v9n3_a03.pdf
- Meldrum, G., Mijatović D., Rojas, W., Flores J., Pinto, M., Mamani, G., Condori, E., Hilaquita, D., Gruberg, H. & Padulosi S. (2017). Climate change and crop diversity: farmers' perceptions and adaptation on the Bolivian Altiplano. *Environment, Development and Sustainability*, 20, 703-730. <https://doi.org/10.1007/s10668-016-9906-4>
- Azero, M. & Gruberg, H. (2009). Evaluación de la sostenibilidad económica, sociocultural y ecológica de la agroforestería sucesional en tres estudios de caso en la zona de Alto Beni, Bolivia. *Acta Nova*, 4(2-3), 236-262. Available at http://www.scielo.org.bo/pdf/ran/v4n2-3/v4n2-3_a04.pdf

5. Congress publications

- Gruberg, H. et al. (2022, November). Relaciones de poder y participación en la (co)creación de una política sobre agua. Abstract. *VIII Congreso Latinoamericano de agroecología*. Montevideo, Uruguay: SOCLA.
- Gruberg, H. et al. (2020, November). Relaciones de poder y participación en la (co)creación de una política sobre agua. Poster. *VIII Congreso Latinoamericano de agroecología*. Montevideo, Uruguay: SOCLA.
- Gruberg, H. et al. (2020, September). Power, legitimacy, and participation in the co-Creation of water policy. Presentation. *Food policy and governance: Examining linkages and food security outcomes. Tropentag 2020. Food and Nutrition Security and its Resilience to Global Crises*. 302. Germany: Tropentag.
- Gruberg, H. (2020). Co-creación transdisciplinaria de soberanía alimentaria P3. Soberanía alimentaria y nutrición. Poster. *Joint Steering Committee*. Cochabamba, Bolivia: UCB.

6. Other publications

- Jimenez, S. & Gruberg, H. (2020). Estado de situación legal y legítima para la construcción de políticas públicas en materia de soberanía alimentaria en el Municipio de Tiraque. *Cuadernillo de Investigaciones - Artículos de discusión sobre derechos humanos P4*. Cochabamba, Bolivia: UCB.
- Catacora, L., Cabrera, M., Gruberg, H. & JP. Benavides. (2020). *Retos y oportunidades del sector agroalimentario nacional y la crisis sanitaria del COVID – 19*. Policy Brief N°2. La Paz, Bolivia: IISEC. Available at

https://www.iisec.ucb.edu.bo/assets_iisec/publicacion_observatorio/ULTIMO_pdf_Polic_y_Brief_No_2_COVID-AGRO_JP_HGC-FW.pdf

- Gruberg, H. (2018). *Agenda de Acciones Resilientes para la Región Metropolitana "Kanata"*. Report. Gobernación de Cochabamba. Secretaría Departamental de Planificación. Equipo Técnico de la Región Metropolitana Kanata. Helvetas Bolivia. Cochabamba, Bolivia: Government Printing Office.
- Gruberg, H. & Mijatovic, D. (2017). Granos andinos y un entorno cambiante. In *Revalorización de productos nativos subutilizados. Amaranto, Cañahua, Isaño, Quinua, Racacha, Tarwi, Yacón*. Latincrop, 64-66, La Paz, Bolivia.
- Gruberg, H., Mijatovic, D. & Rojas, W. (2017). Instituciones locales y la conservación de la agrobiodiversidad, Bolivia. *Revista LEISA*. 33(1). Lima, Perú: LEISA.
- Gruberg, H. (2017). The ecological cultivation of coca in Bolivia, the situation and market challenges. *The Organic Standard. Standards and Regulations*. 169(2017), 11-14. Barcelona, Spain: TOS.
- Andreucci, D. & Gruberg, H. (2015). *Evaluación de la gestión socio-ambiental del sector minero en Bolivia - El caso de la cuenca del lago Poopó*. Cochabamba, Bolivia: CENDA.
- Gruberg, H., G. Meldrum, S., Padulosi, W., Rojas, M., Pinto, & T. Crane. (2013). *Towards a better understanding of custodian farmers and their roles: insights from a case study in Cachilaya, Bolivia*. Rome, Italy: Bioversity International.
- Gruberg, H. (2012). *Translating adaptation to climate change into practice. Three case studies of institutional change in Bolivia*. (Master Thesis). Wageningen, Netherlands: Wageningen University.
- Cruz D., Canedo, F., Gruberg, H., Luján, F., Pérez, C. y Zelada, E. (2012). *Cambio climático y políticas municipales: acciones en las comunidades de Aiquile, Challapata y Padcaya*. La Paz, Bolivia: PIEB-OXFAM.
- Augstburger, H., Gruberg, H. & López, R. (2009). *El tiempo se está cansando. Percepciones del cambio climático*. Cochabamba, Bolivia: COSUDE.
- Augstburger, H., Bustamante, P., Gruberg, H., and López, R. (2009). *El tiempo se está cansando. Percepciones del cambio climático*. Documentary. Cochabamba, Bolivia: COSUDE.
- Gruberg, H. (2007). *Economic, socio cultural, and ecological sustainability evaluation of sucesional agroforestry in three study cases in the Alto Beni region in Bolivia*. (Bachelor Thesis). Cochabamba, Bolivia: UCB.