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ACTIVATING INSTITUTIONAL INNOVATIONS FOR HUNGER AND POVERTY REDUCTION: POTENTIAL OF APPLIED INTERNATIONAL AGRICULTURAL RESEARCH

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DEDICATION

To my beloved mum Cresencia, my late Dads, my wife Rachael and sons Benja and Jojo.

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EXECUTIVE SUMMARY

The world faces challenges to reduce poverty, improve food and nutrition security and achieve sustainable management of natural resources with increasing population and threats such as climate change. Productivity growth, which is closely linked to investments in agricultural research, can help address these challenges. To exploit advances in agricultural science, international agricultural research was institutionalized under the CGIAR at a time when most developing nations had food shortages and faced the challenge of feeding increasing populations. The CGIAR system has made several attempts to improve its organizational structure, the latest being a reform process initiated in 2009.

A key issue that has been debated over the years is how the CGIAR centres are best placed within the range of institutions involved in agricultural research and development. Considering market failure in pro-poor agricultural research and the global mandate of the CGIAR, the concept of "international public goods" (IPGs) has been emphasized as a criterion for setting the priorities of the international centers. National systems are expected to carry out technology adaptation and dissemination. However, due to insufficient capacities in most developing countries, the CGIAR centres have become engaged in these downstream activities to ensure that the technologies they developed are indeed adopted so that impact is achieved. This strategy, however, has been criticized for placing emphasis on local development agendas at the expense of producing international public goods.

The CGIAR still faces the unresolved dilemma between a focus on upstream research that produces IPGs versus downstream activities that ensure impact. Therefore, there is a need to review the CGIAR's position on this important question, and to obtain the views of centre scientists and other actors on this question. It is equally important to develop objective approaches to assess the comparative advantage of the CGIAR within the spectrum from

upstream research on IPGs to downstream technology dissemination, taking context-specific factors, such as national capacities into account. Case studies are suitable to better understand what works in diverse circumstances and the conditions that have, so far, driven centres to engage in downstream activities.

To fill these knowledge gaps, this study used a comparative qualitative case study approach focusing on the legume breeding program of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The studies were conducted in India, Malawi and Ethiopia, a set of countries that makes it possible to study variation in the capacity of national systems. Data was gathered using a combination of methods including a participatory mapping technique called Net-map, expert opinion interviews and a review of relevant documents. Respondents were purposively selected and included ICRISAT scientists, national partners, non-governmental organizations (NGOs), seed corporations, male and female farmers and other stakeholders involved in the research and promotion of improved groundnut and chickpea varieties. The interviews were tape-recorded and transcribed in verbatim and analyzed using a qualitative data analysis software (NVivo). The themes and insights emerging through the coding process served as a basis for discussion and further analysis.

The narrative policy analysis confirms that there are contrasting views on whether the CGIAR should primarily focus on the production of IPGs, or also conduct more uptake-oriented activities. The dominant story identified in the analysis is that the IPG concept is ideal for framing CGIAR research in a niche that would not be served by the private sector or national systems. The counterstory is that the CGIAR can only achieve impact if attention is paid to both research and development-oriented activities that enhance uptake. In view of these contrasting views, which cannot easily reconciled, there is a need to develop objective and practical criteria for assessing the comparative advantage of the CGIAR, taking context-specific factors into account. To fulfil this objective, a cost-effectiveness approach is

proposed for identifying the comparative advantage of different actors for different activities. This efficiency-oriented approach aims at achieving maximum welfare gains from available resources.

Using the case studies to illustrate the transactions involved in the development and uptake of technologies, propositions are derived regarding the attributes of transactions for which international agricultural research centres (IARCs) have a comparative advantage over national systems. The analysis indicates that basic and strategic research transactions, such as molecular breeding, have high economies of scale and spillover potential and should ideally be carried out by IARCs. On the other hand, adaptive research, promotion and seed multiplication transactions have low economies of scale and spillover potential and should therefore be ideally assigned to national systems. Besides these two attributes, which are also highlighted in the literature on international public goods, the analysis revealed that transaction intensity and the scope for elite capture and corruption also influence the comparative advantage of the CGIAR centres.

Applying this normative framework to the case studies, the influence of contextual factors, especially capacity of national systems, emerges as critical factor. Even though the legume varieties developed by ICRISAT fitted agro-ecological conditions in the target countries, the adoption of these varieties was hampered by institutional constraints. All legumes varieties included in the case studies remained “on the shelf” after their release until ICRISAT got itself involved in seed production and promotion. This finding indicates that the CGIAR centres may therefore have to apply different positioning strategies because of variations in the institutional environment across locations and commodities. The centres have to act as boundary organizations and innovation brokers to activate uptake. In some cases, such as Malawi, ICRISAT had to engage in technology adaptation, promotion and seed multiplication. However, this strategy is problematic in the long run as it crowds out national

systems and reduces the incentives of governments to work to address the existing governance challenges.

Capacity building in national systems should be an important role of the CGIAR to ensure that improved varieties are sustainably adopted on a large scale. However, organizations that fund development were found to have a tendency to avoid the difficult and long-term task of capacity strengthening of national systems, and instead use the centres to fill the capacity gaps, which induced the centers to engage in downstream activities. In cases such as India, where the capacity of national systems is relatively high, the centres should play more of a facilitation and science-based advocacy role. The example of the groundnut variety ICGV91114 shows that even though the CGIAR centres may have the capacity to push for certain changes, bypassing national procedures may have the effect that they are perceived as a competitor.

Decision-making and resource allocation for research under the CGIAR Research Programs (CRPs) should therefore take into account the issue of NARES capacity. The centers should constantly assess capacities of national systems to carry out activities that will enable impact in their target locations, and for their mandate crops. Impact analysis should also pay more attention to the contribution of capacity building efforts to total welfare.

Finally, the centres should also manage learning from their involvement in research, as well as complementary activities. Through in-depth case studies, the CGIAR could learn important lessons from successful interventions as well as those that have experienced challenges. Analysis of innovation network dynamics at the local level can inform future innovation processes and offer strategies for application in subsequent scaling up activities.

ZUSAMMENFASSUNG

Armutsminderung, Ernährungssicherung und die nachhaltige Bewirtschaftung natürlicher Ressourcen stellen angesichts von zunehmendem Bevölkerungswachstum und Klimawandel besondere globale Herausforderungen dar. Produktivitätswachstum und damit verbundene Investitionen in Agrarforschung können dazu beitragen, diese Herausforderungen besser zu bewältigen. Um sich die Errungenschaften der Agrarwissenschaften zunutze zu machen, wurden die internationalen Agrarforschungszentren in der Consultative Group on International Agricultural Research (CGIAR) vereint, was zu einem Zeitpunkt geschah als die meisten Entwicklungsländer unter Nahrungsmittelknappheit litten und vor der Herausforderung standen, eine kontinuierlich ansteigende Bevölkerung zu ernähren. Die CGIAR hat mehrfach versucht, ihre Organisationsstruktur zu verbessern – zuletzt durch einen Reformprozess, welcher im Jahre 2009 angestoßen wurde.

Ein Hauptthema, welches in den letzten Jahren vermehrt diskutiert wurde, beschäftigt sich mit der Frage, wie sich die CGIAR-Zentren innerhalb der Vielzahl an Institutionen, welche in die Agrarforschung und -entwicklung eingebunden sind, am besten positionieren können. Als Ergebnis von Marktversagen im Bereich der armutsorientierten Forschung und unter Berücksichtigung des weltweiten Mandats der CGIAR, wurde das Konzept der internationalen öffentlichen Güter wiederholt diskutiert und als wichtiges Kriterium benannt, um Prioritäten zu setzen und Übertragungseffekte zu gewährleisten. Es wird üblicherweise erwartet, dass nationale Forschungssysteme Aufgaben der Technologieentwicklung und -verbreitung übernehmen. Aufgrund von Kapazitätsmangel in den meisten Entwicklungsländern haben jedoch häufig die CGIAR-Zentren diese Aktivitäten übernommen. Dieser Ansatz wurde aber kritisiert, zumal ein zu großer Schwerpunkt auf lokale Entwicklung gesetzt wird und sich zu wenig um die Produktion von internationalen öffentlichen Gütern gekümmert wird.

Die CGIAR steht somit vor der Wahl, einen Forschungsschwerpunkt zu verfolgen, welcher internationale öffentliche Güter hervorbringt oder Aktivitäten zu fördern, die unmittelbare lokale Wirkungen herbeiführen. Vor diesem Hintergrund ist es nicht nur notwendig, die Einstellung der CGIAR zu untersuchen, sondern auch die Perspektiven anderer Wissenschaftler und Akteure besser zu verstehen. Hierzu ist eine Entwicklung objektiver Ansätze unabdingbar, um die komparativen Vorteile der CGIAR zu bewerten. Fallstudien erscheinen besonders gut dafür geeignet, um besser verstehen zu können, was unter vielfältigen Umständen funktioniert und welche Faktoren die Entscheidungen der Zentren letztlich beeinflussen. Die vorliegende Studie versucht diese Forschungslücke zu schließen, indem sie vergleichende Fallstudien als qualitativen Forschungsansatz verfolgt, um das Leguminosen-Züchtungsprogramm des International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) zu untersuchen. Um Variabilität in der Leistungsfähigkeit der nationalen Forschungssysteme herzustellen, wurde die Studie in Indien, Malawi und Äthiopien durchgeführt. Daten wurden anhand mehrerer Methoden erhoben, z.B. durch die partizipatorische Methode ‘Netmap‘, Interviews und Auswertung von Dokumenten. Die Befragten, welche durch eine bewusste Stichprobe ausgewählt wurden, umfassten Forscher von ICRISAT, nationale Partner, Nichtregierungsorganisationen (NROs), Saatgut-Unternehmen, Landwirte (männlich und weiblich) sowie andere Akteure, welche in die Forschung und Förderung von verbesserten Erdnuss- und Kichererbsen-Sorten involviert sind. Die Interviews wurden aufgenommen, wörtlich transkribiert und mithilfe der Software ‚NVivo‘ analysiert. Die Leitmotive und Erkenntnisse, welche sich aus dem Coding-Verfahren ergeben haben, dienten als Basis für die Diskussion der Ergebnisse.

Die narrative Politikfeldanalyse bestätigte, dass eine Kontroverse besteht hinsichtlich der Frage, ob sich die CGIAR vorrangig auf die Förderung von internationalen öffentlichen Gütern spezialisieren sollte oder ob diese auch vermehrt Aktivitäten übernehmen sollte,

welche die eigentliche Anwendung von Produkten vor Ort fördern. Es hat sich einerseits herausgestellt, dass das Konzept der internationalen öffentlichen Güter treffend ist, um die CGIAR-Forschung zu beschreiben, da diese weder durch den Privatsektor noch durch nationale Systeme abgedeckt wird. Eine gegensätzliche Perspektive ist, dass die CGIAR nur Wirkungen erreichen kann, wenn das Augenmerk sowohl auf Forschung als auch auf entwicklungsorientierten Maßnahmen, die lokale Anwendung fördern, gerichtet wird. Es ist deshalb unabdingbar, objektive und praktikable Kriterien zu entwickeln, um komparative Vorteile bewerten zu können. Die Studie schlägt einen kosteneffektiven Ansatz vor, um die Aktivitäten den relevanten Akteuren so zuordnen zu können, damit mit den gegebenen Ressourcen maximale Wohlfahrtsgewinne erzielt werden können.

Basierend auf den Fallstudien, welche die beteiligten Transkationen verdeutlichen, werden Vorschläge bezüglich der Eigenschaften von Transaktionen erarbeitet, für welche die Internationalen Agrarforschungszentren (IARCs) einen komparativen Vorteil gegenüber nationalen Systemen besitzen. Grundlegende und strategische Transaktionen, wie molekulare Züchtung, haben eine hohe Spezifität, Skaleneffekte sowie Übertragungspotential und sollten deshalb idealerweise durch die IARCs ausgeführt werden. Hingegen haben anpassungsfähige Forschung sowie Saatgutvermehrung eine hohe Transaktionsintensität und sollten deshalb idealerweise den nationalen Systemen zugewiesen werden.

Bei der Anwendung dieses normativen konzeptionellen Rahmens auf die Fallstudien wurde deutlich, dass kontextspezifische Faktoren - insbesondere die Leistungsfähigkeit nationaler Systeme - eine wichtige Rolle spielen. Obwohl die von ICRISAT entwickelten Leguminosen-Sorten an die agrarökologischen Bedingungen der Zielländer angepasst sind, so wird ihr tatsächlicher Einsatz häufig durch institutionelle Hindernisse eingeschränkt. Alle Leguminosen-Sorten blieben nach ihrer Freigabe zunächst eingelagert, bis ICRISAT Akteure explizit dazu aufforderte, die Saatgutproduktion weiter voranzutreiben. Aufgrund der

unterschiedlichen institutionellen Kontexte hinsichtlich Standorten und Produkten wäre es angebracht, wenn sich die CGIAR-Zentren dementsprechend strategisch positionieren würden. Die Zentren müssen sowohl als begrenzte Organisationen als auch als Vermittler von Innovationen agieren, um die Anwendung von neuen Produkten besser zu fördern. In einigen Fällen, wie Malawi, war ICRISAT maßgeblich in die Technologieentwicklung, Förderung und Vermehrung von Saatgut eingebunden. Dies kann jedoch nicht auf Dauer funktionieren, da nationale Systeme längerfristig verdrängt würden und die Anreize für Regierungen verringert würden, die vorhandenen Governance-Herausforderungen zu bewältigen.

Bei der Förderung von Handlungskompetenzen und Wissen sollte die CGIAR eine wichtige Rolle spielen, um sicherzustellen, dass verbesserte Sorten nachhaltig und in großem Maßstab verwendet werden. Es konnte jedoch beobachtet werden, dass Entwicklungshilfeorganisationen davor zurückschrecken, Kapazitäten aufzubauen, zumal es sich hier erfahrungsgemäß um einen langwierigen Prozess handelt. Wenn die Leistungsfähigkeit des nationalen Forschungssystems gut ausgebaut ist, wie im Falle Indiens, sollten die Zentren eher eine Rolle des wissensbezogenen Vermittlers einnehmen. Das Beispiel der Erdnusssorte ICGV91114 zeigt, dass die CGIAR-Zentren zwar bestimmte Veränderungen vorantreiben können, dass sie jedoch durch das Umgehen nationaler Vorgehensweisen auch als Konkurrent wahrgenommen werden.

Letztlich könnten die Zentren durch ihre Einbindung in angewandte Forschung und die damit verbundenen Aktivitäten lernen. Durch vertiefende Fallstudien könnte die CGIAR wichtige Erkenntnisse sowohl aus erfolgreichen Interventionen gewinnen als auch aus solchen mit Herausforderungen. Die Analyse der Dynamiken von Netzwerken auf lokaler Ebene bietet wichtige Einblicke für zukünftige Innovationsprozesse und deren weitere Verbreitung.

LIST OF ABBREVIATIONS

ADD - Agricultural Development Division

ADMARC - Agricultural Development and Marketing Corporation

AICRP-C - All India Coordinated Research Project on Chickpea

AICRP-G - All India Coordinated Research Project on Groundnut

AKIS - Agricultural Knowledge and Information Systems

AIS - Agricultural Innovation Systems

ANGRAU - Acharya N G Ranga Agricultural University

AOSCA - Association of Official Seed Certifying Agencies

AP - Andhra Pradesh State of India

APSSDC - Andhra Pradesh State Seeds Development Corporation

AR4D - Agricultural Research for Development

ARI - Advanced Research Institute

ASSMAG - Association of Smallholder Seed Multiplication Action Group

ASTI - Agricultural Science and Technology Indicators

AusAID - Australian Agency for International Development

BAA - Benchmark Area Approach

BMGF - Bill and Melinda Gates Foundation

BMZ - German Federal Ministry for Economic Cooperation and Development

BoARD - Bureau of Agriculture and Rural Development

CGIAR - Consultative Group on International Agricultural Research

CIAT - International Centre for Tropical Agriculture

CIFOR - Centre for International Forestry Research

CIMMYT - International Maize and Wheat Improvement Centre

CIP - International Potato Centre

CP - Challenge Program

CRP - CGIAR Research Program

DAAD - German Academic Exchange Service

DARS - Department of Agricultural Research Services

DoA - Department of Agriculture

DZARC - Debre Zeit Agricultural Research Centre

EIAR - Ethiopian Institute of Agricultural Research

EPMR - External Program and Management Review

ESE - Ethiopian Seed Enterprise

ExCo - Executive Council of the CGIAR

FAO - Food and Agriculture Organization

FTCs - Farmer Training Centers

FSC - Food Security Centre

GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit or

IADB - Inter-American Development Bank

IAEG - Impact Assessment and Evaluation Group

IARC - International Agricultural Research Center

IBPGR - International Board for Plant Genetic Resources (now Bioversity International)

ICARDA - International Centre for Agricultural Research in the Dryland Areas

ICRAF - International Centre for Research in Agroforestry

ICRISAT - International Crops Research Institute for the Semi-Arid Tropics

IDRC - International Development Research Centre

IFAD - International Fund for Agricultural Development

IFPRI - International Food Policy Research Institute

IITA - International Institute of Tropical Agriculture

ILCA - International Livestock Centre for Africa (merged into ILRI)

ILRAD - International Laboratory for Research on Animal Diseases (merged into ILRI)

ILRI - International Livestock Research Institute

IPG - International Public Good

IRRI - International Rice Research Institute

ISNAR - International Service for National Agricultural Research

ISPC - Independent Science and Partnership Council

IWMI - International Water Management Institute

KVK - Krishi Vigyan Kendras (farm science centres)

MASA - Malawi Seed Alliance

MDG - Millennium Development Goal

MoAFS - Ministry of Agriculture and Food Security

MoU - Memorandum of Understanding

NARS - National Agricultural Research Systems

NASFAM - National Smallholder Farmers' Association of Malawi

NGO - Non-Governmental Organization

NIE - New Institutional Economics

NSC - National Seed Company

OECD - Organization for Economic Co-operation and Development

QDS - Quality Declared Seed

RARI - Regional Agricultural Research Institute

SADC - Southern African Development Community

SAU - State agricultural university

SC - Science Council

SFCI - State Seeds Corporation of India

SPIA - Standing Panel for Impact Assessment

SRF - Strategy and Results Framework

SSU - Seed Services Unit

TAC - Technical Advisory Committee of the CGIAR

TCE - Transaction Cost Economics

TLII - Tropical Legumes II Project

TLS - Truthfully Labelled Seed

TVET - Technical and Vocational Education Training

UNDP - United Nations Development Programme

USAID - United States Agency for International Development

WARDA - West Africa Rice Development Association (now AfricaRice)

WFC - Worldfish Centre (formerly International Center for Living Aquatic Resources Management - ICLARM)

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

Agriculture, besides providing food for the world population, plays an important role in the livelihoods of rural populations across the globe. Ironically, farmers in developing countries are among the poorest and worst hit by hunger (FAO et al., 2014). The problem is exacerbated by increasing populations, land and water constraints and degradation, insufficient investment in rural infrastructure and extension, increasing threats from climate change and lack of access to credit and agricultural inputs (von Braun et. al., 2008). As the Millennium Development Goals (MDGs) are reviewed, achievement of the first MDG, which targeted to halve poverty and hunger by 2015, is highly dependent on agricultural growth. Improved agriculture also plays a role in other interrelated MDGs such as ensuring environmental sustainability, promotion of gender equality and empowerment of women, reduction of child mortality and improvement of maternal health.

1.1 Importance of agricultural research

Agricultural research has been a key factor in increasing world food production in the last half century. Investments in agricultural research make significant contributions to productivity growth (Renkow and Byerlee, 2010; IAASTD, 2008; Raitzer and Kelley, 2008; Pardey et al., 2006; Evenson and Gollin, 2003; Alston et al., 2000). This is also evidenced by the Green Revolution during which adoption of high yielding varieties and other complementary inputs and practices such as irrigation, fertilizers and improved crop management practices resulted in increased food production and doubled yields, especially in favorable environments. Advances in agricultural research have also contributed to the development of improved breeds of livestock and fish as well as better tree varieties that have benefited many developing countries in livestock production, aquaculture, agroforestry and mixed crop-livestock systems. These achievements are expected to increase and stabilize food supplies,

lower food prices for both urban and rural consumers, reduce reliance on food aid and increase livelihood opportunities and incomes through agriculture-led economic growth (Hazell and Haddad, 2001).

Taking into account the heterogeneous nature of poverty and existing institutional weaknesses, a concerted research and development (R&D) effort is required to achieve agricultural growth especially in less favored areas. In recognition of the potential of agricultural research in reducing hunger and poverty, world leaders and the international community called for support for agricultural science and technology following two decades of underinvestment.

In the recent years, interest in agricultural research has grown with the World Development Report of 2008 (World Bank 2007) and "L'Aquila" Joint Statement on Global Food Security[1], stressing the importance of agriculture-led growth to address development challenges in least developed and developing countries. African leaders also committed to invest in agriculture under the Comprehensive Africa Agriculture Development Program (CAADP). CAADP aims to eliminate hunger and reduce poverty through agriculture. To achieve this, African governments agreed in the 2003 Maputo Declaration to increase public investment in agriculture by a minimum of 10 per cent of their national budgets and to raise agricultural gross domestic product by at least 6 per cent[2] yearly for nations where agriculture plays a major role in the economy. The context is also changing as the private sector is taking up a bigger role in research. National research systems in some countries such as Brazil, China and India have also made quick advances and are playing a growing role in agricultural research.

Despite these advances and high-level political recognition of the importance of agricultural research, many developing countries especially in Africa have been bypassed by the benefits

[1] Statement issued in July 2009 by a G8 leaders meeting held in L'Aquila, Italy.
[2] http://www.nepad-caadp.net/

even though agriculture contributes significantly to their economies (Reifschneider and Hussain, 2004). The "State of Food Insecurity in the World" report of 2014 (FAO et al., 2014) notes that over 800 million people are estimated to be chronically undernourished in 2012 - 14 and the developing world is not on track to achieve the target of halving the number of undernourished people by 2015. Agricultural research still faces several challenges including the need to meet the rising demand for food with a projected world population of 9 billion people by 2050. There is a need to achieve these targets while at the same time protecting the diminishing natural resources that communities depend on such as energy sources, water, soils, forests, fisheries, wildlife among others. This has led to new emphasis on concepts such as bioeconomy[3] to transition to more resource efficient societies that use renewable biological resources to satisfy consumers' needs, industry demand and tackle climate change.

There is still limited agricultural research capacity in many low-income countries. In Sub-Saharan Africa, increased agricultural production has mainly resulted from a rise in the amount of land cultivated rather than intensification (World Bank, 2007), which puts pressure on natural resources. There is a knowledge gap as to how agricultural research for development can be effectively organized so as contribute to development and poverty reduction in a sustainable way. The main challenge that has remained unaddressed and is increasingly becoming important is the appropriate institutional organization to ensure uptake and impacts among the rural poor.

1.2 The need for coordination and integration in agricultural research

Resources for research are limited and the needs are many. Coordination and integration are therefore required to avoid duplication, enable sharing of lessons and make research more cost-effective (Sumberg, 2005). The concept of aggregation of knowledge production refers to

[3] http://ec.europa.eu/research/bioeconomy/

the way in which scarce resources for research can most effectively be apportioned among nations with different competencies to cost-effectively generate beneficial social outcomes (Spielman, 2007). The comparative advantage principle can help define responsibilities of different stakeholders in knowledge production and use. Even before independence, integration of research efforts was practiced in African colonies. Faced by financial constraints, the research administrators during the colonial period set up regional research institutes so as to exploit economies of scale and research spillovers instead of maintaining research systems in each country (Eicher and Rukuni, 2003). International agricultural research is one way in which research efforts can be integrated.

Another justification for international coordination of agricultural research is the weak capacity of national agricultural research systems (NARS). In developing nations, the average rate of return to NARS is much lower compared to international agricultural research centers (IARCs) (von Braun et al., 2008. Public funding for agricultural research also diminished over the years, more so in agriculture-based countries (Lynam et al., 2012; World Bank, 2007). International agricultural research has stepped in to exploit advances in agricultural science in lifting productivity (Zeigler and Mohanty, 2010).

1.3 Importance of legumes

Legumes make significant contributions to diets of the poor in developing countries. They are more affordable than animal sources of protein and can thus be referred to as "poor people's meat"[4]. They are also rich in oil and micronutrients such as iron and zinc, which are often deficient in the diets of the poor. At the same time, legumes also play an important role by biologically fixing nitrogen, which maintains soil fertility. This reduces the costs of fertilizer

[4] http://grainlegumes.cgiar.org/why-grain-legumes-matter/

use at the farm level and also minimizes externalities such as pollution and the climate change impacts of fossil fuel used to produce fertilizer.

Farming systems involving legumes in rotation or as an intercrop allow farmers to get more food from their land, and also reduce risk as one of the crops can escape extreme events such as droughts. Legumes such as chickpea have a deep rooting system that can withstand droughts by taking up water deep within the soil profile (Parthasarathy Rao et al., 2010). Legumes in rotation make use of residual soil moisture allowing for the growing of a second crop. They also break weed and disease cycles and act as cover crops reducing soil erosion.

In mixed crop-livestock farming systems, leaves, stems, pod walls and grain residues are a source of protein that enhance the nutritional value to cereal straw feeds improving animal health and productivity. Women often cultivate crops like groundnut for urban and export markets and benefit from employment created from local processing of the legumes.

Chickpea and groundnut were chosen for this study as they are widely grown in developing countries (Table 1-1), but their seed systems have not been adequately developed. Chickpea (Cicer arietinum L.), originally from Anatolia in Turkey, is the world's second-largest cultivated food legume. ICRISAT and the International Centre for Agricultural Research in the Dry Areas (ICARDA) have global mandate for the improvement of chickpea in the semi-arid tropics and dry temperate regions (Shiferaw et al., 2004). World chickpea production is over 11 million tonnes, with over 90 percent of area in developing countries (Table 1-1). There are two types[5] of chickpea - Desi and Kabuli - with Desi accounting for about 85 percent area[6]. India is the world's biggest producer and consumer chickpea, with over 66 percent of production. Other major producers of chickpea are Pakistan, Turkey, Iran, Myanmar, Australia and Canada.

[5] Desi type chickpea has a thick, colored seed coat and colored flowers. The kabuli type has a thin, white seed coat and white flowers.
[6] https://www.integratedbreeding.net/chickpea-facts-figures

Table 1-1 Distribution of Groundnut and Chickpea Area Across Regions

Region	Groundnut (%)	Chickpea (%)
Asia	63.9	84.6
Africa	27.3	5.5
Asia + Africa	**91.2**	**90.1**
Americas	8.7	3.9
Europe	-	0.9
Oceania	0.1	5.2

Source: Average of triennium 2010-2012 from FAOSTAT data

The origin of groundnut (Arachis hypogaea) is South America from where it spread in tropical, sub-tropical and warm temperate areas across the world. World groundnut production is over 41 million tonnes, with over 90 percent of area in developing countries (Table 1-1). Major growers include India, China, Indonesia, Myanmar, Nigeria, Sudan, Senegal, Mali, Burkina Faso, Chad, the Democratic Republic of Congo, Uganda, Malawi, Zimbabwe, Mozambique and Tanzania.

1.4 Research problem and objectives

Scientists in the CGIAR continue to develop new knowledge and improved technologies including breeding materials, crop varieties of major global food crops, natural resource management techniques, research methods and databases, agricultural machinery and others. Promising technologies are initially tested at experiment stations before being tested on farmers' fields and later introduced on a larger scale in pilot sites. Research therefore consists of the "upstream" technology development phase, and the "downstream" technology delivery phase (Kassam, 2003).

The technology adaptation and dissemination component is considered to be development work, which should be carried out by national partners with little or no involvement of international agricultural research centre (IARC) scientists. Discussions, literature and many CGIAR statements and documents on the strategic role of IARCs have often emphasized the economic point of view that the centres focus on production of international public goods that have wide applicability, accessibility and relevance across many countries (CGIAR Science Council, 2006). However, national systems in most developing countries have weak capacity implying that the CGIAR centers have had to engage in downstream activities. This has been criticized that it places emphasis on local development agendas while sacrificing the production of IPGs. Even so, some still view such a role as essential if impact is to be achieved. The CGIAR reform process, which will be discussed in more detail in the next chapter, has also put more emphasis on the achievement of CGIAR system level impacts.

In view of the persistent dilemma on how the CGIAR centres should strategically position themselves, it is important to examine the opinions of center scientists and other actors on this issue. It is also important to develop alternative approaches that will assess the comparative advantage of the IARCs more objectively. The conditions that drive centers downstream also need to be analyzed.

Therefore, the objectives of the thesis are to:

1. Analyze perspectives of different stakeholders on the dilemma regarding focus of the CGIAR on international public goods versus downstream uptake-oriented work.

2. Develop a framework to guide decision making on how the CGIAR centers should position themselves in relation to national systems.

3. Examine the underlying issues at the national level that drive CGIAR centers to conduct activities for which they may not have a comparative advantage.

1.5 Structure of the thesis

In Chapter 2, we discuss the origins of international agricultural research, establishment of the CGIAR system, its governance structure and reform efforts. We also discuss various concepts that have been put forth to define what role the CGIAR centers should play in the agricultural research for development path. Chapter 3 presents the research methods starting with a brief overview of the case study countries, and their national agricultural research and extension systems specifically for groundnut and chickpea. Theoretical concepts and analytical frameworks used in the study are introduced in brief followed by an overview of the data that was collected, how and where it was collected, and how it was analyzed.

Chapter 4 analyzes the dilemma regarding focus on IPGs versus downstream impact-oriented work. Perspectives of different stakeholders on this issue are examined using a narrative policy analysis approach (Roe, 1994). Results indicate that the IPG concept is still questionable as an approach for decision making on how the centers should position themselves. A metanarrative is therefore put forward to develop alternative criteria for determining what activities the IARCs should focus on, based on their comparative advantage.

Chapter 5 uses the case study of legume improvement at ICRISAT to illustrate the research and dissemination process of improved technologies from international agricultural research. Based on this illustration, and applying transaction cost economics (Williamson, 1991), a conceptual framework is developed to define the functional boundaries of IARCs based on their comparative advantage. The results indicate that international agricultural research plays an important role in developing improved varieties. However, due to factors such as insufficient capacity, they also engage in downstream activities that can be done more cost-effectively by national systems.

Chapter 6 goes further to analyze more closely the underlying issues in seed systems for legumes at national level that drive centers to go downstream. Results show that even in locations where the agro ecological suitability of improved legumes is high, actual spillovers are limited by political and institutional constraints. International agricultural research centers are therefore forced to apply different strategies across countries, depending on the context, sometimes engaging in downstream activities of seed production and promotion in order to achieve impact. The concluding chapter provides a discussion of the findings and offers final conclusions and recommendations the management of international agricultural research.

CHAPTER 2

THE EVOLUTION OF THE CGIAR

2. THE EVOLUTION OF THE CGIAR

International agricultural research traces its origins to the work of the Rockefeller and Ford Foundations in the 1940s and 1950s that saw the establishment of rural development programs in developing countries (Herdt, 2012). In 1943, a pilot program in Mexico developed into an innovative, sustained collaboration between local and international researchers (Ozgediz, 2012). Since most developing nations were facing food shortages and populations were rapidly increasing (Zeigler and Mohanty, 2010), the foundations invented the IARC model to exploit the emerging scientific advances to improve the lives of the poor. The Rockefeller Foundation's program in India in the 1960s comprising American and Indian scientists brought about new inventions in agricultural technology that led to the Green Revolution (Herdt, 2012).

2.1 Establishment of the CGIAR

The first two centers of the Consultative Group on International Agricultural Research (CGIAR) to be established were the International Rice Research Institute (IRRI) in the Philippines in 1960, and the International Maize and Wheat Improvement Center (CIMMYT[7]) in Mexico in 1966. These centers built on previous research and introduced dwarfing genes into wheat and rice producing semi-dwarf. These improved varieties and agronomic practices such as irrigation and fertilizer application increased yields resulting in what in commonly referred to as the green revolution. In 1967, the International Institute of Tropical Agriculture (IITA) and the International Center for Tropical Agriculture (CIAT[8]) were established to focus on smallholders in tropical and sub tropical environments in Africa and Latin America.

[7] Spanish acronym - Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)
[8] Spanish acronym - Centro Internacional de Agricultura Tropical (CIAT)

Under the leadership of champions such as Robert McNamara, a donor support group was formed with the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO) joining the World Bank as sponsors (Ozgediz, 2012). In May 1971, international agricultural research was formalized as the CGIAR system.

The CGIAR system grew rapidly in the initial years as donors and contributions increased, and new centers were added; The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT - 1972), the International Potato Centre (CIP[9] - 1972), the International Laboratory for Research on Animal Diseases (ILRAD[10] - 1973), the International Board for Plant Genetic Resources (IBPGR[11] - 1974), the West Africa Rice Development Association (WARDA[12] - 1974), the International Livestock Centre for Africa (ILCA - 1975), and the International Center for Agricultural Research in the Dry Areas (ICARDA-1976) (McCalla, 2014, page 14). Since then, the CGIAR has expanded to the current 15 centers located across the world (Figure 2-1) and focusing on commodities, agro-ecologies or production systems, natural resources, livestock and fisheries, preservation of genetic resources and institutions and policies. The "CGIAR System" is often just referred to as the "System" and the "CGIAR Centers" as the "Centers". In this thesis, these terms are also used interchangeably.

[9] Spanish acronym - Centro Internacional de la Papa (CIP)
[10] ILRAD and ILCA were later merged to form the International Livestock Research Institute (ILRI)
[11] Now Bioversity International
[12] Now AfricaRice

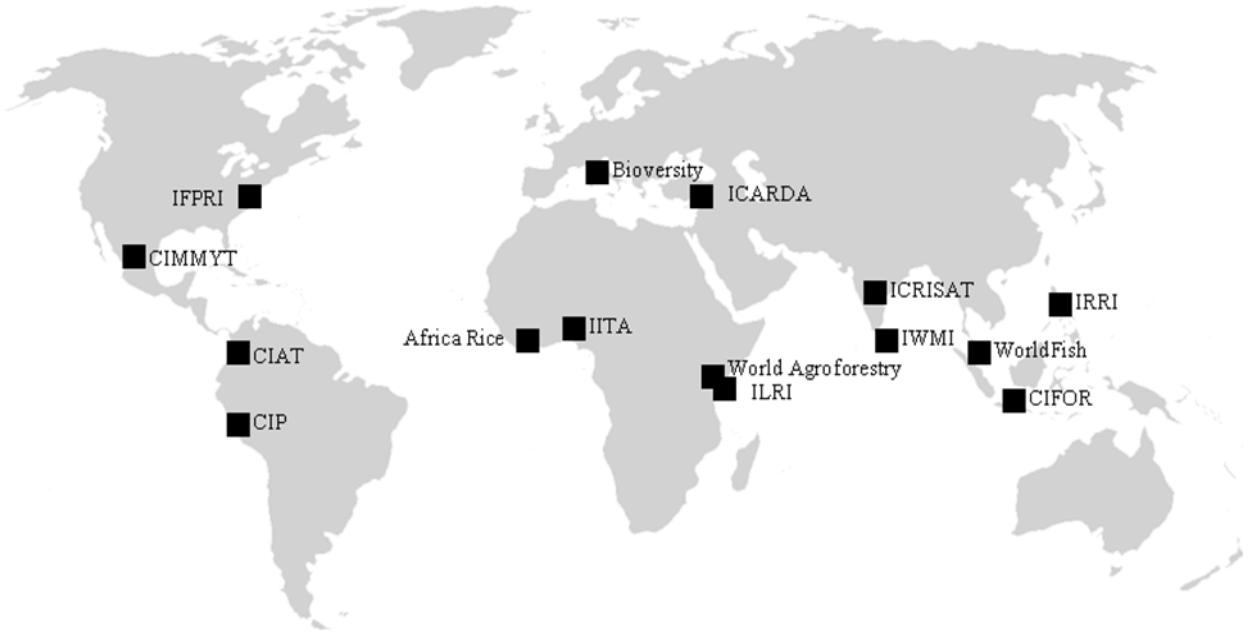

Figure 2-1 Location of CGIAR centres' headquarters.
Source: Authors, Based on CGIAR Fund (2013)

The work of the CGIAR was facilitated by the executive council (ExCo) (Figure 2-2). The technical Advisory Committee (TAC) that was later renamed as the Science Council (SC) set priorities and allocated resources (CGIAR Technical Advisory Committee, 2000). Committees were also included to provide perspectives from Non-Governmental Organizations (NGOs) and the private sector. The Impact Assessment and Evaluation Group (IAEG), now Standing Panel for Impact Assessment (SPIA), was in charge of assessing the impact of CGIAR research. Challenge programs (CPs) and system-wide programs were formed to shift financing arrangements from the centers to global and strengthen partnerships among the centers, with NARS and other actors.

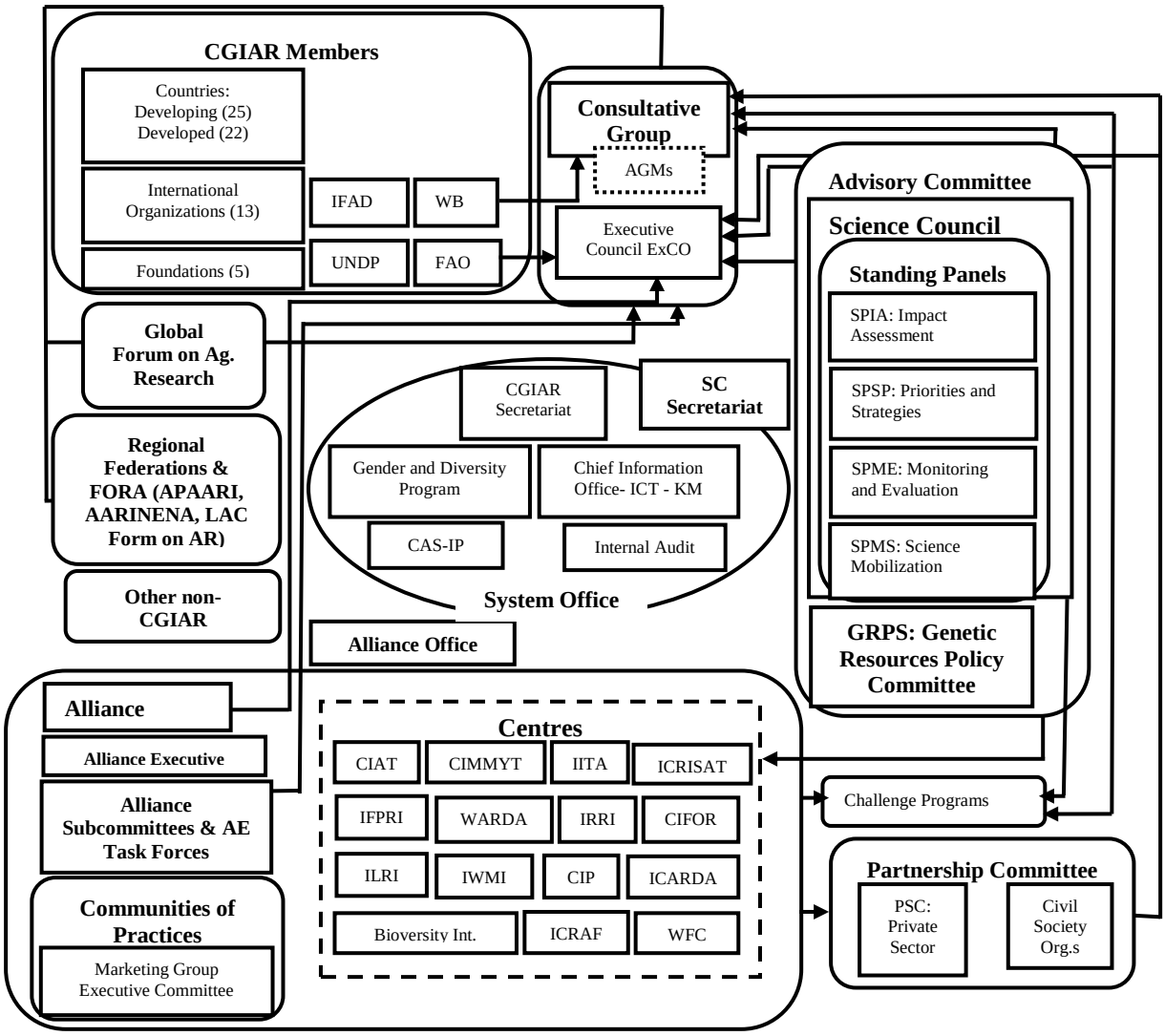

Figure 2-2 CGIAR system structure before the reform process. Source: Le Page, 2011

2.2 Reforms in the CGIAR system

In the last 40 years since its establishment, there have been several attempts to reform the CGIAR with various task forces, committees, independent reviews and others seeking to alter the structure. There have been over twenty inter-center initiatives, more food commodities have been added including forestry, fisheries, water management, policy and capacity building and new centers have been added and others merged or terminated. However, these did not lead to fundamental changes in the CGIAR system (McCalla, 2014) as the 15 centres are still the basic building blocks.

The centers faced funding shortages in the 1990's forcing them to take actions such as downsizing of staff. They were given "hunting licenses" to attract project support and increasingly relied on bilateral projects that included technology dissemination components. There was an increasing number of projects that were negotiated with donors with centers competing for funds, often duplicating efforts, and increasingly focusing on local development problems (CGIAR Science Council, 2006). There was concern that besides distorting research priorities, this shift was increasing transaction costs and reducing the efficient use of resources. Millennium development goals (MDGs) added to this trend by focusing attention to specific targets on poverty and hunger reduction. More attention has also been paid to aid effectiveness in contributing to development (Kanbur, 2001). Center management therefore became preoccupied with resource mobilization activities, and funders increasingly influenced the direction of research (Wright, 2012).

In 2008, a comprehensive review of the structure and activities of the CGIAR was carried out (CGIAR Independent Review Panel, 2008). The review noted that there was proliferation of CGIAR programs and dispersal of research focus, which impeded effectiveness. In order to effectively harness strengths and assets of different CGIAR centers and improve the organizational structure of the CGIAR system, a reform process was initiated in 2009. To best utilize the capabilities and incentives of different actors, an agricultural-research-for-development (AR4D) approach was adopted (CGIAR SRF, 2011). Research priorities would be set based on their potential contribution to system level outcomes in line with the CGIAR mission.

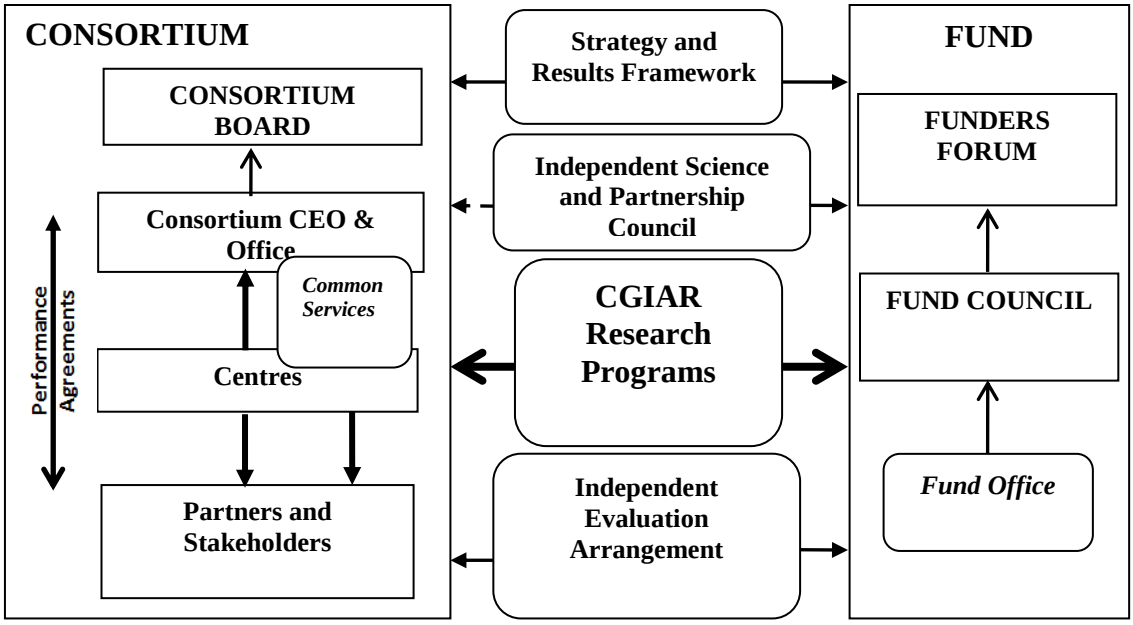

Figure 2-3 CGIAR new system structure after reform.
Source: Le Page, 2011

The centers now form the CGIAR Consortium (Figure 2-3) and research is organized under the CGIAR Research Programs (CRPs[13]). The CGIAR Fund finances the CRPs providing a single contact point for donors and ensuring research is guided by the strategy and results framework (SRF). Independent Science and Partnership Council (ISPC) is composed of a panel of experts who provide advice to the Consortium and the Fund. It was planned that approved CRPs would be financed through two windows; the first to be allocated to the CRPs by the Fund Council and the second where donors target specific CRPs (CGIAR SRF, 2011). However, donors preferred to have a third window during the transitional period so that they could continue making direct contributions to particular centers. The new CGIAR model has faced uncertainty on how donors would respond to the proposed harmonization, and the bureaucratization that comes with the CRPs (Ozgediz, 2012).

[13] http://www.cgiar.org/our-research/cgiar-research-programs/

2.3 Governance structure for international agricultural research

The types of outputs produced by CGIAR centers are classified in Table 2-1. They comprise technologies, either embodied or disembodied, and knowledge base in the form of institutional options or databases. Ekboir (2009) categorizes the products as codified such as a paper, embedded such as an improved variety, or tacit for example why an experiment failed. The respective roles of the international centers and national systems in the development and uptake of these outputs have been debated for a long time.

Table 2-1 Classification of the types of outputs from CGIAR centres

	Types of output	**Examples**
Technology	Embodied	Germplasm, parental lines, crop varieties, farm tools, equipment
	Disembodied	Natural resource management techniques, agronomic or management practices, laboratory methods and protocols
Knowledge base	Managerial, institutions and policies	Participatory approaches to plant breeding or water management, options to reduce transaction costs in input & output markets
	Databases	Genomic information of crops, simulation models, panel data on rural households, commodity situation and outlook reports

Source: Author

2.3.1 The agricultural research-development continuum

The concept of the research-development continuum is displayed in Figure 2-4. It outlines the primary domains of advanced research institutes (ARIs), a term used for research organizations located in industrialized countries, the IARCs, the national agricultural research and extension systems (NARES), non-governmental organizations (NGOs) and farmers (Craswell and de Vries', 2001; cited in CGIAR, 2006).

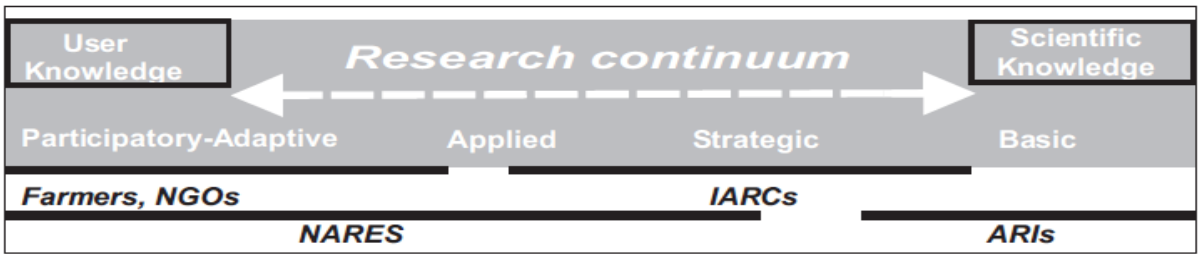

Figure 2-4 Domains of different actors along the research-development continuum. Source: CGIAR Science Council, 2006.

ARI= Advanced Research Institute, IARC= International Agricultural Research Centre, NGO= Non-Governmental Organization, NARES= National Agricultural Research and Extension System (NARES)

Four types of research are identified: basic, strategic, applied and adaptive. Basic research is designed to generate new understanding, strategic research aims for the solution of specific research problems, applied research aims to create new technologies and participatory-adaptive research is needed to adjust the technologies to the specific needs of a particular set of users (in this case, farmers) within their specific environmental conditions.

According to this concept, the CGIAR should concentrate on strategic research, which is located between the basic and the applied. This type of research is to be carried out in different countries and focuses on technologies that fit relevant ecological and production conditions across the developing world (CGIAR Science Council, 2006). The centers should collaborate with ARIs, who have their focus on basic research, and with the NARES, who cover the spectrum from strategic to applied and participatory-adaptive research. This is because not many NARS can devote significant funds for strategic research, and advanced research institutes (ARIs) based in developed countries may not have the development perspective to do research that is directly relevant to the needs of farmers (Craswell, 2006). However, this approach is too idealistic and may work for some types of activities like germplasm development, testing and variety release but not in others such as natural resource management (Sumberg, 2005).

Stokes (1997) argued that basic-applied research was a false dichotomy. It did not capture the multidimensional nature of research, and also the fact that most scientific advances were entwined with the search for practical solutions. To illustrate this point, he mapped the two in different axes, one representing the increasing search for knowledge and the other increasing practical application (Figure 2-5). Neils Bohr's work, which was purely for fundamental understanding is contrasted with Thomas Edison's, which was application-driven.

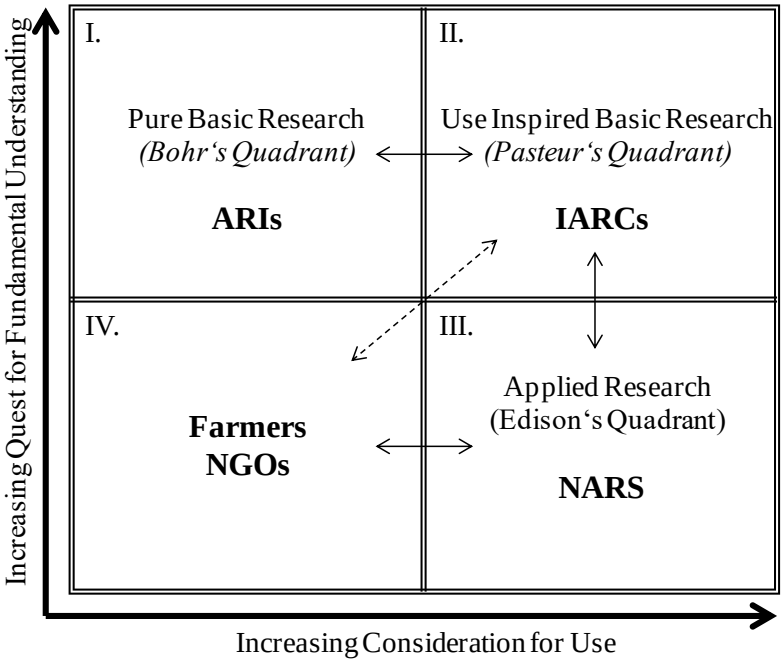

Figure 2-5 Pasteur's Quadrant.
Based on Stokes (1997) and Craswell (2006)

The upper right hand quadrant is named "Pasteur's Quadrant" following Louis Pasteur's work as a model of how these two forms of research converge. Through his work on microbial growth as well as pasteurization, Pasteur not only advanced the understanding of the nature of disease, but also created technology that remains currently used (Krajewski and Chandawarkar, 2008).

The traditional path of technology development and uptake follows the numbering of quadrants I to IV with adjacent players interacting with each other. The IARCs can be placed

in quadrant II to represent their bridging role. However, as Craswell (2006) argued, the quadrant-based analysis does not capture overlaps that take place in collaborative research. He therefore included an arrow linking quadrant IV and II reflecting the importance of client orientation of IARCs' research.

2.3.2 Agricultural research as a public good

The concept of market failure in pro-poor agricultural research is well recognized in economics (Spielman, 2007; Alston et al., 1999; Hayami and Ruttan, 1971). This arises because of ineffective property rights, which mean that researchers may not be able to get full returns from their research investments. This implies that benefit distribution once the products are adopted does not necessarily match with the research cost distribution (externalities), and users lack of incentives to finance research (free riding) (Sagasti and Timmer 2008).

As a result of market failure, the private-sector does not have incentives to invest in agricultural R&D leaving the research to be treated as a public good conducted by public agencies (Pingali and Kelley, 2007). This is especially the case for agricultural innovations that are not embodied in a particular technology, or - as in case of seeds - if they can be reproduced by the farmers themselves. Since farmers in many developing nations still mainly rely on the public sector for agricultural technology (Pineiro 2007), publicly funded research centers are expected to step in to fill this gap.

In economics, the concept of public goods follows the theory of public expenditure by Samuelson (1954). According to his theory, pure public goods differ from private goods by the two criteria of being non-rivalrous in consumption and at the same time non-excludable. Non-excludability implies that it is either impossible or very costly to exclude those who do not pay for the good from utilizing it, and once the good has been produced its benefits (or

harm) accrue to everyone. The non-rivalry criterion means that any one person's consumption of the public good has no effect on the amount of it available for others.

Most public goods exhibit some attributes of rivalry and excludability, and are therefore impure (Kanbur, 2001). The literature hence identifies other categories (Table 2-2) of goods, such as club goods that are non-rivalrous but excludable, and common pool resources that are non-excludable, but rivalrous (see Hardin, 1968). Other related concepts are externalities where the costs or benefits of a good are not reflected in the price of the good and free riding, where there is lack of incentives by users to finance supply of the good (Sagasti and Timmer 2008).

Public goods are meant to be paid for by governments since they are intended to be used within national boundaries (Dalrymple, 2008). Nevertheless, they can also be defined at the local, national, regional, international or global levels[14]. With recognition that most development challenges extended across national borders, agricultural research started to be increasing framed around the global public good concept (Dalrymple, 2002).

Table 2-2 Classification of Economic Goods

Consumption	**Access**	
	Exclusive	**Non-Exclusive**
Rival	Private (eg, food, clothing, cars)	Common pool (eg, air, water, soil, landscapes, ocean fisheries)
Non-Rival	Club/Toll (eg, INTELSAT, Suez Canal, Panama Canal, private schools, theatres, professional associations)	Public (eg, sunshine, national defense, lighthouses)
Source: Ryan (2006 p. 3)		

[14] Local public goods are available within a district, municipality or state; national public goods only within the borders of a country; regional public goods to two or more contiguous countries within a geographic or political environment; international public goods to two or more countries across geographic, political or continental divides; and global public goods are available to all countries.

Global public goods have coordination problems that make them non-attractive to governments and the private sector. The free-riding attribute is also exacerbated at the international level since capacities and willingness to pay for and participate in the provision of IPGs varies greatly across countries (Spielman, 2007).

Concepts related to international public goods are the economics of size, economies of scale in technology use and the factors influencing spillovers. In agricultural research, economies of size are high in activities like molecular biology that require significant investments infrastructure but lower for natural resource management, which involves adaptation to local conditions (Byerlee and Traxler, 2001). Economies of scale refer to the market size meaning, that the more widely a technology is adopted, the more significant the payoff from the research (Dalrymple, 2008). The spillover potential is another interrelated issue which refers to applicability of a technology to other agro-ecological locations or for a different crop (Deb and Bantilan, 2001; Shiferaw et al., 2004).

IPGs in the CGIAR context

The international public goods term was not used to describe the functions of the CGIAR in the early years. Nonetheless, terms such as "spillover effects" and "positive externalities" were common in the 1970s and 1980s. The IPG concept began to be explicitly used in the late 1990s and early 2000s (Sagasti and Timmer, 2008). It has since been proposed on several occasions that the CGIAR system should focus on research that produces IPGs (CGIAR Science Council. 2008; CGIAR Science Council, 2006). Harwood et al. (2006 p. 381), defined IPGs in the CGIAR context as:

"*Research outputs of knowledge and technology generated through strategic and applied research that are applicable and readily accessible internationally to address generic issues and challenges consistent with CGIAR goals*".

Public international agricultural research is considered to fit readily into an IPG framework as products from the CGIAR are intended to benefit many people across nations. Even in cases where this initial knowledge is drawn on by the private sector and intellectual property protection is exercised leading to some form of excludability, it is argued that "it becomes of greater value or use to individuals or society as a whole" (Dalrymple, 2008 p. 351).

2.3.3 Capacity gaps and the need for innovation facilitation

Another critical factor affecting the role of the CGIAR is capacity of national systems. Even from the colonial era, there was failure to train and provide career incentives to African scientists, which continues to hamper performance in many countries (Eicher and Rukuni, 2003). Mrema (2001) found that 80 percent of agricultural researchers in Africa were based in 13 countries, and 20 percent in the remaining 35 countries. Maredia and Raitzer (2006) estimated that the CGIAR devotes 20-22 percent of its expenditures to capacity building but there is still a significant capacity gap in many developing countries.

In order to effectively prioritize its activities in different regions and countries, it is important for the CGIAR to not only establish the agricultural innovation capacities at national level but also understand what determines these capacities. Spielman and Birner (2008) contribute to this goal by demonstrating the potential value of indicators to inform national agricultural innovation policymaking.

Successful technology development and uptake also depends upon the dynamics of personal, professional and institutional relationships (Hall et al., 2001). An important factor influencing the emergence and consolidation of innovation networks is the role of a catalyzing agent or innovation broker who induces other partners in the network (Banerjee, 2013; Klerkx and Aarts, 2013; Ekboir, 2009; Klerkx et al., 2009).

A similar concept was introduced in institutional analysis by DiMaggio, who identified institutional entrepreneurs as mobilizers of diverse social skills and resources to achieve a certain goal (DiMaggio, 1988; Fligstein, 1997; Perkmann and Spicer, 2007; Lawrence, 1999). The centers may be considered as boundary organizations that act as intermediaries and straddle the divide between research and policy (McNie, 2007). Bridging is required even within research organizations as illustrated by Klerkx and Leeuwis (2008a) who analyzed the bridging role of research councils in principal-agent relationships involving governments and scientists.

2.4 Implications of institutional design on returns to investment

In cases where more than one institution has been involved in research and technology dissemination, benefit attribution presents a challenge. Since it is a joint effort of many organizations, a full description of the role played by each actor in the R&D process and associated costs is required. Reducing the total costs, including transaction costs of planning, research, technology transfer, monitoring and evaluation and uptake, through appropriate institutional design will result in higher internal rates of return.

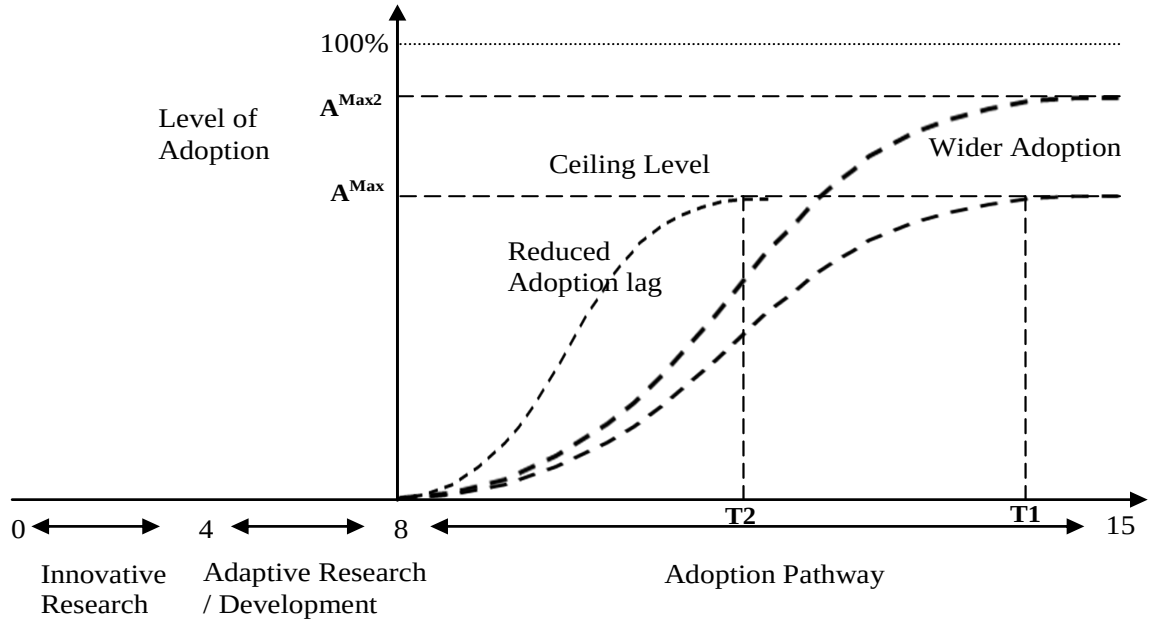

Figure 2-6 The Research-Adoption Pathway.
Source: Adapted from Bantilan et al., 2009

Aside from the estimated net benefit per unit of adoption, referred to as the unit cost reduction (Alston et al., 1998), the institutional choice has an effect on other parameters including the probability of success in research, capacity to conduct adaptive research and the actual likelihood, timing and scale of adoption. The adoption parameters can be influenced in two ways; First is advancing adoption so that benefits materialize earlier as indicated in Figure 2-6 by the reduced time to reach maximum adoption from T1 to T2. The other is an increase in the total level of adoption from A^{Max} to A^{Max2}.

While facilitating adoption is a critical part of agricultural R&D, it is important to decide whether it should be carried out by the centers themselves or other partners. Ideally, each activity should be assigned to an institution that is best at carrying it out i.e. has a 'comparative advantage'. This would achieve an economizing result and higher total welfare from a given set of resources.

2.5 Learning approaches for institutional change

The capacity to close existing yield gaps through increased adoption at the ground level depends on the institutional context for research and development (Klerkx and Leeuwis, 2008b; Hall et al., 2003; Ekboir, 2003). Economic impact assessment methods have been used to evaluate agricultural research mainly for accountability and public awareness purposes (Horton and Mackay, 2003). However, these methods have been criticized for having poor diagnostic power and their inability to help in understanding how institutional contexts contribute to agricultural innovation (Ekboir, 2007; Horton and Mackay, 2003; Hall et al., 2003; Raina, 2003).

Over the years, a number of complementary approaches have evolved including participatory learning and action research (Stroud 2003; Kristjanson et al. 2008), learning alliances (Lundy et al. 2005), learning selection (Douthwaite et al. 2002), institutional learning and change (Watts et al., 2003), innovation histories/ institutional histories (Douthwaite and Ashby 2005; Shambu Prasad et al. 2006; Shambu Prasad et al. 2005), learning from the positive (Biggs, 2008), and action and reflection (McAllister and Vernooy 1999). The agricultural knowledge and information systems (AKIS) and agricultural innovation systems (AIS) perspectives (World Bank 2006; Spielman 2005; Hall et al. 2004) consolidate these attempts by encouraging systems thinking in agriculture.

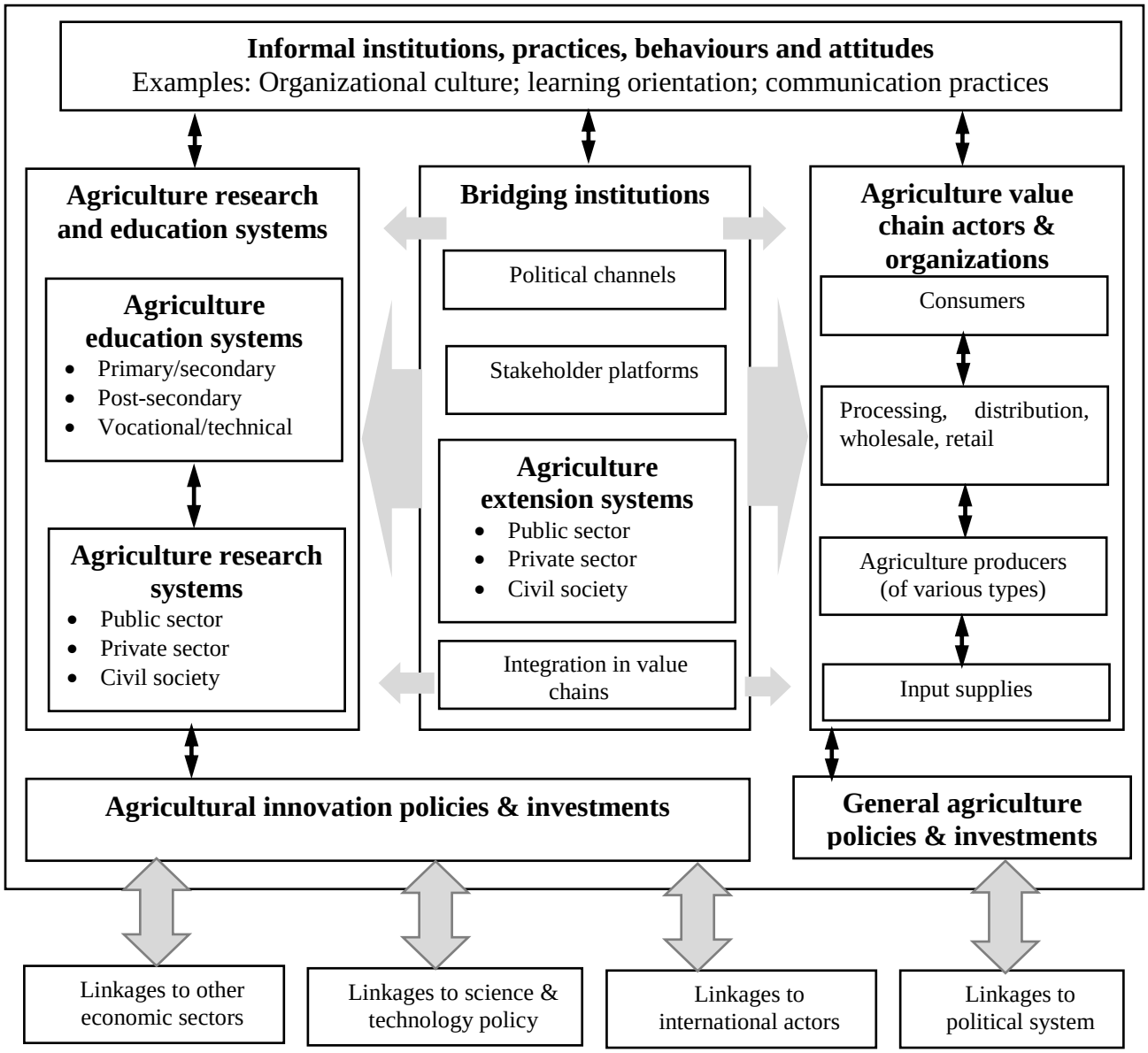

Figure 2-7 A Conceptual Diagram of a National Agricultural Innovation System
Source: Spielman and Birner, 2008.

The innovation systems approach has gained popularity as it captures the complex relationships and networking among heterogeneous agents (researchers, farmers, government, civil society, extension workers, donors, universities, private sector, etc) that condition successful development and utilization of research outputs. The main elements of a national agricultural innovation system include the knowledge and education domain, the business and enterprise domain, and the bridging institutions that link the two domains (Figure 2-7).

Technology development and dissemination activities take place in a context that is historically defined in political, economic, agroclimatic and institutional terms (Biggs, 1990). Documentation of innovation network dynamics (Klerkx et al., 2010; Hall et al., 2001), and evolution of socio-technical change at the micro level can inform future innovation processes. For example, in the case of location-specific natural resource management, Harwood et al. (2006) present examples that generated knowledge of international relevance. The International Institute of Tropical Agriculture (IITA) provided lessons on coordinating multi-locational research from its benchmark area approach (BAA) (Douthwaite et al., 2005). Bertram (2006) presents several cases suggesting that IARCs can learn through involvement in development-oriented activities. Devaux et al. (2010) identified challenges that the Papa Andina Partnership Program of International Potato Center (CIP) faced and discussed policy issues on functions of boundary organizations and innovation brokers. Lessons learnt on participation and collective action in ICRISAT's watershed development projects (Joshi et al., 2005) led to development of the consortium approach to watershed management.

Therefore, through in-depth case studies, the CGIAR system could learn important lessons from successful interventions and those that faced binding constraints (Walker et al., 2008; Bertram, 2006; Gardiner and Chapman, 2006; de Janvry and Kassam 2001). At ICRISAT, several review teams have suggested that location-specific, downstream work should be designed from the outset in such a way that it generates knowledge for wide application (ICRISAT, 2007; CGIAR Science Council, 2009). The sixth external program and management review (EPMR) included this as a recommendation by recognizing the importance of research on the process of scaling up.

This thesis builds upon this recommendation by conducting case studies to understand the innovation process for improved legume varieties in different countries. While quantitative ex-ante impact analysis is widely viewed in the CGIAR as an objective means to guide

resource allocation decisions between research themes and countries (Byerlee, 2000; Alston et al., 1998), it does not capture the (within-country) trade-offs between upstream research to increase productivity and downstream activities that enhance uptake. There is still a knowledge gap on how to balance between basic and strategic research activities, versus involvement in the delivery programmes to enable achievement of CGIAR system level goals. This study aims to address these tensions between a focus on upstream research that produces IPGs versus downstream activities to enable impact. The insights drawn from the case studies will guide the design of effective institutional structures for international agricultural research for development.

CHAPTER 3

RESEARCH METHODS

3. RESEARCH METHODS

The research adopted a qualitative case study approach with empirical analysis being conducted at breeding program for improved legume varieties at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Case studies were conducted in three countries: India, Malawi and Ethiopia.

3.1 Overview of study areas

The three countries were chosen for the case studies because they differ with regards to capacity of their national agricultural research and extension systems and the state of their seed systems. They are also leading producers of either groundnut or chickpea in their respective regions and ICRISAT has a country office in each of them.

In India, a significant proportion of the population depend on agriculture for their livelihood. About 60 percent of the labor force is employed in agriculture with majority being smallholder farmers (Pal et al., 2012). Agriculture also contributes about 14 percent to the gross domestic product (GDP). The country has one of the most elaborate public agricultural research systems organized under the Indian Council of Agricultural Research (ICAR) and state agricultural universities (SAUs) and almost entirely funded by the federal and state governments. India is the world's biggest producer of pulses and the second largest producer of rice, wheat and sugar (India Brand Equity Foundation, 2014). Overall, the country ranks within the world's top producers of most agricultural products. After a period of stagnation, Indian agriculture was revived in the 1960s following policy and technological interventions for food security (Bhalla and Singh, 2001). The green revolution led to increased agricultural productivity in the country, but to date there are still challenges in reducing poverty and malnutrition.

In Malawi, agriculture has benefited from subsidies since 2005 and accounts for one-third of GDP, over 80 percent of employment and 90 percent of export revenues (CIA, 2014). The main cash crops are tobacco, tea, cotton, groundnuts, sugar and coffee and food crops include are maize, cassava, sweet potatoes, sorghum, rice and bananas among others. The Department of Agricultural Research Services (DARS) is the main agency for agricultural research that accounts for about half of the country's agricultural researchers (Flaherty and Kamangira, 2014). The DARS headquarters, ICRISAT Malawi office and several other international agricultural research centres are located at the Chitedze Research Station in Lilongwe. Most of the farmers in Malawi are smallholders with less than one hectare and do not have good access to credit and extension services, which constrains agricultural productivity (Simtowe et al., 2012). The sustainability of the Malawi subsidy programme with reduced donor support has been a subject of controversy (Pauw and Thurlow, 2014).

In Ethiopia, the agricultural sector also contributes a large proportion to the economy with coffee as the major export crop. Agriculture accounts for about half of the GDP, over 80 percent of exports, and 80 percent of employment (CIA, 2014). The Ethiopian Institute for Agricultural Research (EIAR) is responsible for the overall coordination of agricultural research and also advises the federal and regional governments on the formulation of agricultural R&D - related policies (Beintema et al., 2014). The institute, has its headquarters in Addis Ababa and operates 13 research centers across the country. Regional agricultural research institutes (RARIs) are managed by regional state governments and, as a group, employ the largest share of agricultural researchers. Although there are still some localized food shortages, the country has made a lot of progress toward food security since the famine that occurred in 1984 (Dorosh and Rashid, 2013). Further details on the NARES in the three countries, and specifically for the two legumes that were studied, are provided in chapter 6.

3.2 Theoretical concepts and analytical frameworks

In this section, a summary of the theoretical concepts and analytical frameworks relevant for the thesis are provided with further details explained in the respective chapters. These include market failure and state failure in agricultural research and development, the concept of international public goods, the role of ideas, beliefs and interests in policy making, and the transaction cost economics approach.

3.2.1 Market failure in agricultural research and development

National innovation systems adopt two broad policy approaches; the free-market view where government plays a minor role except in ensuring market failures are dealt with, and the contrasting approach where government has a major role in facilitating technological competitiveness, social inclusion and equity (Dodgson et al., 2011). Market failure can be defined as "the inability of a market production system to provide a good or service either at all or at a level that is optimal from the society's perspective" (Birner and Anderson, 2007. p. 11). The effect of market failures on the demand and provision of agricultural extension services has been widely studied (Feder et al., 2010; Birner and Anderson, 2007; Anderson and Feder, 2007; Bennett, 1995; Umali and Schwartz, 1994).

Seed systems especially for legumes also encounter market failures brought about by the nature of the seeds and other externalities. The seeds of self-pollinated varieties of crops such as groundnuts and chickpea are easier to handle and maintain in good condition for many years. Farmers in developing countries can hence save seed and also exchange with neighbouring farmers who will then not need to purchase for each successive planting (Brennan and Byerlee, 1991). This presents problematic property rights that reduce ability of breeders to appreciate gains from research investments and is a disincentive for private seed companies (Byerlee et al., 2007; Loch and Boyce, 2003; Tripp and Louwaars, 1997). Another

challenge to the private seed sector for legumes is the number of generations required to produce seed in usable quantities. This depends on the seed multiplication factor i.e. the net increase achieved in each generation. Compared to crops such as maize or sorghum, grain legumes have a lower seed multiplication factor. This lends crops such as groundnut, with a bulky seed, seed requirement as high as 80-120 kg/ha, and multiplication factor less than 10, non-attractive to commercial seed producers (Birthal et al., 2010; Asfaw et al., 2010).

3.2.2 Agricultural research as a public good

As a result of market failure, agricultural research and extension services have largely been considered as a public good provided by public sector agencies (Spielman, 2007; Alston et al., 1999; Hayami and Ruttan, 1971). Public international agricultural research is considered to fit readily into an IPG framework as products from the CGIAR are intended to benefit many people across nations. The CGIAR system having a global mandate and is expected to produce outputs that are freely available, accessible and relevant to many countries (Ryan, 2006). However, the CGIAR system has faced challenges in characterizing all its outputs as international public goods and how to operationalize this concept within the centers.

3.2.3 State failure in agricultural research

Market failure, that have been discussed above, means that public sector agencies have to be involved in providing services to citizens. When the public sector is also not able to correct market failures and contribute to the well-being of society, the situation can be referred to as state failure. The reasons for state failure in services such as agricultural extension are summarized in Feder et al. (2010) as scale and complexity of agriculture and farming systems, dependence on broader policy environment, poor feedback loops between knowledge generation and extension, assignment of government employees to other public duties other than knowledge transfer, difficulty in attributing the contribution of extension services in final impact, weak accountability to farmers and treating them as subjects rather than clients,

bureaucratic procedures not flexible in responding to local demands and limiting institutional learning and change, weak incentives for government employees to perform and weak political commitment and support for extension services.

Until the 2007-2008 world food crises, public funding for agricultural research had diminished especially in agriculture-based countries (World Bank, 2007; Lynam et al., 2012). The lack of operational funds within government agencies means that activities such as extension and seed quality control may be affected by lack of transportation. The heterogeneous nature of smallholder agriculture, where a large number of small farmers are dispersed across the country (Binswanger and Rosenzweig, 1986) also presents challenges in research and extension. Higher transactions costs are incurred to access them and it becomes difficult to standardize the extension package. Research and extension workers must exercise discretion (Pritchett & Woolcock, 2004) and provide advice tailored to varying local conditions. Considering that a lot of staff is required on a daily basis for programs such as extension throughout the country, there is difficulty in monitoring and supervision.

Public sector agencies may not have adequate staff and even when they do, the staff may not have sufficient skills and knowledge to carry out the required activities effectively. The fact that they are poorly compensated means that they lack incentives to perform effectively leading to problems such as shirking or rent seeking behaviour. Programs such as input provision that involve large amounts of resources distributed under conditions that are difficult to monitor are prone to leakage and procurement challenges (Birner, 2008). In addition, although the situation is improving, many developing countries especially in Africa have been faced with problems such as corruption, political instability and civil war. Efforts to use community action are also prone to the risk of elite capture where benefits accrue to the better-off and more powerful groups (Feder et al., 2010 ; Birner, 2008). Partnerships between

the public agencies and the private sector or civil society organizations are also affected by a culture of mistrust between the three sectors.

3.2.4 Role of ideas and beliefs in policy processes

The role of ideas and beliefs in policy making has gained interest over the years (Campbell, 2002; Hajer and Wagenaar, 2003; Finlayson, 2004; Birner et al., 2011). The literature recognizes that people engage in politics to translate their beliefs into action. Three main types of beliefs are identified namely; Core beliefs that are fundamental and rarely change, policy beliefs that are more specific and may change, and secondary beliefs that relate for example to the way policy is implemented (Jenkins-Smith and Sabatier, 1993). Deliberative or discursive democracy (Bessette, 1980) refers to a decision making systems where deliberation and consensus building plays a central role. Birner et al. (2011), using a case study of fertilizer and electricity subsidies in India, demonstrate how coalitions advocate alternative policy paradigms in an attempt to influence policy change.

One of the key methods that has been used to study the role of beliefs and language in politics and practice is discourse analysis. "Discourse is defined here as an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices" (Hajer and Versteeg, 2005 p. 175). Approaches related to discourse analysis include frame analysis (Schön and Rein, 1994), analysis of belief systems (Sabatier and Jenkins-Smith 1993) and narrative policy analysis (Roe, 1994).

A narrative policy analysis approach was used in chapter 4 to identify the controversies about how the centers should position themselves in the research-development continuum. This approach was chosen because it is suitable for cases characterized by great uncertainty, complexity and polarization. During the analysis, the stories (Kaplan, 1993) within the transcribed interviews, as well as counterstories that run opposite to the dominant

international public good concept were identified and categorized through qualitative data analysis (coding). The narrative analysis illustrated how ideas, beliefs and interests of various actors in agricultural research and development influence their actions. This calls for the development of priority setting criteria that are more practical and aligned with the beliefs of stakeholders on how to address development challenges.

3.2.5 Transaction cost economics

The international public goods (IPG) concept has often been put forth to guide decisions on what the CGIAR centers should do. However, this criterion is still debatable as we will see in subsequent chapters. Transaction cost economics (TCE), a branch of the New Institutional Economics (NIE), offers an alternative analytical framework. The "discriminating alignment hypothesis" aligns transactions that differ in their attributes with governance structures that differ in costs and competence so as to achieve an economizing result (Williamson, 1991, p. 281). This approach was combined with insights from the fiscal federalism literature (Birner and von Braun, 2009; Bardhan, 2002; Oates, 1972) to develop a framework for analyzing the comparative advantage of the CGIAR centers and appropriate level of decentralization for different types activities along the research-impact pathway.

In order to apply the transaction cost economics approach, a typology of transactions involved in the agricultural research and development process had to be developed. This was achieved through an empirical study of the legume improvement program at ICRISAT. The choice between different governance structures is influenced by the attributes of these respective transactions. We will discuss these attributes in detail in chapter 5 and also examine their influence on the comparative advantage of IARCS over national systems. The framework also identifies the role of contextual factors, especially capacity of national systems, in determining the appropriate level of decentralization.

3.3 Data collection and analysis

In this section, a brief overview is given of the data that was collected, how and where it was collected and how it was analyzed. Further details are provided in each of the three main chapters. Since the research laid a lot of emphasis on the context, the data was collected between 2012 and 2013 in three countries that differ in terms of capacity of their national systems. A diverse set of materials were used for data collection including the application of a participatory mapping technique called Net-map (Schiffer and Hauck, 2010), interviews, review of relevant documents, field observations and taking of field notes to capture elements such as body language and contextual information.

The Net-map procedure involved asking questions to gather information and map the main actors in the research process and dissemination of improved technologies, how they are linked with each other, level of influence of each actor on the intended outcome, and follow-up questions on governance challenges in the innovation process. The exercise was first conducted with the respondents who understood the whole process best, then with different stakeholders to get their perspectives and capture any information that may have been missed out during the initial mapping.

In-depth key informants interviews were held with 71 respondents including ICRISAT scientists, national partners, non-governmental organizations (NGOs), seed corporations and certification agencies, male and female farmers and other stakeholders involved in the research and promotion of improved groundnut and chickpea varieties (Table 3-1). A total of 13 Focus Group Discussions (FGDs) were also held with farmers in Kurnool and Ananthapur districts in Andhra Pradesh (AP) state of India, Lilongwe district in Malawi and Lume district in the Oromia region of the Ethiopian central highlands. This was followed by intensive qualitative interviews with a few individual farmers. The districts are located in the major

chickpea and groundnut growing areas in the respective countries where the new varieties have been taken up.

Table 3-1 Interviewed stakeholders

Stakeholder Type	**India**	**Malawi**	**Ethiopia**	**Total**
ICRISAT (Scientists, technicians)	8	8	4	20
Government agencies (Research, extension)	9	3	5	17
Seed corporations / Certification agencies	8	2	2	12
Non-governmental organizations	3	3	2	9
Farmers (FGDs)	4	2	2	13
Farmers (Individual interviews)	9	6	4	13
Total	**41**	**24**	**19**	**84**

Source: Authors

The respondents were sourced through personal contact with the key stakeholders in groundnut or chickpea research and development in each country and based on the mapping of the process using the Net-map tool. The interviews were held face-to-face and in the home or office of the interviewee or at convenient meeting points that were agreed upon with the respondent. Each interview took on average about half an hour and was conversational in style and open ended so as to ensure that the main viewpoints of the respondents were captured. A list of typical questions that were used to encourage respondents to talk and clarify open questions is included in Appendix B.

The data collection and analysis was also complemented with extensive review and synthesis of relevant literature including a range of documents such as meeting minutes, centre and program review reports, project documents, press reports or newspapers, and workshop proceedings. This approach allowed for triangulation to ensure validity of the findings (Yin, 2003). Additional respondents and questions were identified based on principles of theoretical

sampling, theoretical saturation (Charmaz, 2006). Constant comparison and data collection continued until the point when additional data did not add to the development of core categories of the emerging results.

The interviews (including those from the Net-map exercise) were fully recorded and transcribed (Strauss and Corbin, 1998) to permit detailed analysis (coding). A qualitative data analysis software called NVivo was used in the analysis to structure and store the data, for making changes and identifying the connections between different sections of the data (see Figure 3-1 for a screenshot of NVivo showing the coding process).

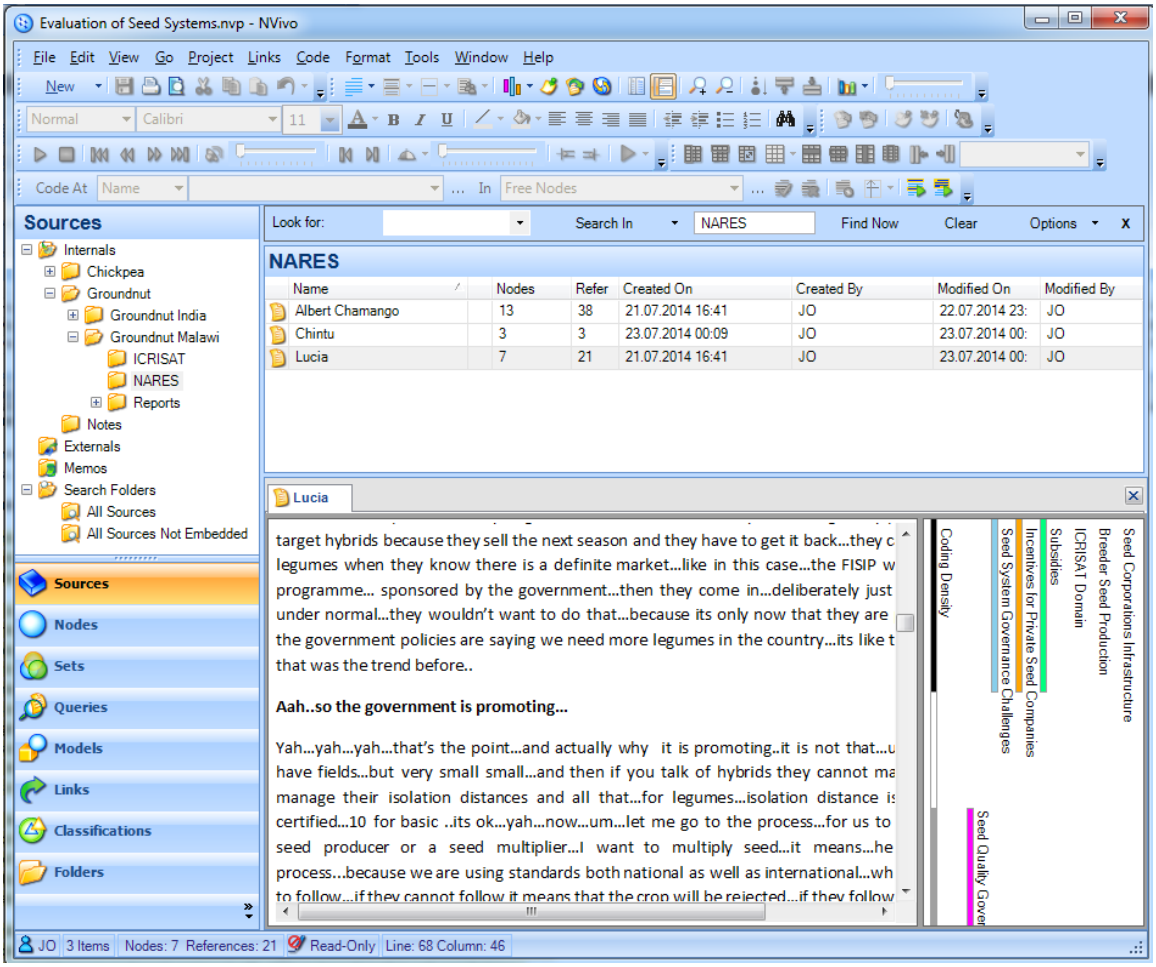

Figure 3-1 Screenshot showing coding in NVivo
Source: Authors

The qualitative methods were used to generate codes and categories. Coding breaks down and conceptualizes the data through the attachment of "labels to segments of data that depict what each segment is about" (Charmaz 2006, p. 3). Coding was done line by line to ensure that the emerging categories were based on the data and not highly influenced by the researcher's pre-conceived notions. Categories were generated through analysis of the codes in order to see their connections and group them under a higher order (Strauss & Corbin 1998) while at the same time continuously testing the emerging insights against the data. The themes and insights from the coding process, as well as their emerging interpretations, served as a basis for discussion and structuring of each of the chapters in a systematic way.

CHAPTER 4

INTERNATIONAL PUBLIC GOODS VERSUS UPTAKE: CONFLICTING VIEWS ON ROLE OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS

4. INTERNATIONAL PUBLIC GOODS VERSUS UPTAKE: CONFLICTING VIEWS ON ROLE OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS

4.1 Introduction

This chapter looks at how competing paradigms and associated political processes influence agricultural innovation. By taking into account the role of beliefs in policy making, we analyze the recurrent dispute on whether scientists in the CGIAR centres should focus entirely on the production of international public goods. The reform process of the CGIAR has led to an increasing emphasis on the achievement of system level outcomes such as reduction of poverty and food insecurity, improvement of nutrition and sustainable management of natural resources. With low capacity of national systems in most developing countries, the extent to which the centres should focus on upstream research or be involved in technology promotion and dissemination activities to enable impact is a political decision. It may therefore present a political challenge if tensions on this outstanding issue are not resolved taking into account the beliefs, ideas and storylines of different stakeholders in research and development.

A narrative policy analysis approach was adopted for this chapter as it is best suited for cases that are uncertain, complex and polarized (Roe, 1994). The complexity of decision making and level of polarization between the dominant "IPG" story and the "Uptake" counterstory made the use of a narrative policy analysis approach suitable. The objective of this chapter is to provide a deeper understanding of how the actions of various agents are linked to their storylines on how impact can be best achieved from their work.

Case studies of legume research and development were used to provide deeper insights into how different narratives play an important role in the contested issue. Through a review of literature, it was identified that there are still competing narratives at the CGIAR system level.

Various stakeholders in the research and dissemination of improved groundnut and chickpea varieties developed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) were therefore engaged to obtain their views. To obtain perspectives from different contexts, stakeholders were interviewed from three countries that differ in capacity of their national systems; India, Malawi and Ethiopia. Insights from the study can be applied to different countries and for other crops, livestock, or production systems.

The analysis identified polarized opinions on what activities the CGIAR should be involved in. In the case studies, the innovation process for improved legume varieties was found to involve engagement in political processes that were driven by the actors' beliefs. This called into question the acceptance and applicability of the international public goods criterion for determining the focus of the centres. Consequently, the chapter recommends, as a metanarrative, the development of alternative criteria that can be applied for priority setting in international agricultural research by objectively assessing the comparative advantage of the CGIAR in relation to other actors in different contexts.

In section 4.2, we summarize the relevant literature on the role of beliefs in decision making. Section 4.3 and 4.4 present the conceptual framework and an outline of the methods used, highlighting the suitability of narrative policy analysis. Based on review of documents and analysis of recorded transcripts, the dominant stories and counterstories around what kinds of activities the CGIAR centres should focus on is then presented in section 4.5. Sections 4.6 and 4.7 discuss these conflicting narratives and conclude by suggesting what can be done in the form of a metanarrative (Roe, 1994).

4.2 The role of beliefs in decision making

This section, the concept of discourse is introduced to provide a background on how it might help in understanding debates on the role of the CGIAR by describing some of the common storylines on this matter. The role of ideas and beliefs in policy making is increasingly gaining interest (Campbell, 2002; Hajer and Wagenaar, 2003; Finlayson, 2004; Wittmer and Birner, 2005; Birner et al., 2011). The literature recognizes that people engage in politics to translate their beliefs into action. It is therefore important to take into account these ideas, beliefs and interests when planning and implementing reform processes.

Jenkins-Smith and Sabatier (1993) identifies three main types of beliefs namely; Core beliefs that are fundamental and rarely change, policy beliefs that are more specific and may change, and secondary beliefs that relate for example to the way policy is implemented. Ideology can be defined as a "set of beliefs about the world, including beliefs about the morality of the division of labour, income distribution, and the existing institutional structure of a society" North (1981, p. 49. If differences in ideology within a society are large and majority of the society do not share the same feeling about the justice of the governance system, revolution will follow (Lin, 1989. p 9).

Among the key methods that have been used to study the role of language, beliefs and ideology in politics and practice is discourse analysis. "Discourse is defined here as an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices" (Hajer and Versteeg, 2005 p. 175). To frame an issue and position it in the political system requires the existence of a discourse coalition. "A discourse coalition is the ensemble of a set of story lines, the actors that utters these story lines, and the practices that conform to these story lines, all organized around a discourse" (Hajer, 1993 p. 47).

Birner et al. (2011) review the role of ideology and discourse in reform implementation. Using an advocacy-coalition approach (Jenkins-Smith and Sabatier, 1993) and a case study of fertilizer and electricity subsidies in India, they demonstrate that ideas and interests do matter and go a step further to examine the mechanisms through which they influence policy change. Since reforms come about by changing the perceptions of policymakers, changes can be made depending on how the coalitions advocate alternative policy paradigms. Deliberative or discursive democracy (Bessette, 1980) refers to a decision making where deliberation and consensus building plays a central role. However, this approach is likely to be influenced by existing power structures that may not allow for equal participation (Birner et al., 2011).

Academic research can be used strategically by stakeholders to justify certain policy solutions. However, as Jenkins-Smith and Sabatier (1993) argue, groups whose interests or beliefs are affected by the proposed policies can use several strategies to challenge the research. They can challenge the validity of the data and analysis or the feasibility of the proposed solutions to the problem. Groups that have different belief systems would engage in debate each with an effort show that their argument is more plausible or to gain what is referred to in the literature as discursive hegemony (Liu, 2013). Discursive hegemony is determined by credibility, acceptability and trust; Credibility depends on both the plausibility of the argument and authority of the author, acceptability implies that the position held by the group is considered as attractive or necessary, and trust leads to the suppression of doubts for example by showing how the storyline or conclusion was reached (Hajer, 1995. p. 59).

The literature on innovation champions also identifies the role of institutional entrepreneurs who mobilize diverse social skills and resources to achieve a certain goal (DiMaggio, 1988; Fligstein, 1997; Perkmann and Spicer, 2007). An institutional entrepreneur goes beyond existing institutions and challenges existing norms, rules, laws and bureaucratic rules in creative ways (Daokui et. al, 2005). The methods used to push for the desired institutional

changes may include open advocacy or constant private persuasion of the key stakeholder. This requires a good understanding of bureaucratic systems and the skills of navigating through policy processes (Daokui et al., 2005).

The economics literature on agricultural policy choices considers ideas and ideology as endogenous and as tools used strategically by rational actors to defend or promote economic or political interests (Birner and Resnick, 2010; Roemer, 1985). This chapter departs from the mainstream economic literature on international public goods and contributes to understanding of the political economy of agricultural research. It takes into account the role of beliefs in deciding how the centres should position themselves in the research-development continuum. The analysis is conducted at the CGIAR system level through review of relevant CGIAR documents and statements as well as at the centre level and below through interviews with multiple stakeholders.

4.3 Conceptual Framework

There are several interrelated approaches for analyzing the role of ideas, interest and beliefs, as well as the use of language in policy processes. Some of them include frame analysis (Schön and Rein, 1994), analysis of belief systems (Sabatier and Jenkins-Smith 1993) and narrative policy analysis (Roe, 1994).

A narrative policy analysis approach was used for this study. Emery Roe (1994) highlighted the importance of narratives in policy making and demonstrated how narrative policy analysis can help resolve complicated controversies. Narrative policy analysis is suitable for cases characterized by great uncertainty, complexity and polarization. Complexity is defined as the intricacies of the problem and the interrelatedness in the policy issues, while polarization refers to the concentration of groups around the policy issues (Roe, 1994).

Stories are useful because they are a tool that people use to create an understanding of their world (Feldman et al., 2004; Fischer and Forester, 1993). As van Eeten (2007 p. 252) points out, "The stories contain metaphors, distinctions, and other sense-making elements that help the analyst to connect the language of actors to their actions". "Often stories contain narrators' understandings of specific ''recipes'' for change" (Feldman et al., 2004 p. 148). A story has a beginning, middle and an end while a nonstory does not (Kaplan, 1993). Counterstories, run opposite to the controversy's dominant policy stories (Figure 4-1).

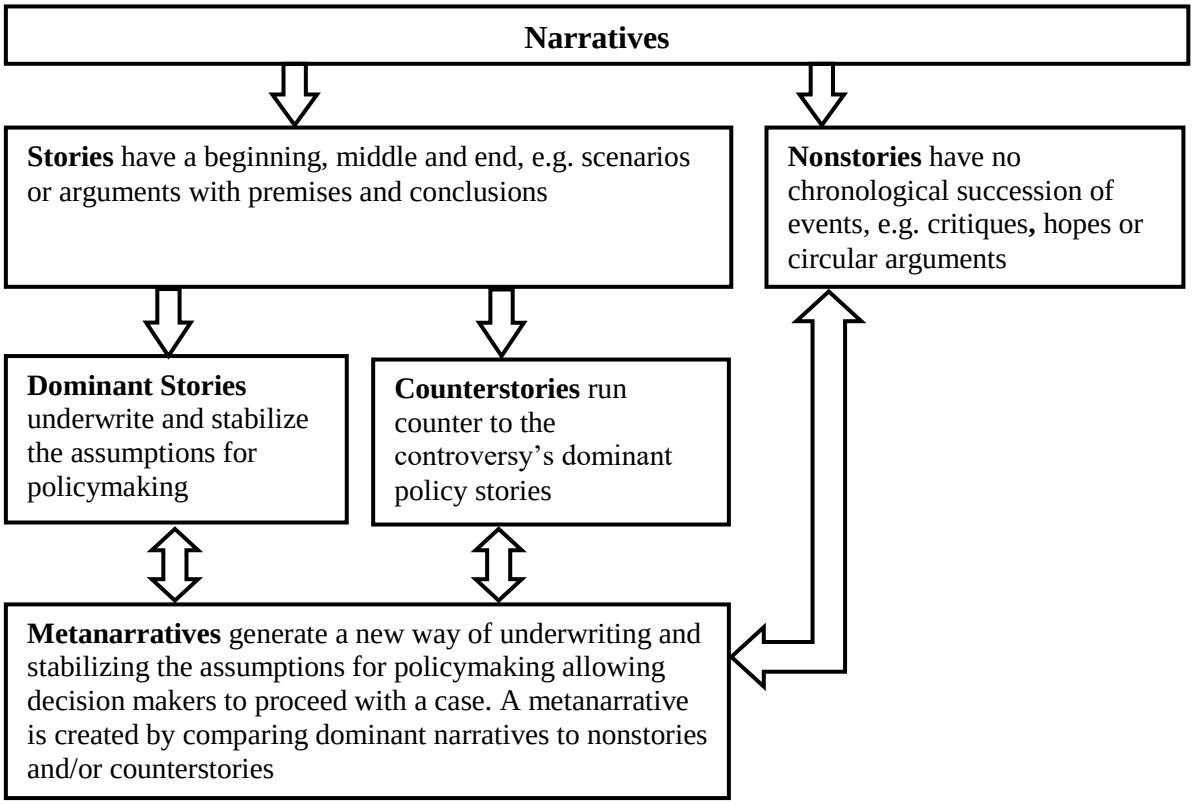

Figure 4-1 Key concepts in narrative policy analysis and their mutual relationships. Source: Berg and Hukkinen, 2011 p. 153.

A narrative policy analysis usually starts with in-depth interviews with the key stakeholders in the issue being studied. The interview is conducted in such a way that stimulates the respondent to express his or her experiences and views through telling stories or narratives

without interruptions. The respondents are encouraged to describe events using their own language and emphasize details that they consider significant (Jovchelovitch and Bauer, 2000). This is important because the narrator highlights the points they feel are relevant thus revealing their position on the issue in the process. The narratives can then be recorded and transcribed for qualitative analysis.

During the analysis, the stories within the transcribed interviews are identified. The statements in form of narratives are examined as the respondents convey facts in a story form, each with their own version of the story (Hajer and Versteeg, 2005). The analysis looks for "similar lines of reasoning" that are shared by many "little stories" (van Eeten, 2007 p. 253). The coding process proceeds as explained in chapter 3. Aggregated policy narratives can then be constructed from the transcribed texts through content analysis (Linder, 1995). Narrative analysis generates metanarratives by comparing dominant stories to counterstories (Berg and Hukkinen, 2011).

4.4 Methodology

The study applied a narrative policy analysis approach to identify the controversies about what kinds of activities the CGIAR centres should focus on. Qualitative case studies across countries were used to capture different institutional contexts. In selecting the case studies and respondents, attention was paid not only to the differences but also opportunities presented for particular case learning or "thick description" (Stake, 2005, p. 457-9). The groundnut and chickpea research and seed systems in India, Malawi and Ethiopia were found to be information-rich, with more accessible respondents and providing an opportunity to learn.

In chapter 3 and section 4.3 above, an overview has been provided on how the interviews were conducted. Data was gathered in India, Malawi and Ethiopia through in-depth key

informant interviews with ICRISAT scientists, NARS partners at different levels and non-governmental organizations (NGOs) as summarised in Table 3-1 in the previous chapter. Out of the 71 individual interviews, only narratives from 30 respondents (Table 4-1) could be categorized as falling under the two main narratives discussed in this chapter. The respondents were purposively selected based on an initial process influence mapping of research and uptake using a participatory tool called Net-map (Schiffer and Hauck, 2010).

The in-depth interviews were guided by broad questions starting with the key challenge to productivity growth in the agricultural sector. As the interview progressed, additional questions were posed on what the role of the CGIAR should be, whether IPG should be used as a criterion for CGIAR focus, what would happen if the CGIAR goes "downstream", and who should be responsible for capacity building. With the consent of the respondents, the interviews were recorded and transcribed in verbatim (Strauss and Corbin, 1998).

The transcribed data from the interviews was imported into NVivo software as individual files for qualitative data analysis. Three subfolders, one for each country, were created within the "Internals" folder and further subfolders were created to import data for each type of respondent e.g. ICRISAT, NARES, Seed Companies, NGOs and so on. Field notes served as the initial memos which were integrated in the analysis as a method of filling up the gaps.

The analysis was also complemented with extensive review and synthesis of relevant literature including a range of documents (e.g. meeting minutes, centre and program review reports, project documents). It also presented an initial feel of the range of opinions and positions expressed on the issue. Document analysis was therefore the first step in obtaining a basic notion on the ideas and beliefs, structuring the concepts and categorizing storylines into different narratives before conducting interviews with the key stakeholders.

The NVivo program improved efficiency in the process but this does not imply that the computer did the analysis (Bringer et al., 2006). The data had to be interpreted by the researcher including decisions on what codes to use and what text to include into different codes. Figure 4-2 shows a screenshot of NVivo showing the codes, which are referred to in the software as nodes.

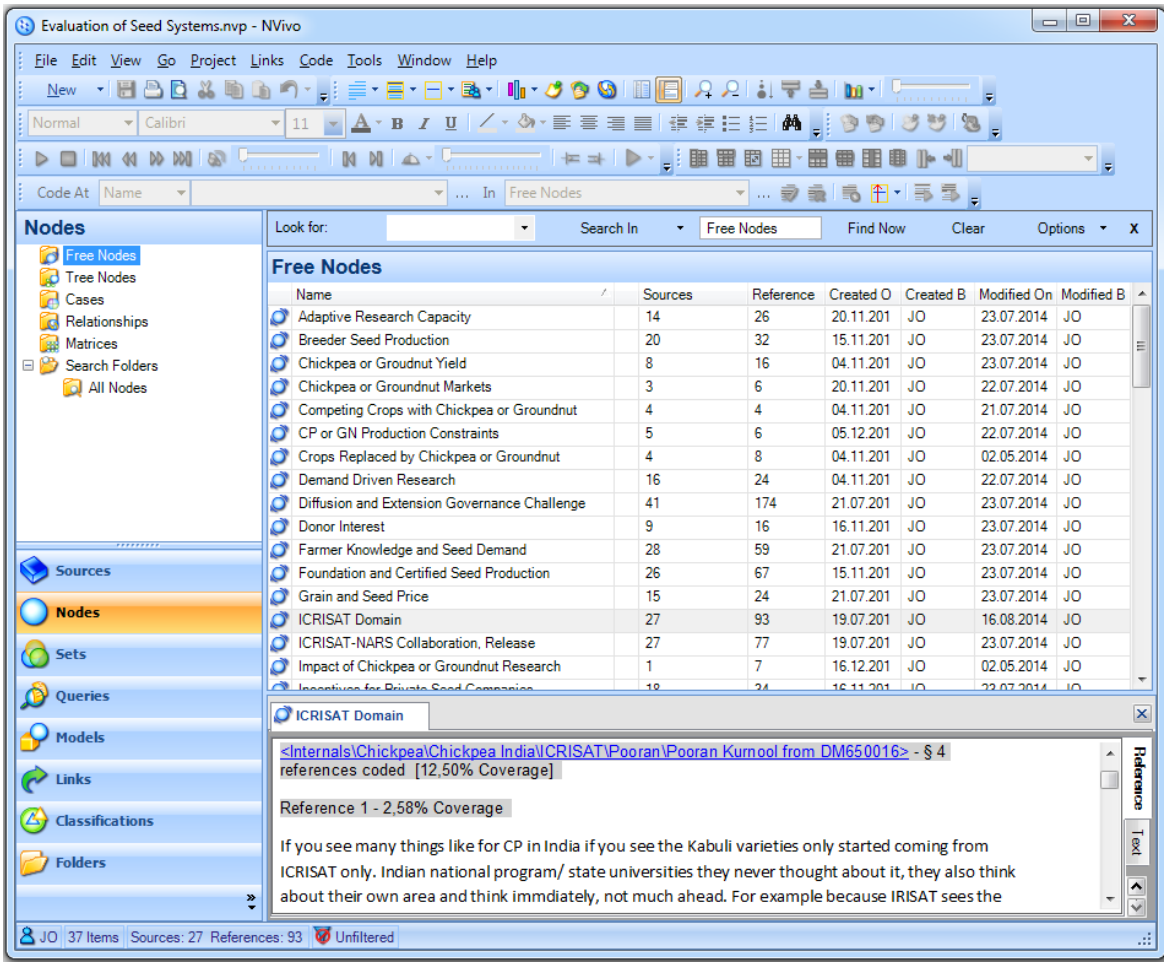

Figure 4-2 Screenshot of NVivo showing the codes
Source: Authors

In the previous chapter we provided details of how codes are constructed and how aggregate categories develop from the codes. The analysis focused on codes that dealt with the role of the CGIAR, such as "*ICRISAT Domain*", "*Setting Priorities*", "*NARS, IARCs Competition*", "*Individual Agency or Champion*" or "*Research and Adoption Lags*". The emerging categories were grouped into the two competing narratives namely the "Pro-IPG narrative" and the "Pro-

Uptake Narrative". These were then examined and described in detail exploring the tensions and contradictions between the two schools of thought.

4.5 Results

The analysis undertaken revealed respondents' opinions on whether ICRISAT should only focus on IPGs or also be involved in activities such as technology promotion and seed multiplication to enable impact. Based on content analysis of the recorded narratives, it was found that there were two contrasting positions on ICRISAT's role among the interviewed stakeholders (Table 4-1). The first group maintained that the institute should only be involved in "upstream" activities that generate IPGs while the second group argued that involvement of ICRISAT in "downstream" activities was necessary to achieve impact.

Table 4-1 Narrative polarization on "IPGs" versus "Uptake"

	India		**Malawi**		**Ethiopia**	
Stakeholder	IPG	Uptake	IPG	Uptake	IPG	Uptake
ICRISAT	3	3	-	5	2	-
Government agencies	5	1	-	3	3	-
NGOs	-	3	-	2	-	-

Source: Authors, based on in-depth interviews

For the purposes of analysis, the first group was labelled as "Pro-IPG" and the second group as "Pro-Uptake". In India and Ethiopia, except for a few staff members of the groundnut research program of ICRISAT, one former extension official and NGO officials, there was a general agreement that ICRISAT should focus on IPG research. However, the situation was different in Malawi where all stakeholders were of the opinion that ICRISAT should be engaged in technology promotion and seed multiplication. Unlike most discourse coalitions that would normally be composed of stakeholders from a particular organisational base or

linked to a specific policy or academic community, the opinions were aligned to the context in the country where the interviewed actors were located.

4.5.1 The Pro-IPG narrative

Proponents of the pro-IPG narrative were drawn from ICRISAT and national system scientists who are involved in Chickpea research and development in India and Ethiopia. This section provides their storylines on why ICRISAT should only be engaged in IPG research.

Framing of the problem

Since the establishment of the CGIAR, the dominant argument has been that the centres should exploit advances in agricultural science to produce improved technologies that are beneficial to many countries. Pro-IPG actors postulate that retarded productivity growth is as a result of lack of new technologies with superior performance over ruling varieties.

What role should the CGIAR centres play?

Proponents of the IPG view considered ICRISAT as having an important role in centralized research, applying advanced scientific methods such as genomics and marker assisted selection to reduce the research lag (see Alston et al., 2008 on the research lag concept). An ICRISAT scientist in India explained "*This kind of work is for example important in breaking "linkage drag" which refers to the undesirable effects of introgressed genes.*"

The main argument for centralized strategic research was that benefits to other countries or locations could be achieved through technological spillovers. An ICRISAT scientist explained "*When we talk about ICRISAT's program, very unfortunately we always keep in mind India, we forget about all the other countries. When review happens everyone only sees India and says it has a strong program so ICRISAT does not need to be there. Why don't we talk about Myanmar, Bangladesh and other countries where all the varieties are ICRISAT varieties.*"

Should IPG be used as a criterion for CGIAR focus?

It was felt that the CGIAR should focus on IPG research since research that produces private goods can be protected by property rights and is therefore likely to be taken up by private agents. The least debatable in IPG terms were the germplasm accessions of different plant varieties that are held by the CGIAR centres, and research that makes use of sophisticated techniques. The worth of the ICRISAT germplasm bank was mentioned by several respondents as a valuable IPG that served a wide range of countries. A chickpea breeder in India NARS argued "*ICRISAT is useful for supporting us in doing our work. Actually I started my research with the material obtained from ICRISAT only. When we started chickpea research in 2005, we didn't have any germplasm at the time, so we contacted ICRISAT and at annual chickpea scientists meet I got material*." A groundnut breeder in Indian NARS added "*ICRISAT's role is to generate material, and the other people's role is to use the material according to their own requirements and give due recognition to ICRISAT. Not that ICRISAT is breeding for India or Kenya or something like that. It is the main centre, and it has to cater so many needs and work on germplasm for different zones and countries*."

What will happen if the CGIAR centres go downstream?

It was repeatedly emphasized that ICRISAT should focus its efforts in research and not on seed multiplication or promotion. The pro-IPG stakeholders stressed that involvement of CGIAR centres downstream was not sustainable as it led to competition that might push out the national systems and not help in addressing system failures. As a chickpea breeder in the Ethiopian NARS put it, "*It is better if ICRISAT is involved in research rather than using their resources for seed production which is a large task as you need huge facilities like godowns. Even for awareness activities its better if they have a Memorandum of Understanding (MoU) with universities other national partners instead of doing it themselves.*" An ICRISAT scientist in Nairobi referring to the Indian case of a groundnut variety ICGV91114 pointed out

that "*Ultimately ICRISAT has to phase out, no way can ICRISAT keep promoting that variety, it's not sustainable. Engage the state machinery to pick that variety, you have to bring them on board*". Regarding the Malawian case he added "*We seem to be going on as if things are ok, but this is because there is injection of donor money. We are not running it as a business and that is why we are still continuing*."

The other concern was that involvement in many downstream initiatives with small budgets presented project management and reporting challenges. An ICRISAT scientist in India stated that "*When each partner gets 10,000 USD, what are they going to do in that? This is affecting our research. We have decided in India we are not going to submit any project on promotion of varieties where there is no research, just development.*"

Who should be responsible for capacity building?

IPG narrative supporters believed that it is the responsibility of governments to ensure that adaptive research is carried out to utilize international public goods locally. Some statements from CGIAR system meetings also support this stand. For example, the CGIAR Science Council Secretariat (2006, p. 41) states "The CGIAR cannot be held accountable for the failure of national systems as it has neither the resources nor the comparative advantage to disseminate technologies on a sufficient scale for more than piecemeal outcomes".

An ICRISAT scientist in India put across his impression of people's attitude towards change "*In this country in my assessment things will only change when this attitude of you know, it's ok, goes - 'Chaltha Hai' means you know it I know it and the whole village knows that this guy is corrupt, am tolerating, it's ok, its accepted. So he is one person and you have the whole village, you have the power to change it if you want, to rise up, but nobody does anything*". A plant breeder in Indian NARS added "*The political will is lacking. For example what the*

Department of Agriculture now does is they buy anything and everything at the market rate, put some label on it and sell it to the farmer at 50 percent subsidy."

The perceived problem therefore was that NARS or extension departments were not doing their job to enable impact. An ICRISAT scientist in India said "*You see agriculture department is such a huge department with such a basic infrastructure they can go to grassroots level anywhere. It's wonderful I tell you, it's just great. You know but unfortunately it's not working*."

4.5.2 The Pro-Uptake narrative

Proponents of the pro-uptake narrative were drawn from ICRISAT and national system scientists as well as non-governmental organizations that are involved in groundnut research and development in India and Malawi. In this section, their storylines on why the institute should not only be involved in IPG research but also be engaged in downstream technology promotion and seed production activities is provided.

Framing of the problem

The counterstory to an international public good emphasis for the CGIAR was that good technologies already exist in scientists shelves and agricultural productivity growth can be achieved by ensuring they are delivered for farmers.

What role should the CGIAR centres play?

The pro-uptake coalition argued that development-oriented work has played an important role in achieving impacts. It was felt that the centres should devote resources to the achievement of tangible, on-the-ground impacts (scaling up) and continue to work with other partners to ensure that this is achieved. The IPG construct was perceived to put researchers on an ivory tower, not in touch with ground realities. A former extension official in India remarked "*Many*

varieties released might have gone unnoticed as one has to demonstrate its potential. Unless you are keen in its development, the tendency we have is that - I get my salary even without doing that also." An ICRISAT technician in Malawi stated "*Currently we are doing a lot of production and dissemination. Any breeder who produces little breeder seeds and if they think the variety will get out, it will not happen. We should pack the seeds into the seed chain.*"

Should IPG be used as a criterion for CGIAR focus?

The uptake school of thought argues that it is not easy to characterize some of the outputs from the CGIAR (such as databases, institutions and policies and natural resource management) using the IPG criterion. While performance of scientists is mostly pegged on publication in high impact journals, restricting access contradicts the role of the CGIAR as an IPG provider. The issue of publications as IPGs is also questioned by some CGIAR documents. "Are journal editors and referees then the ultimate arbiters of what is a PG or IPG? Is the professional publication containing the research the PG or IPG, regardless of its geographic or agroecological relevance or spillover potential, or is it the content or knowledge embedded in the publication and its relevance?" Ryan (2006 p.8).

During a special session on international public goods at the CGIAR annual general meeting of 2008 in Maputo, several speakers shared their thoughts on the downside of using the IPG concept to frame the CGIAR system's activities (CGIAR Science Council, 2008). The general argument was that attaining impact depended on many cause-and-effect relationships and declaring that something is an IPG would be an empty gesture that is open to debate if a functional delivery system did not exist. A former ICRISAT scientist in India also honed in on this issue "*This is where CGIAR should decide if they want to create impact. We have to be in the farmer's field. Leaving the material at the gate saying we have done our job and let the national breeder and extension system come, it doesn't happen that way*".

What will happen if the CGIAR centres go downstream?

Pro-uptake actors felt that because of serious constraints facing national systems in many developing countries, CGIAR involvement in downstream activities was necessary to get technologies taken up and impact to be realized. A NARS official in Malawi gave an example relating to lack of operational funds said "*Definitely we need projects like TLII because the resources available with us are not that much. We can release the variety but giving free samples to the farmers is not that much affordable to us because the budget available is limited*." An ICRISAT scientist in Malawi also asserted "*We are not a bystander, if nobody else is producing, it's our technology, we must keep producing seed. If ICRISAT was not here, groundnut would not be in the subsidy program*". A former ICRISAT scientist in India also argued "*Projects like TLII, IFAD* (referring to an International Fund for Agricultural Development funded project) *gave ICRISAT an opportunity to create impact. The fault lies with the CGIAR as it's not very clear about what they want to do. They want to achieve results there is no doubt about it, but how? They say we have to stop here and after that the national programme has to take over but if you leave it to the national programme it does not make any difference. Why should they promote your material, or at all why should they promote any material? Then you will say there is no impact*." In reference to the Malawi case he also added "*In Africa if you have the variety and if you have to promote, you have to make your effort. The only good point is nobody is going to object or put obstacles if the variety is released properly. Not like India, here they will put obstacles. But then you have to do everything yourself.*"

Who should be responsible for capacity building?

Capacity building and advocacy at the national level was viewed as a key role of the CGIAR centres. An ICRISAT scientist in Malawi commented on this "*New varieties will come up, persons will move. I may be here and I may have some contacts and I may learn the things*

and the things go with me. We are not really sure how much ICRISAT scientists transfer to the next person and the next person may take a lot of time to learn. But national system scientists may be there for a long time so we need to train them. "A plant breeder in Malawi NARS also added "*I look at ICRISAT as a very big contribution in the capacity building component, mentoring and ensuring that research and adoption can continue. ICRISAT should also be the one to convince policy makers since they have the reputation*."

4.6 Analysis

The conceptual framework presented in section 4.3 illustrates how the stories narrated by different players represent their view of the world, and understanding what needs to be changed. We examined the puzzles on defining the functional boundaries of the international agricultural research centres using narrative policy analysis. Stakeholders in both the "Pro-IPG" and "Pro-Uptake" narratives presented their storylines beginning with what they feel is the major problem facing agriculture. In the middle they spoke about what role they feel the CGIAR centres should play to address the agricultural development problem. Their stories ended by answering "what will happen" questions that revealed what they perceived would be the implications of CGIAR centres' involvement in either IPG research or downstream activities including technology promotion and capacity building.

The narrative policy analysis reaffirms polarized views on whether the CGIAR should focus on the production of IPGs, or whether they should also be involved in more location-specific impact-oriented work. The analysis linked the opinions of different agents in the research and uptake of improved legume varieties bred by ICRISAT with their actions. Many CGIAR system documents and statements analyzed, mention the provision of IPGs as a key rationale for the existence of the international agricultural research centres. However, there is

disagreement on whether the concept captures all types of outputs from the CGIAR, how to operationalize it, and how to organize the delivery systems after IPGs are produced.

Table 4-2 Elements of the IPG - Impact Narratives

	Storyline	Pro-IPG	Pro-Uptake
Beginning	**Framing of the problem**	Lack of new technologies that significantly perform better than existing ones	Good technologies exist on-the-shelf, but the delivery systems are poor
Middle	**What should be the role of the CGIAR?**	Comparative advantage in delivering IPG outputs e.g. improved technologies	Complementary advantage in facilitating partnerships in the wider innovation system
	Should IPG be used as a criterion for CGIAR focus?	Good criterion considering market failures in agricultural research and international mandate of centres	Not easy to characterize for all types of products from CGIAR e.g. databases, institutional innovation
End	**What will happen if the CGIAR centres go "downstream"?**	Crowding out national systems, reduce incentives for addressing systems failures	Technologies will be taken up, there will be impact from research
	Who should be responsible for capacity building of national systems?	National governments	CGIAR working with others
	Source: Authors		

Since the IPG concept has been the main principle that the CGIAR system has put forth for defining its role, the analysis considered this as the dominant story that aims to underwrite and stabilize existing assumptions for policymaking. Arguments against this narrative were considered as counterstories (Figure 4-1) that run parallel to, and oppose the dominant policy stories. Table 4-2 shows a summary of the dominant and opposing narratives with a beginning, middle and end for both storylines. They comprise information from the interviews as well as from review of CGIAR documents.

In section 4.5, the arguments put forward by respondents to support their position have been presented in detail. Proponents of each policy narrative framed the problem as a failure of the

opposing institutional set-up and assigned blame to existing institutional structures. For example, while IPG-narrative supporters pushed for continued development of new technologies that significantly perform better than existing ones, uptake-narrative supporters insisted that good technologies existed but delivery systems were not effective.

The case studies also illustrate that opinions on the role of the CGIAR, are greatly influenced by the context. Where NARS played a significant role in adaptive research and the release of a variety, ICRISAT is seen to be best suited for IPG research. An example is the research and dissemination of improved chickpea varieties JG 11 in India and Shasho in Ethiopia. Where NARS are weak or ineffective, a downstream role for ICRISAT is seen as essential to get technologies taken up. In the case of groundnut in India, ICGV91114 was released as a special case implying that State Agricultural Universities (SAUs) played a lesser role in adaptive research. In Malawi, ICRISAT coordinated adaptive research and is still involved in seed multiplication and promotion. This means that prevailing conditions at the national level play a critical role in and ability to mobilize constituents to support a given policy narrative.

4.7 Discussion

Narrative policy analysis as an analytical tool has a good potential for providing insights on the conditions that enable or hinder successful institutional reform, and the process by which the reform can be achieved. For example, the literature recognizes the role of field level conditions and characteristics of the actor in enabling institutional reform (Dorado, 2005; Lawrence, 1999; Fligstein, 2001). So far, implementation of the IPG concept to guide priority setting for CGIAR activities has not been very successful because of the difficulty in characterizing all CGIAR products as IPGs. Donors, who have the resources and power to drive the research agenda, have also increasingly paid attention to impact rather than IPGs.

4.7.1 Difficulty in operationalizing the IPG concept within centers

The international public good concept has been used in CGIAR strategy to defend the idea that centres should focus on research whose outputs are available and applicable across many countries. While the classical public goods definition appeals to non-rivalry and non-excludability principles, CGIAR products fall under different "shades of grey" (Pardey, 2006). Samuelson (1955, p. 389) also warned that a public good is an ideal theoretical concept that has limitations in strictly applying it to real policy matters. Characterizing CGIAR products as IPGs may be helpful in contextualizing the underlying knowledge that research is hoped to generate, but not for a practical, priority setting context" Pardey (2006, p. 85). Considering the broad goals of the CGIAR, the system has a trade-off between focus on IPGs versus system level outcomes and impacts. Whether or not a focus on IPGs results in optimization of the CGIAR goals is a big ideological question.

This leads to the opposing view that if capacity to adapt these technologies to conditions at the national level is lacking, IPGs will not be widely adopted. Declaring something to be an IPG has meaning only when considered within the political and policy processes that ensure its delivery (Dalrymple, 2008). As a result of insufficient capabilities of research and extension systems in developing nations such as Malawi, merely producing IPGs is not enough. We have seen that players in the pro-uptake narrative contend that the IPG argument is not feasible and that investment in complementary national and regional public goods is more plausible. Such discursive strategies are well recognized in the literature for creating credibility, acceptability and trust (Hajer, 1995. p. 59).

The analysis undertaken in this study shows that many still feel that the CGIAR centres are responsible for working downstream to ensure uptake and impact. The CGIAR research program on grain legumes (CRP 3.5) also recognizes the need for downstream engagement. Three out of its five strategic components aim at; (i) facilitating legume seed and technology

delivery systems, (ii) enhancing post-harvest processing and market opportunities, (iii) and, fostering innovation and managing knowledge (CGIAR, 2012).

4.7.2 Actor interests and the role of donor pressure

Prior to the formalization of the CGIAR as a system, the initial overseas development work of the Ford and Rockefeller foundations involved sponsoring scientists to work with their counterparts from developing countries. The long term intention was that of developing local capacity after which the "international" scientists would return to their former employers once the country programs were closed (Herdt, 2012). Over the years, as the centres established themselves, the situation has changed. CGIAR scientists no longer have another headquarters apart from their own centre to look to for their long-term job security. For this reason, the individual centres have to work towards their long-term survival so as to maintain the job security of the scientists. Most national programs would not offer matching incentives and because of the applied nature of their research, the scientists may not fit well in advanced research institutes either.

A key determinant of continued operation for the centres is access to financial resources. Therefore besides interests and beliefs, access to funding and the source of those funds determine the research direction of the CGIAR. Donors have the political capital (Birner and Wittmer, 2003) to push for agendas that are in their interest, and get what they pay for. This has been the case in the last two decades when the centers faced funding shortages and had to increasingly rely on bilateral projects (Wright, 2012). As such, discursive democracy (Bessette, 1980; Birner et al., 2011) is undermined by power structures associated with funding mechanisms. Even though it had been emphasized at the system level that research should focus on the production of international public goods, a lot of these projects had substantial technology dissemination and promotion components. This forced the centres to

engage in location-specific projects with short term impacts at the expense of pursuing long-term CGIAR system priorities.

The CGIAR institutional reform process initiated in 2008 was meant to address this problem and ensure more stable funding to the centres. In the new arrangement, donors should provide funding through the CGIAR Fund, which in turn funds the CGIAR Research programs (CRPs). Funding through Window 1 and 2 would enable the CGIAR system to organize its research in line with the strategy and results framework (SRF). However, to date donors still prefer to provide a significant proportion of funding through a third window where they can channel funds directly to centres. As suggested by Daokui et al. (2005), actors with a good understanding of the bureaucratic systems have the capacity to navigate through policy processes within a system. This means that the reforms are still contested and donors are reluctant to let go of their role in influencing the research direction of the centres.

4.7.3 Reframing the CGIAR positioning debate

The narrative analysis shows that there is still a knowledge gap in objectively tackling the dilemma of how the international centres should position themselves in the R-D spectrum. Proponents of the international public good criterion have not been able to provide a credible argument as to how the concept can be practically applied in guiding CGIAR research activities. For priority setting purposes, there is the need to develop an alternative framework for justifying the extent to which the CGIAR centres should work on producing IPGs, and to what extent they should engage in location-specific activities to ensure impact. Alternative criteria are required for assessing the comparative advantage of the CGIAR especially at a time when the CGIAR system is undergoing a reform process. As Roe (1994) points out, criticism of the dominant story will only strengthen its position as long as there is no fully developed alternative approach to the policy issue (Roe, 1994).

One potential approach is to use perspectives from New Institutional Economics (NIE) to identify the most cost-effective arrangements for achievement of a given outcome. Transaction costs economics, one of the branches of NIE, offers a framework where transactions that differ in their attributes are aligned with governance structures that differ in their costs and competence (Williamson, 1991). It is therefore a plausible approach that can provide conceptual guidance on how impact from IARCs can be achieved most cost effectively. In order to use this approach, more empirical work would be required and to specify the transactions involved in the development and uptake of products from international agricultural research, and a comparison of different governance alternatives.

4.8 Conclusion

The analysis undertaken in this chapter shows that beliefs and interests of stakeholders do matter in decision making. There are differing opinions on whether IPG is the right criteria for deciding what the CGIAR should invest its resources in. The dominant story from various documents and statements from the CGIAR is that the IPG concept places the CGIAR niche in research that may not be conducted by national systems or the private sector. The difficulty lies with defining and operationalizing it for priority setting. The counterstory is that attention has to be paid to both research and development-oriented activities so that IPG outputs can be taken up, without which international agricultural research will not achieve its mission. However, none of these narratives offer an objective and practicable means to decide what activities the CGIAR should actually do and what should be the role of national partners and other players. The use of transaction costs economics is proposed for developing alternative criteria for positioning the CGIAR, taking into account cost-effectiveness considerations.

CHAPTER 5

DEFINING THE FUNCTIONAL BOUNDARIES OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS: A CONCEPTUAL FRAMEWORK

5. DEFINING THE FUNCTIONAL BOUNDARIES OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS: A CONCEPTUAL FRAMEWORK

5.1 Introduction

In the previous chapter we have seen that there is an alternative view suggesting that achieving impact requires involvement by international centers in activities such as adaptation, dissemination, extension, technical assistance, policy advice, and training (Pingali and Kelley, 2007). Therefore, even though they should have a clear direction in pursuing long-term strategic goals, this should also encompass some degree of flexibility. In order to effectively address agricultural development concerns, the centers are expected to be open to change and respond sensitively to the wishes of a broad array of local stakeholder groups (Horton and Mackay, 2003).

To take full advantage of talents and opportunities of different actors in the wider agricultural innovation system[15], a reform process of the CGIAR was initiated in 2009 (CGIAR SRF, 2011). The CGIAR Fund was established to finance thematic CGIAR Research Programs (CRPs) that involve several centers. Funding is allocated through two funding windows, one channeling funds to the overall system, and one to specific CRPs, with the goal to ensure increased and coordinated funding linked to CGIAR system agenda and priorities. However, donors preferred to have a third window to be able to channel funds directly to specific centers and projects. This suggests that there is still tension between the focus on the generation of international public goods (IPGs), as guided by the strategy and results framework (SRF), and more location-specific activities to be funded under bilateral projects in Window 3 through which donors pursue their priorities.

[15] The agricultural innovation system comprises the agricultural research and education system, the interactions of bridging institutions for technology delivery, and the ultimate users.

It is therefore crucial, as the CGIAR undergoes this reform process, to analyze the outstanding debate on the comparative advantage of the international centers, and the question of what activities they should focus on. So far, the international public goods (IPG) concept has been put forth to guide decisions on what the CGIAR centers should do, but as has been discussed in chapter 4, there are contrasting views on this criterion. This chapter aims to contribute to this debate by developing a framework based on concepts of the New Institutional Economics to identify the factors that determine the comparative advantage of IARCs. This framework is illustrated with an empirical case study conducted in India, Ethiopia and Malawi.

From a normative point of view, the comparative advantage of IARCs is related to the question as to what governance structure is best suited for the different types of transactions involved in research and in the implementation of research findings. The transaction costs approach, a branch of the New Institutional Economics, offers an analytical approach that aligns transactions that differ in their attributes with governance structures that differ in their costs and competence so as to achieve a cost-effective result (Williamson, 1991). The chapter adapts this transaction cost economics framework to the specific features of agricultural research organizations with the aim to provide conceptual guidance on how impact from international agricultural research can be achieved in the most cost-effective way.

In order to use this approach, it is necessary to specify the different transactions involved in the development and uptake of products from international agricultural research. An empirical case study of an important area of agricultural research was conducted for this purpose: research that aims to improve legume crops, which is supported by one of the fifteen CGIAR centers, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Legumes, which include crops such as beans and lentils, also referred to as the “meat of the poor”, make significant contributions in developing countries as a source of protein. They also play an important role in maintaining soil fertility as they are able to fix nitrogen.

In the empirical case study, an innovative empirical research tool called "Net-Map" was used. Net-Map is a participatory mapping technique (Schiffer and Hauck, 2010), which was applied in three developing countries to identify the different activities (transactions) and organizations involved in research on improved legumes and their promotion. After developing a typology of transactions based on the empirical study, a transaction cost economics framework was developed and used to analyze the comparative advantage of different organizations in conducting the different types of transactions. By integrating contextual factors, the framework also serves to identify why international centers engage in activities for which they are not expected to have a comparative advantage vis-à-vis national or local organizations, as was the case in all three case study countries.

The chapter is structured as follows: Section 5.2 provides a brief account of the governance challenges in the international agricultural research system. Section 5.3 reviews some of the drawbacks of the concept of "international public goods", which has so far dominated the debate on what IARCs should and should not do. Section 5.4 presents the methodology, and Section 5.5 presents the case study of groundnut improvement, taking Malawi as an example. Section 5.6 develops the conceptual framework based on transaction cost economics, using the empirical case study for illustration. Section 5.7 discusses the application of the framework, and Section 5.8 concludes.

5.2 Governance challenges in the international agricultural research system

Since the establishment of IARCs under the CGIAR, their mandate has expanded to include reduction of rural poverty, increasing food security, improvement of human health and nutrition, and ensuring more sustainable management of natural resources. These goals are also emphasized in the World Development Report 2008 on "Agriculture for Development",

which stresses the importance of agriculture-led growth for reducing poverty, achieving food security and contributing to sustainable resource management (World Bank 2007). It has long been acknowledged that productivity improvements, based on investments in agricultural research, are key drivers for this growth (Alston et al., 2000). The CGIAR system plays an important role in this regard, as it employs almost 10,000 scientists and staff and has a funding volume of more than 870 million US$ (CGIAR, 2012: 3).

While contribution of the CGIAR to agricultural development has been widely acknowledged[16], the organizational structure of the CGIAR system has been subject to debate and reform efforts for decades. As a recent review by McCalla (2014) indicates, these reform efforts did not lead to major changes in the institutional structure of the system. Being a large institution comprising diverse interest groups of political players (donors) as well as operational ones (centers and their research partners), and strategic ones (advisory bodies), the CGIAR is inevitably confronted with governance and co-ordination challenges (Kassam, 2006; Alston et al. 1998). In the first quarter of the century after their establishment, the centers remained under a loosely-knit, decentralized structure and received a large share of unrestricted funds based on voluntary contributions (Anderson, 1998). The centers were independently governed and research programs were directed by centre boards and management (Herdt, 2012).

Over time, poor coordination among donors and an increasing amount of "special project" funds reduced the ability of the centers to pursue long-term priorities. The result has been a lack of a system-wide vision and strategy for impact, limited sense of overall ownership, duplicate mandates and loss of system efficiency, complex and cumbersome governance and

[16] The CGIAR played a prominent role in the "Green Revolution" in Asia, the unprecedented increase in food production in Asia starting in the 1960s that was made possible by the promotion of high-yielding varieties. According to the CGIAR's website, the current overall benefits of CGIAR research in Asia are estimated at US$10.8 billion a year for rice, US$2.5 billion for wheat, and US$0.8 billion for maize (see http://www.cgiar.org/who-we-are/).

lack of accountability. At a meeting of stakeholders of the CGIAR system in 2008, rising concerns over these problems and stagnating funding levels led to the decision to promote a fundamental institutional reform of the CGIAR system (BCG, 2009: 5).

A key factor affecting the desired outcomes from the CGIAR is the role played by donor countries and other organizations and their indirect influence on the CGIAR research agenda. First, investment patterns still reflect the dominant position and contributions of a small group of donors (Table 5-1). Secondly, the UN bodies, aside from providing financial resources that support the CGIAR's science advisory body, also nominate the members and chair of the Independent Science and Partnership Council (ISPC) for approval by the CGIAR (Herdt, 2012). Third, US grant-making foundations operate under legal constraints that do not give them a free hand in deciding what projects they should fund (Council on Foundations, 2011).

Until the Gates Foundation came in as a key donor[17], the relative importance of private foundations and support from national governments to the CGIAR had weakened (Pingali and Kelley, 2007). The private sector has also not provided substantial financial support to the CGIAR system, from which they also benefit (Alston et al., 1998). These financial constraints and the requirement by donors to show impact pushed centers down the Research-Development (R-D) continuum (see next section), inducing them to engage in more location-specific research and extension activities (Bertram 2006). Katyal and Mruthyunjaya (2003) observed that centers were overstretched and compelled by donors to oblige to pet downstream projects. This is a shift from way the CGIAR system was initially crafted to encourage funding of long-term research institutes, but keeping aid professionals from setting research agendas and hiring scientists (McCalla, 2014).

[17] The Bill and Melinda Gates Foundation (BMGF) started funding the CGIAR system in 2006 and by 2010, it was spending about 10 times more than the ‘old’ foundations annually (Herdt, 2012).

Table 5-1 Top Donors by Decade (Amount in US$ million)

1971-1979		1980-1989		1990-1999		2000-2010	
United States	**105.7**	United States	**412.7**	World Bank	**426.8**	United States	**650.4**
World Bank	**42.9**	World Bank	**236.0**	United States	**392.3**	World Bank	**539.9**
Canada	**39.3**	Japan	**127.9**	Japan	**321.9**	United Kingdom	**389.4**
Germany	**33.9**	Canada	**103.0**	European Commission	**159.3**	European Commission	**337.5**
IADB*	**29.2**	IADB*	**88.8**	Switzerland	**149.7**	Canada	**298.2**
United Kingdom	**23.7**	Germany	**87.5**	Germany	**146.7**	BMGF***	**218.6**
Rockefeller Foundation	**21.2**	United Kingdom	**78.1**	Canada	**143.6**	Switzerland	**198.5**
Ford Foundation	**20.3**	UNDP	**72.1**	Netherlands	**110.3**	Netherlands	**185.6**
UNDP **	**19.3**	European Commission	**67.3**	United Kingdom	**109.7**	Japan	**184.0**
Sweden	**15.3**	Switzerland	**58.5**	Denmark	**102.8**	Germany	**170.6**
		Italy	**58.5**				

*** Bill and Melinda Gates Foundation (Began contributing in 2004), ** United Nations Development Program, *Inter-American Development Bank

Source: CGIAR Fund Office, 2011.

As indicated in chapter 2, even though windows 1 and 2 funding provide the opportunity to finance research in accordance with the strategy and results framework (SRF) of the CGIAR system, a significant proportion of funding is still allocated through Window 3. Moreover, in 2012, more than half of the funds provided to the CGIAR system was still provided through bilateral funding from donors to centers outside these funding windows[18]. This indicates that, so far, a major element of the reform has not yet been implemented.

There is still uncertainty on how the relationship between the Consortium and the centers will evolve over time, especially regarding oversight and accountability[19] (Ozgediz, 2012). Ultimately, the reform aims to result in a more centralized system of CGIAR governance.

[18] According to the CGIAR Fund update for February 2014 (page 2), the total inflows as of December 31, 2013 comprised USD 292.3 million for Window 1, 149.8 million for Window 2 and 253.5 million for Window 3. Besides the window funding, there is still a large contribution from bilateral projects, which in 2013 accounted for 45percent of all CRP funding (CGIAR Financial Report, 2013: 18).

[19] While the Consortium controls the flow of funds from the CGIAR Fund to the centers, it has limited authority over the centers since it is their own creation.

This move has not been without criticism. Hartmann (2009) sees the CGIAR reforms as moving research decisions too far away from center scientists, who interact more frequently with national colleagues, farmers and national governments and therefore understand local needs.

Ekboir (2009) argued that it will be vital to develop a coordinated system of decentralized experimentation with centralized learning to address the challenges that prompted the reform process. Against this background of a major reform, which has remained contested and only partly implemented, it seems important to reconsider the question of the comparative advantage of the CGIAR centers, as it is essential for current and future reform efforts. The next section reviews the concepts that have, so far been applied to deal with this question.

5.3 Assessing the comparative advantage of CGIAR centers

The question of the comparative advantage of the CGIAR centers vis-à-vis national agricultural research and extension organizations has been subject to long-standing debate. Two concepts have been developed in this context: the concept of a research - development continuum, and the concept of International Public Goods, which have been discussed in chapter 2.

5.3.3 Drawbacks of the IPG criterion

The emphasis on applying the international public goods lens to a variety of issues has led to a certain degree of confusion, and has mystified policy and decision makers who have had to apply the concepts in practice (Sagasti and Bezanson, 2001, p. 1-3). IPG characteristics are easy to define, but the challenge lies in how to operationalize them in the centres. Ryan (2006: 5) noted that "The IARCs (and the Science Council) are currently wrestling with both the identification of these boundaries (of the different types of economic goods) and how to

weigh up choices about the focus on the more obvious "public" outputs, versus other goals of the CGIAR related to impacts on poverty, food and nutrition security and the environment". This concept can be more easily applied to traditional CGIAR research, like germplasm improvement and development of new crop varieties, for which economies of scale and spill-over effects can be determined more easily compared to other types of technologies or knowledge, such as natural resource management.

The term "public good" has been used to describe a large number of products and services that do not comply strictly with the economic definition derived from economic theory. For example, Sagasti and Timmer (2008) note that the CGIAR system is suitable for the development and dissemination of three types of international public goods associated with agricultural research: knowledge, products and services, and institutional capacity. Natural resource management research that involves substantial development of locally adapted technologies has also been framed in IPG terms (Harwood et al., 2006).

According to the definition of IPGs presented in chapter 2 (Harwood et al., 2006 p. 381), it is not sufficient that the CGIAR outputs are available internationally (in fact, everything placed on the internet would fulfill this criterion). The IPG stance also rests on the premise that benefits are inherently international in range and applicable to members of the public within that range, without necessarily implying that all people derive a measurable benefit. The presence of a public good is not a guarantee that every member of the public will derive the same benefit from it (Muraguri, 2006). The question that remains is whether it is enough for the CGIAR centres to just make IPG outputs available to its potential users, or whether they are also responsible for ensuring that these products are also delivered and utilized by its consumers.

The IPG concept has also been criticized for not adequately taking into account what is required for the IARCs to achieve impact. IPGs have to be utilized by national programs, organizations or individuals in a specific location to achieve impact. The impact pathways for IPGs will be influenced by the institutional context, including policies and political systems (Kherallah and Kirsten, 2001). Some critics consider the IPG criterion as "a conceptual barrier with an unrealistic division of labor between research and development" (CGIAR Science Council 2008, Page 3). Since obstacles to achieving impact are particularly pronounced in developing countries, it has been argued that "IPGs should not be a shelter to hide behind the institutional bottlenecks". For instance, if seed markets are a limiting factor, would producing improved lines be a 'relevant' IPG? Some critics argue that "the most significant transformations led by the CGIAR took place before the advent of 'IPGs'" (CGIAR Science Council 2008, Page 4).

These arguments, and the ones presented in chapter 3, show that there are contrasting views on whether the IPG concept is refined enough to provide clear guidance on what the CGIAR centers should do or not do. Whether one adopts the research-development continuum or the IPG concept, the question still remains as to how the CGIAR is best placed within the range of institutions involved in agricultural research and development. Against this background, this paper therefore develops a more refined conceptual framework to provide conceptual guidance for assessing the comparative advantage of IARCs.

5.4 Methodology

The research presented in this paper consists of two components: (i) A case study, which aims to provide a detailed account of the research and dissemination process of improved technologies produced by international agricultural research centers, and (ii) a conceptual framework to define the functional boundaries of IARCs based on their comparative

advantage. The case study focused on examples from the breeding program for legume varieties at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

The study was conducted in three countries that differ with regard to the capacity of their agricultural research systems and the state of their seed systems: India, Malawi and Ethiopia. Data collection methods included a meta-analysis of adoption studies, a participatory mapping tool called Net-map and key informant interviews. Respondents included ICRISAT scientists, national partners, non-governmental organizations (NGOs), seed companies and certification agencies, male and female farmers and other stakeholders involved in the research and promotion of improved groundnut and chickpea varieties.

To develop the conceptual framework for analyzing the comparative advantage of the CGIAR centers in conducting different activities along the research-impact pathway, the case study was combined with an application of the fiscal federalism literature (Oates, 1972) and transaction cost economics (Williamson, 1991; Birner and Wittmer, 2004). This approach follows earlier applications of the fiscal federalism literature and transaction costs economics to analyze the appropriate level of decentralization for different types of rural services (Bardhan, 2002; Birner and von Braun, 2009).

5.5 Case study: The legumes improvement program at ICRISAT

Improved legume varieties with higher productivity and disease resistance can make a huge contribution to the well-being of poor farmers. Legumes, however, have two characteristics that make their seed production not very attractive to the commercial seed industry, leading to market failures. These are the self-pollinating nature, which implies that farmers can

reproduce their own seeds, and the low seed multiplication ratio[20], which renders seed production relatively expensive.

Hence, breeding, adaptation, multiplication and dissemination of improved legumes typically relies on publicly funded international and national agricultural research and distribution systems. ICRISAT[21] currently leads the CGIAR research program on grain legumes (CRP 3.5[22]) and collaborates with three other CGIAR centers and partners to increase the production, value and nutritional quality of grain legumes cultivated in the poorest regions of the world.

For the development of a transaction costs framework, it is important to understand all transactions involved in a process. We will use the empirical results from the case study on the groundnut variety CG 7[23] in Malawi as an example to identify and illustrate these steps. The results from using the Net-map tool for this case are presented in Figure 5-1. The diagram shows the different transactions and the actors including performing them, including ICRISAT, donors, relevant ministries, NARS and agricultural universities, extension systems, seed companies, NGOs, farmers and farmer organizations.

[20] This is the number of seeds to be produced from one single seed when it is sown and harvested.
[21] Chickpea, pigeonpea and groundnut) are among the mandate crops of ICRISAT
[22] The Grain Legumes CRP is led by ICRISAT in partnership with International Center for Tropical Agriculture (CIAT), International Institute of Tropical Agriculture (IITA), ICARDA, CGIAR Generation Challenge Programme, USAID-supported Feed the Future initiatives, and NARS in Ethiopia, Brazil, Turkey and India.
[23] This variety is also known as ICGV-SM 83708 and ICGMS 42.

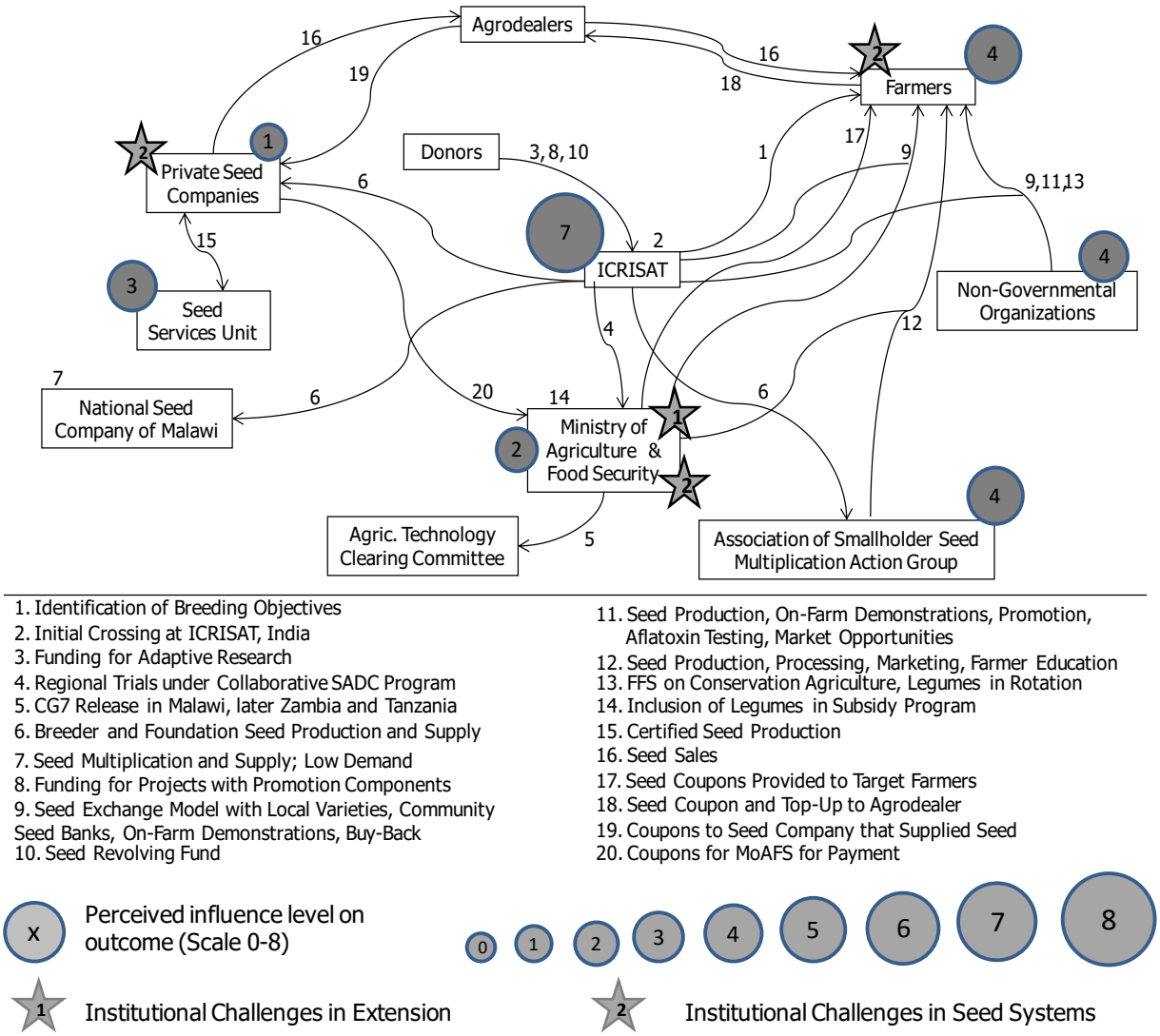

Figure 5-1 Process-Influence Map for Research and Promotion of Groundnut Variety CG7 in Malawi.
Source: Authors

The arrows indicate the different transactions, and the numbers indicate the sequence of activities, which are explained at the bottom of the diagram. The circles indicate the rating of influence of the actors (on a scale of 1-8) by the respondents of the Net-map tool. They rated their influence on the final outcome, which was defined as the goal that the improved seed varieties are actually adopted by the farmers. The stars represent governance challenges in extension and seed systems that were identified by the respondents.

The following transactions were identified; (i) the first step was identification of the production constraints faced by farmers and breeding objectives to be pursued (ii) the variety

was bred at the ICRISAT headquarters in India in 1977/78 by the crossing two lines (USA 20 and TMV 10); (iii) breeding material was supplied to different regions; in Southern Africa it was introduced by ICRISAT in 1982 under the Southern African Development Community (SADC) Groundnut Project, which involved 9 countries and was funded by the German Society for International Cooperation (formerly GTZ) and later the International Development Research Centre (IDRC); (iv) Starting from the 1983/84 growing season , yield trials, testing and adaptation were conducted across locations against existing varieties (v) the CG7 variety was released and notified in 1990 upon approval by a varietal release committee; the release was based on submission of performance data reflecting a yield advantage of between 11 and 35 percent. In 1991 it was released as MGV 4 in Zambia and in 1999 as Serenut 1R in Uganda. (vi) breeder and foundation seed were produced by ICRISAT, while the National Seed Company of Malawi produced certified seed, but there was low demand from farmers; (vii) the variety was promoted by ICRISAT and partners to create awareness among farmers through the distribution of small seed samples, field days, on-farm demonstrations, farmers field schools, the media and other means; (viii) Further foundation and certified seed production was carried out by ICRISAT's revolving scheme that involved contract growers who got seed on credit. ICRISAT also established community seed banks to hasten the diffusion of the variety. NGOs (World Vision, CARE, Plan International, ActionAid, CADECOM) and smallholder farmer and seed producers associations like the National Smallholder Farmers' Association of Malawi (NASFAM), and Association of Smallholder Seed Multiplication Action Group (ASSMAG) also started producing seed; (ix) private seed companies (Peacock Enterprises, CPM Agri-Enterprises, Demeter Agriculture, SeedCo, Pannar Seed, Funuwe, Pantochi etc) joined in certified seed production as legumes got included in the government subsidy program 2009 and created high demand for new varieties (x) the variety was taken up by farmers, with incentives from the input subsidy program (coupons), and also through farmer to farmer exchange. (xi) Several organizations in the seed

sector came together to sell CG7 and other varieties under the Malawi Seed Alliance (MASA) umbrella.

The Net-map exercise also served to identify the governance challenges involved in the different transactions. As the capacity of the national system in Malawi for testing of the new variety was rather limited, ICRISAT decided to post a groundnut breeder from its Indian headquarters. He spent 5 years in Malawi to initiate and coordinate regional testing of material and facilitate varietal release, and after he returned to India, ICRISAT maintained the scientist position at the Chitedze Agricultural Research Station. During an interview he explained "Each country has its own protocol for variety release. CG 7 was selected among the several hundred breeding populations carried by me to Malawi in 1982/83. It was evaluated in Cooperative Regional Yield Trials in the SADC region during 1983/84 - 1986/86. After this, it was further evaluated in national trials / on-farm verification trials in some countries (in Malawi 1988/89 and in Zambia 1987/88 -1988/89). In 1988, it was accepted as pre-release cultivar in Zambia and was named as MGS 4. Varietal release is a long drawn process in some countries". CG7 was released in 1990 and for a long time was a typical case of a variety that remained on the research station shelf long after its release even though it had a proven yield advantage.

As can be seen from steps 8-13 in Figure 5-1, the variety was only adopted after donors provided resources for seed multiplication and promotion to ICRISAT, NGOs and other seed producers. The National Seed Company of Malawi that had initially produced foundation and certified seed was taken over by Monsanto in 1999. It took further interventions by ICRISAT and partners in the area of agricultural extension (e.g., field demonstrations) as well as a subsidy program to get the variety adopted.

To date, even though government institutions like the Extension Department and Department of Agricultural Research Services (DARS) do exist, capacity gaps still remain and the

ICRISAT Malawi office continues to be engaged in downstream activities. This explains why it was ranked highest in terms of level of influence on the desired outcome, i.e. wide adoption of CG7 among farmers (Figure 5-1).

For reasons of scope, the findings from the other Net-map exercises are not reported here, but the main steps in the research and promotion process were similar. Both in India and Ethiopia, varieties were tested by agricultural universities or research stations and the results submitted to a varietal release committee. However, unlike Malawi, seed corporations played an important role in seed multiplication. With regards to technology dissemination, all the chickpea and groundnut varieties required promotion efforts by ICRISAT and partners even in countries with better NARES capacity.

In the next section, the findings from the case studies are used to develop a conceptual framework to identify the comparative advantage of IARCs in conducting the different transactions that were identified, taking the governance challenges into account.

5.6 Conceptual framework

The transaction cost economics approach used here is based on the so-called "discriminating alignment hypothesis" developed by Williamson (1991), according to which "transactions that differ in their attributes are aligned with governance structures that differ in costs and competence so as to achieve an economizing result" (Williamson, 1991, p. 281). The first sub-section introduces the basic structure of this framework, and the following sub-sections apply the framework using the case study results.

5.6.1 Determining the comparative cost-effectiveness of IARCs versus national systems

The decision on whether a transaction should be carried out by a an international research center or a national organization can be conceptualized as a choice between a more centralized (international) and a more decentralized (national) governance structure. The choice between these governance structures is influenced by the attributes of the respective transactions Figure 5-2, which is based on Williamson's (1991) original approach, illustrates this choice problem in a cost-effectiveness diagram.

The vertical axis displays the total cost involved in achieving a specified result of the respective transaction, including transaction costs and other costs. They include direct costs that can be directly assigned to the respective activity (such as the salary of the researchers and the cost of the research infrastructure) as well as the transaction costs, e.g., the costs of planning, coordination and supervision.

The horizontal axis depicts the level of the attributes that influence the comparative advantage of different governance structure. The figure displays two different hypothetical cost curves[24], which show how the total costs arising for achieving a specified result change, depending on the level of the attribute displayed on the horizontal axis. One curve depicts the costs arising for carrying out the transaction by a IARC (TC^i), and the other depicts the total costs for carrying out the same transaction by a National Agricultural Research and Extension System (NARES) (TC^n).

[24] While the above comparison considers IARCs and NARES, we recognize that there are many other actors in the agricultural R&D process. IARCs often work in collaboration with partners on joint research projects.

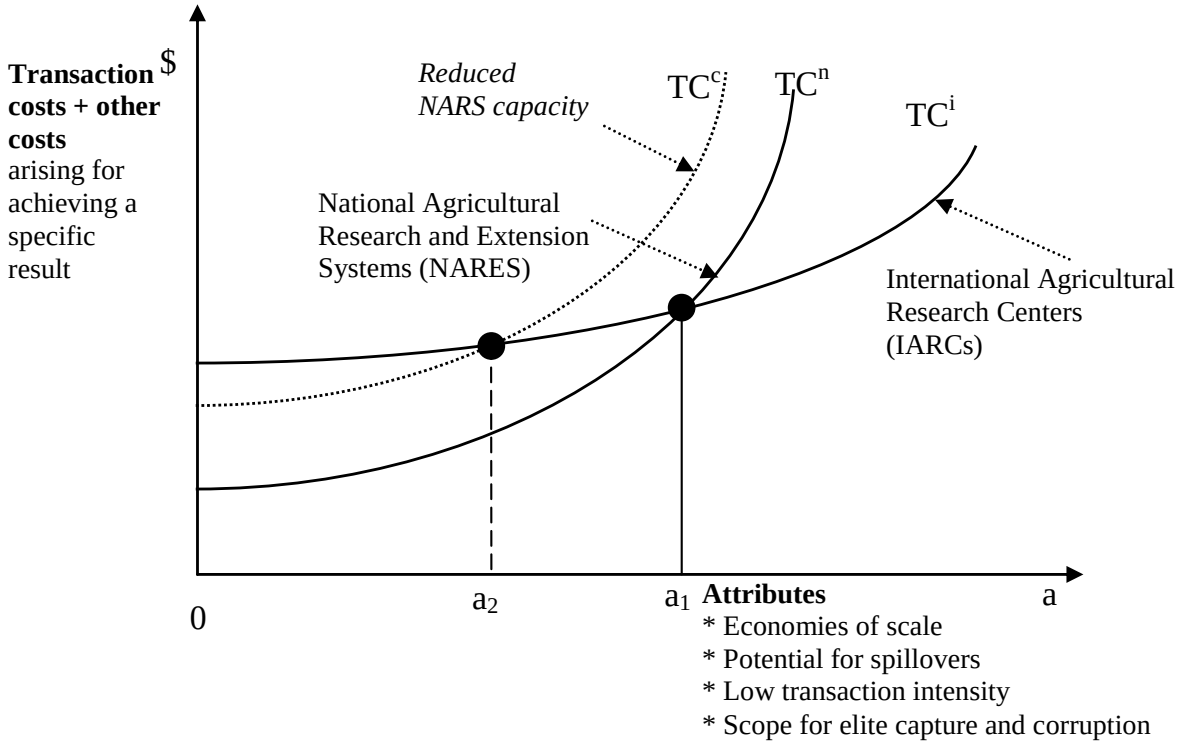

Figure 5-2 Comparative cost-effectiveness of conducting research by IARCs versus NARS.
Source: Based on Williamson (1991), Birner and Wittmer (2004) and Birner and von Braun (2009)

The fiscal federalism literature (Oates, 1972) identifies economies of scale and potential for spillovers as important attributes of transactions, which influence the appropriate level of decentralization. In the example displayed in the figure, the costs of providing the transaction increase more rapidly for the governance structure of the NARES if the level of the respective attribute, for example, *economies of scale*, increase (moving to the right-hand side on the horizontal axis). This is indicated by the relatively steeper slope of the TC^n cost curve. If the potential for economies of scale is low (moving to the left-hand side on the horizontal axis), the transaction is more economically provided by NARES. From point a_1 onwards, it is more economic to assign the transaction to the IARC, because the IARC will achieve the same result at a lower cost. Phrased differently, the diagram shows that from point a_1 onwards, the governance structure of the IARC has a comparative advantage over NARES for carrying out the respective transaction.

Following the considerations of the IPG criterion explained above, the rationale is that the IARCs have higher set-up costs and running costs than NARES. Taking the case study as example, the salaries of ICRISAT researchers are much higher than those of staff employed in the NARES Malawi. IARCs have a comparative advantage if they use their more expensive set-up to engage in activities with high economies of scale, such as applying expensive breeding techniques for crops that can be grown in different regions.

The same argument applies to the attribute of *spill-over effects*, as indicated above. The term "spillovers" has been used in the international agricultural research community before the 1990's (Davis et al., 1987). Bantilan and Davis (1991) identify three types of spillovers: across-location, across- commodity and price spillovers. Technologies are said to have spillover potential if they have applicability to other agro-ecological locations or for a different crop (Deb and Bantilan, 2001; Shiferaw et. al, 2004). Price spillovers occur when the technological change at a specific location increases supply of the commodity and changes the price at other locations through trade. As long as the expected outputs are intended to be relevant to many agro-climatic conditions and achievable through spillovers, the location where research activities are carried out is of little significance (Ryan 2006). Since the CGIAR centers have a global mandate, the research objectives and associated outputs are more likely to benefit other regions or countries (i.e. the potential impact domain is wider). It can therefore be expected that more farmers will be reached resulting in lower costs for a given outcome (level of adoption). The literature on decentralized governance also indicates that heterogeneity of local needs is an attribute that increases the comparative advantage of decentralized governance structures (see Birner and von Braun, 2009 and the fiscal federalism literature quoted there).

The framework also identifies the role of contextual factors, in particular, the capacity of the respective organizations carrying out the transaction. In a cost-effectiveness diagram, low

levels of achievement due to capacity constraints are depicted in form of a higher level of costs, since the diagram displays the costs for a defined unit of output. Figure 5-2 displays a case of low capacity of NARES, resulting in an upward shift of the respective cost curve (TC^c). Accordingly, the point from which onwards IARCs have a comparative advantage over NARES moves towards the left-hand side to point a_2. A reform or investment that results in increased capacity of the NARES would have the opposite effect (moving the TC^n curve downwards and shifting the intersection of the curves to the right-hand side).

The application of the transaction costs framework to the question of decentralization has shown that the effect of some attributes on the level of decentralization depends on contextual factors (Birner and von Braun, 2009). This is in particular the case for the following two attributes:

- *Transaction intensity*: This attribute refers to transactions that have to be carried out frequently (transaction intensity in terms of time) and in large areas (transaction intensity in terms of space). Transaction intensity has been used to characterize transactions in service delivery (Pritchett & Woolcock, 2004; Birner and Linacre, 2008; Birner and von Braun, 2009). The effect of transaction-intensity is ambiguous: One the one hand, this attribute increases the comparative advantage of NARES, because they have lower costs for carrying out a large number of transactions. On the other hand, the costs of supervising and ensuring the quality of activities with high transaction intensity is high. This increases the comparative advantage of organizations with high capacity that are able to provide strong performance incentives for their staff. In case of low capacity of the NARES, this will increase the comparative advantage of the IARCs.

- *Scope for elite capture and corruption*: If transactions are subject to these hazards, it depends on the organizational capacity to deal with these issues to what extent a more

centralized or a more decentralized organization has a comparative advantage (Bardhan, 2002, Birner and von Braun, 2009).

5.6.2 Types of transactions and their attributes

This section discusses how the approach outlined above can be applied in determining the comparative advantage of IARCs versus NARES in carrying out the agricultural research and development activities identified in the case study. For simplification, one can classify the types of transactions involved in the research-development continuum into the following types:

- ***Planning and priority setting***: The identification of breeding objectives (Step 1 in Figure 5-1) can be considered as a planning and priority setting transaction. Some breeding objectives can be considered rather universal, such as yield potential, while others are affected by a diversity of local preferences, such as taste and color.

- ***Technology development*:** Technology development transactions included activities such as setting up and maintaining the required infrastructure, genetic resources, and partnerships required for research, as well as the actual conducting of research. In Figure 5-1, activities from the initial crossing at the ICRISAT headquarters until the variety was incorporated into national breeding programs for evaluation (step 2-3) can be classified under technology development transactions. These activities range from basic and strategic research to participatory/adaptive research. The centers collect and maintain germplasm accessions, carry out crosses depending on breeding objectives and release advanced breeding lines for adaptation, testing and release.

- ***Field testing and varietal release***: Promising cultivars were initially tested at the ICRISAT experiment stations before further testing on a larger scale in different agroecologies, and later in farmers' fields. Varieties were approved for release if data

from multi-locational testing indicated that they performed better compared to the existing best variety (step 4-5 in Figure 5-1).

- ***Multiplication***: To obtain the required volumes of improved seed for sale/ distribution, seed multiplication is carried out in seed company farms or by using contract growers. Decentralized seed multiplication can also be carried out by small scale farmers who then sell the seed locally. Many of the activities between step 6-15 in Figure 5-1 involved seed production, processing, storage and distribution.

- ***Certification***: Since most characteristics of improved seed are not outwardly visible, information asymmetries are likely as the knowledge on seed quality is retained by sellers (Byerlee et al., 2007). Seed certification, usually by an independent body, is used as a means of quality control. Multiplication transactions and certification are specific to embodied technologies such as seeds, but the other types of transactions are equally relevant for disembodied types of technologies, such as natural resource management practices.

- ***Promotion***: Over the years, ICRISAT received funding from various donors including the Norwegian Development Fund, Irish Aid, BMGF, the McKnight Foundation and the Australian Agency for International Development (AusAID), for seed multiplication and promotion of CG7. Details of the activities conducted by ICRISAT together with NGOs and various departments under Ministry of Agriculture and Food Security (MoAFS) can be seen in steps 8-13 of Figure 5-1. The beneficiaries also had to undertake certain activities and incurred some costs aside from the cost of seed e.g. time and money used for travel or to access extension agents.

- ***Evaluation and impact assessment***: Impact assessments (ex post or ex ante) are carried out to identify and measure the economic, social, and environmental

consequences resulting from a program or project's interventions (Walker et al. 2008). Ex post evaluations serve as a means of showing accountability to donors and other stakeholders, and also help in learning on how to make agricultural research more effective (Horton and Mackay, 2003). Resource allocation and targeting decisions for research can be guided by rigorous ex ante evaluation of impacts, including spillover benefits across regions.

Having categorized these activities, we can now make an assessment of the relevance of each attribute identified in sections 5.6.1 for the each of the of transactions in the agricultural research-development continuum. The results are summarized in (Table 5-2).

Table 5-2 Relevance of Attributes

Transactions	**Relevance of Attributes**			
	Economies of Scale (incl. asset specificity)	**Spillover Potential**	**Transaction Intensity**	**Scope for elite capture and corruption**
Planning and priority setting Generic goals	High	High	Medium	Low
Location-specific goals	Low	Low	High	Medium
Technology Development Basic - strategic	High	High	Low	Low
Adaptive - participatory	Low	Low	High	Medium
Field testing and varietal release	Low	Low	High	Medium
Multiplication	Low	Low	High	Medium
Certification	Low	Low	Medium	High
Promotion	Low	Low	High	High
Evaluation/impact assessment	Medium	Medium	Medium	Medium
Source: Authors				

Planning and priority setting transactions

Priority setting activities together with resource mobilization require interaction with donors and other stakeholders who have knowledge on constraints facing the farming communities. Planning is carried out at the centre level to develop the global research agenda, and at the regional level to set priorities that address location-specific needs. These activities are associated with decision costs such as the direct costs of attending meetings (e.g. for strategic planning) and time spent in donor relations. The new system under CRPs exploits economies of scale and reduces transaction costs of interface activities. From a cost-effectiveness[25] point of view, the risk of incurring decision failure costs (Birner and von Braun, 2009) arises if the research agenda is not driven by local needs leading to suboptimal decisions.

Tools used for priority setting such as models for forecasting, scenario analysis and ex-ante impact assessment can be applied elsewhere representing a spillover potential. Planning transactions at the centers can therefore be associated with attributes of economies of scale and potential for spillovers and a more centralized approach is likely to reduce the costs. However, planning for the purpose of pursuing location-specific goals can be done more cost-effectively by the relevant government agencies in each country as it would otherwise involve high transaction intensity for the centers.

Technology development transactions

The running costs for research activities conducted by national system scientists may be lower compared to than IARCs. However, depending on the sophistication of techniques required, failure costs may be incurred if the research is delegated to a partner that does not have the required skill sets. The research lag may also be longer resulting in higher overall costs for a given research output if the NARS do not have sufficient capacity.

[25] Costs associated with achieving a set outcome are analyzed the outcome being held constant

The capacity to exploit economies of scale in agricultural R&D at a global scale is linked to the specialized assets the centers possess. In the case study, considering that ICRISAT has a specific mandate on groundnut research (also chickpea, pigeonpea, sorghum and pearl millet), the physical and human assets that the institute possesses are specialized. For example, the genebank will contain germplasm accessions for these mandate crops that cannot serve other crops' needs in terms of seeds[26]. On the other hand, agricultural research, requires a multidisciplinary approach e.g. integrated genetic and natural resource management approach (Twomlow et al., 2008). Some form of site specificity is required where synergy across themes is achieved when stations are located in a "cheek-by-jowl" relation to complement each other and economize on inventory and transportation expenses (Williamson, 1991). For instance, ICRISAT has facilities like gene bank, molecular lab, greenhouse etc. as well as human resources comprising molecular scientists, breeders, pathologists and agronomists all working on the same crop.

Where technical knowledge is relevant, such as basic research activities, IARCs may be more suited to exploit economies of scale in providing or utilizing this knowledge. An example is the ICRISAT genomics research that is based at its headquarters in India, but serves the needs of both Asia and sub-Saharan Africa.

Where potential for spillovers is high, research programs and infrastructure can be centrally set up with assurance that the products can be transferred and applied in similar environments elsewhere. For example, Maredia and Byerlee (1999) quantified spillover benefits for improved wheat germplasm across agro-ecological boundaries. Spillovers from research in one region within a country to another have also been estimated. For example, Alston et. al (2011) measure the returns to the United States public agricultural research with spillover benefits across states. Developed country agricultural research systems also benefit from the

[26] Except cases where there are across-commodity spillovers representing benefits for multiple crops

technology spillovers generated by the CGIAR; Brennan (1986) measured the benefits to Australian wheat breeding programs of access to breeding materials from CIMMYT. Brennan and Bantilan (2003) and Brennan et. al. (2003) use case studies of production spillovers to Australia from the work of ICRISAT and the International Centre for Agricultural Research in the Dryland Areas (ICARDA) respectively. Pardey et al. (1996) measured benefits to US wheat and rice production from germplasm developed at CIMMYT and IRRI. In the case of CG 7, the variety was not only released in Malawi, but also Zambia as MGV 4 in 1991, and Uganda as Serenut 1R in 1999 (Shiferaw et. al, 2004).

Basic and strategic research transactions can therefore be associated with attributes of high economies of scale and high potential for spillovers. Since a lot of interaction with farmers or travel to dispersed field locations is not required at this stage, basic and strategic research activities can be characterized by low transaction intensity. In this case, a more centralized approach is likely to reduce transaction costs. However, participatory and adaptive research activities having low economies of scale and low potential for spillovers and involving evaluation of breeding lines in different agro-ecologies across the country can be carried out most cost-effectively by the decentralized national systems.

Field testing and varietal release transactions

Field testing transactions have similar attributes to participatory and adaptive research since they involve testing of selected varieties across environments. However, the application of tight controls on variety release and seed trade presents a scope for elite capture and corruption. Plant breeders from the public sector are protected from competition as only varieties approved by the varietal release committee can be sold. These committees are composed of officials from the same monopolies and release is based on yields documented in government-run trials (Tripp and Rohrbach, 2001). In the case of groundnut variety ICGV91114 in India, although the performance of the variety was evident, it may not have

been released without lobbying from ICRISAT and the intervention of the Chief Minister (Birthal et al., 2012). This means that even though NARES should ideally have a comparative advantage in field testing and varietal release based on the attributes of low economies of scale and potential for spillovers and high transaction intensity, the scope for elite capture and corruption make this decision less straightforward.

Multiplication transactions

Seed multiplication is carried out based on demand projections for a specific country. Accordingly, breeder and foundation seed are produced by the research station or university that released the variety, while certified seed is produced by state corporations or private firms. Seed production under centralized seed company farms may have higher economies of scale but depending on the location of processing, storage and distribution facilities there will be additional costs of transportation. Use of decentralized systems such as contract growers has high transaction intensity as constant supervision is required. These factors imply that seed multiplication can be carried out most cost-effectively by NARES rather than IARCs.

However, as was observed in Malawi, these organizations often lack the resources and incentives to perform this function as required. From the case studies, we noted that breeder seed production is not funded separately from the actual breeding activities, the NARES have insufficient numbers of research and seed technicians, they lack processing, storage and distribution infrastructure, and breeders are rewarded for varieties they release and not seed multiplied. For this reason, ICRISAT was forced to engage in seed production activities even though they have high transaction intensity.

Certification transactions

Seed certification has high transaction intensity as it involves field inspections of the seed crop to guarantee the identity of the variety, and laboratory tests for attributes such as

germination percentage, purity, seed health and moisture content. Decentralization through smaller regional laboratories would provide rapid response to seed producers but is likely to present challenges in monitoring and maintaining quality standards (Cromwell et al., 1992). The responsibility for seed certification was placed on independent agencies in India (Andhra Pradesh State Seed Certification Agency) and Malawi (Seed Services Unit) while in Ethiopia a quality assurance department was set up within the Ethiopian Seed Enterprise (ESE) itself. While this separation is intended to avoid the certification being compromised, we noted that this did not guarantee quality.

The fact that certification agencies are mostly financed by the government makes them vulnerable to budgetary constraints. For example, seed production plots in Malawi were visited fewer number of times than what is stipulated in the regulations, as the resources available were limited. Inspectors with poor salaries are likely to engage in rent seeking behavior that might compromise transparency of the certification procedure (Tripp and Louwaars, 1997).

Promotion transactions

Technologies that are available for dissemination require further local development and adaptation. This makes it difficult to standardize activities such as extension and reduces the economies of scale and likelihood of spillovers. Promotion programs also have high transaction intensity as they require frequent interactions with farmers and the deployment of multiple staff throughout the country on a daily basis. These transactions should therefore be the responsibility of national systems who have local offices to facilitate monitoring and supervision and reduce transaction costs.

Nevertheless, the transaction intensity depends on what is being promoted. For example, as compared to information on new varieties, guidance on crop management practices such as

tillage operations, spacing or methods of seed placement and fertilizer application requires more interactions with farmers (Birner and von Braun, 2009). There are situations where NARES may lack sufficient capacity to promote certain techniques. In this case IARCs may then have a comparative advantage in carrying out promotion as has been seen in many natural resource management research projects (Harwood et al., 2006).

In the case of ICGV91114 in India, the variety faced a backlash from the national partners who have been reluctant to promote it alongside varieties such as K6 that were released by the local universities. ICRISAT made efforts to promote it through NGOs, but it still faces an adoption lag and has not been taken up on a large scale in the formal seed production process. This example shows how other players face additional costs of competition with the public extension system that accounts for a significant percentage of seed sales in developing countries.

Evaluation and impact assessment transactions

Impact assessment and project reporting activities involve costs for data collection, analysis and write-up. These costs escalate when the centers have a large number of bilateral projects with small budgets that need to be reported separately. Projects that do not budget for evaluation activities may be unable to show accountability to donors and therefore run the risk of losing additional funding.

We can conclude from the examples in the case study that the attributes of economies of scale and potential for spillovers, which are also recognized in the literature in international public goods, increase the comparative advantage (cost-effectiveness) of IARCs over NARES in carrying out the transaction. In addition, we identify transaction intensity and the scope for elite capture and corruption as important but ambiguous attributes that depend on the context and make the decision on comparative advantage less straightforward.

5.6.3 The role of contextual factors

An important factor emerging from the case studies that were undertaken and the hypothetical cost curves above is the influence of contextual factors especially capacity of national systems. As Von Braun et al. (2008) found, the average rate of return (ROR) to NARS in developing countries is much lower compared to IARCs; in Africa, the median ROR for IARCs is 83 percent higher than NARS, while in Asia and Pacific the gap is 72 percent (Von Braun et al., 2008). The fact that workers in national systems are often poorly compensated means that they lack incentives to perform effectively.

Another example is the green revolution in Asia, which is often seen as technological revolution. Much of the success is attributed to India's political interest to become food sufficient as well as willingness of the US government and donors such as the World Bank, and Rockefeller and Ford Foundations to provide support. C. Subramanian, the then Indian Minister for Agriculture, championed institutional changes in the agricultural innovation system of India that enabled the green revolution to materialize (Banerjee, 2013; Bhagat, 1998). Along the same lines, while the CGIAR has focused on advancing agricultural science and its application to productivity growth, actual realization of its mission depends on the institutional and policy context in target countries.

Contextual differences across countries will shape the uptake of technologies and subsequently the spillover benefits generated. There are huge variations across locations and across different commodities making it difficult to apply similar intervention strategies in different regions. As a consequence, CGIAR centers may not apply consistent positioning strategies because of differences in donor demands as well as huge variations in the institutional environment across locations and commodities. The lower the institutional capacity of national systems, the more IARCs will engage in downstream activities of seed multiplication and promotion.

5.7 Applying the framework

Based on the reviewed case studies and literature review on transaction costs, we have suggested a conceptual framework to compare which among a selected set of governance structures is the most cost-effective in agricultural R4D, taking into account the contextual conditions. Empirical research provides a set of institutional alternatives whose feasibility (administrative, fiscal, and political) can then be assessed. The standard approach in empirical transaction cost economics does not require a measurement of transaction costs (Shelanski and Klein, 1995). Empirically quantifying attributes of transactions may be challenging since variables such as asset specificity are difficult to measure. Although some surveys have used scaling methods (Brown and Potoski, 2003), such data are subject to the general limits of survey data since that they are based on the stated beliefs of respondents rather than those revealed through choice. The measurements, based on ordinal rankings, are also difficult to compare across institutions (Shelanski and Klein, 1995).

In the case of agricultural research for development, there is no market mechanism which ensures that the most efficient governance structures survive. Research managers therefore have to define the most appropriate institutional structures to achieve impact with a given set of resources. This analysis has derived propositions on the attributes of transactions for which IARCs have a comparative advantage over NARS. Transactions with high economies of scale and spillover potential should be ideally assigned to a centralized institution (IARC) while those with high transaction intensity to a more decentralized institution (NARS or other partner). While these implications are easier to derive for basic and strategic research, the other activities involve trade-offs depending on the context, technology and intended objective.

If we apply the normative framework to the case studies, we expect that international agricultural research should play an important role in upstream research such as breeding improved varieties, for which the centers have a comparative advantage. However, the contribution of outputs from agricultural research to improve welfare of the poor depends on contextual factors where the people live.

From the case studies undertaken, the role that ICRISAT and partners played as well as perceived level of influence depended on the context. In section 5.5 we discussed the case of CG7 in Malawi in detail. In the case of JG11 chickpea variety in India, the Jabalpur agricultural university had the capacity and willingness to engage in a collaborative program with ICRISAT and other universities for testing of the improved variety. The variety was tested through the All India Coordinated Research Project on Chickpea (AICRP-C) and released in 1999. Until promotion efforts were started by ICRISAT and state agricultural university (SAU) partners, it took about 10 years for farmers to adopt the variety due to limited awareness. Promotion efforts stimulated farmer demand, and entry of the variety into the seed production process. JG11 is now the most widely grown in South India.

However, in the same country the situation is different for groundnut variety ICGV91114 where there were NARS with capacity but lacked the will to engage. The variety was therefore proposed by ICRISAT and released in 2006 at the state level as a special case bypassing the All India Coordinated Research Project on Groundnut (AICRP-G). Although the performance of the variety is evident (Birthal et al., 2012), it faced a backlash from the national partners who have been reluctant to promote it. Efforts have been made to promote it though NGOs but it still faces an adoption lag and has not been taken up on a large scale in the formal seed production process. In Ethiopia, the NARS were empowered through training programs on chickpea improvement and by conducting joint research. Testing and promotion

efforts for Shasho and other chickpea varieties are now led by the Debre Zeit agricultural research centre.

ICRISAT has had to conduct seed production and promotion activities where developing countries lacked their own capacity to do so. Declines in core funding also led to increased dependence on bilateral projects with donor pressure to show impact pushing the centers downstream. This is problematic from a governance perspective because the IARCs compete with NARS, or reduce the incentives for national governments to overcome the governance challenges in their national systems. The CGIAR should device ways of addressing the capacity challenges instead of driving centers downstream. This would in the long run shift the cost curve for national systems (Figure 5-2) downwards, and allow them to carry out the activities for which they have a comparative advantage. This long term vision to build NARS capacity to do applied and strategic research was also expressed by the Technical Advisory Committee (TAC) of the CGIAR in the early 1990s (McCalla, 2014).

5.8 Conclusion

International agricultural research aims to address a range of issues facing resource-poor farmers in different nations. For the intended benefits to be achieved, investments are required at all levels from the international to the national. The analysis undertaken in this paper reviews concerns regarding governance of IARCs, and the ongoing CGIAR reform process to address some of these concerns. Review of discussions in literature and various fora identifies a gap in objectively tackling the dilemma of how the international centers should position themselves in the R-D spectrum. The IPG concept has been put forth as a criterion for what the CGIAR centers should focus on but there are still difficulties in defining and operationalizing it. In this paper, a normative framework is developed to address the critical

question on who should do what so that publicly funded international agricultural research can result in wider and sustained welfare benefits.

The framework presented applies transaction cost economics perspectives to conceptually analyze potential institutional options for carrying out activities along the R-D chain. This is a useful basis for strategic discussions on how far downstream the CGIARs should go in order to achieve impact from agricultural R&D most cost-effectively. Based on consideration of the relevant attributes of transactions and contextual factors, one can make trade-offs on whether to assign an activity to IARCs, NARS or other actor in the innovation system.

The differentiated approach used in the case studies shows that a complicated set of factors such as availability of funds and political pressure e.g. donor preferences will influence the decision to carry out specific activities. Donors have a goal to achieve impact in poor areas but the main problem is the capacity gap. There is a choice between investment in the tedious and long-term task of local capacity strengthening or avoiding these governance challenges by driving centers downstream. The example of ICRISAT research on groundnut improvement and promotion illustrates how IARCs are involved in activities for which they don't have a comparative advantage. It also highlights the relevance of this issue among donors and centers and the need for cost-benefit analysis to take transaction costs perspectives into account in order to make national systems more efficient and impact sustainable.

CHAPTER 6

SEED SYSTEMS FOR IMPROVED LEGUME VARIETIES: WHAT ARE THE GOVERNANCE CHALLENGES?

6. SEED SYSTEMS FOR IMPROVED LEGUME VARIETIES: WHAT ARE THE GOVERNANCE CHALLENGES?

6.1 Introduction

In the last two chapters, we have analyzed how the ideal role of IARCs in the agricultural research for development spectrum has been dealt with in the CGIAR. Chapter 4 examined in detail the position of different actors on whether the CGIAR should be engaged in downstream research or just focus on production of IPGs, as has been emphasized in CGIAR strategic discussions. The contrasting opinions and actions of stakeholders showed that there is no agreement on the issue.

Consequently, in Chapter 5 we have proposed a framework for defining what activities should be conducted by the IARCs, and which ones should be delegated to NARES in order to obtain impact most cost-effectively. In both chapters, we observed that contextual factors were important in determining whether the CGIAR should carry out technology promotion and dissemination activities. This chapter digs deeper into these contextual factors to provide more insight as to why there has been limited impact from some of the IPG research conducted by the CGIAR. The case of groundnut and chickpea seed systems is examined to understand the governance challenges in the innovation process.

Legumes make significant contributions in developing countries as a source of protein to diets of the poor, and also in maintaining soil fertility. Improved legume varieties with higher productivity, disease resistance and nitrogen fixing traits could make a significant contribution to the well-being of smallholder farmers while also improving farming system sustainability (Tripp, 2011). Investments in international agricultural research can help in achieving the required productivity gains in legumes. Nevertheless, although legume improvement research has produced a wide range of improved cultivars, this has not

translated fully to enhanced productivity at the ground level as farmers still continue to grow old varieties (Macharia et al., 2012; Birthal et al., 2010). Yield improvements in grain legumes has often been much less than for cereals (Parthasarathy Rao et al., 2010; Birthal et al., 2010) and in India pulse yields have only increased by 25 percent while those for cereals have increased by 211 percent in the last 50 years (Srivastava et al., 2010).

Most technology adoption literature has focused more on characteristics of the adopter (farmer). In addition, the use of quantitative ex ante impact assessment analysis has often been seen as an objective means to guide resource allocation decisions in the CGIAR (Byerlee, 2000; Kelley et al., 1995; Alston et al., 1995). However, the rate of adoption of innovations and likelihood of achieving impact is determined by a broader set of factors (Rogers, 2003), one of the main ones being the institutional context for research and development (Klerkx and Leeuwis, 2008; Ekboir, 2003; Hall et al., 2003).

To address the question of why is it more difficult to get legumes adopted, the key institutional challenges in the development and uptake of improved varieties need to be understood. One of the major constraints is the availability of affordable improved seed (Tripp, 2011; Simtomwe et al., 2010; Asfaw and Shiferaw, 2009; Rukmani and Manjula, 2009; Teshale et al., 2006; Aw-Hassan et al., 2003). Even so, the complexities associated with organizing effective seed delivery systems have received less attention as compared to issues such as extension, credit services, fertilizer delivery and marketing of agricultural produce.

Legumes in particular have attributes that make them less attractive to formal seed production efforts. They produce fewer seeds per plant compared to cereals, thus slowing the multiplication process required to build up large quantities of seed. Unlike open pollinated crops such as maize, farmers can also recycle the seed for self pollinating crops like groundnut for several seasons without major drops in yields. The self-pollinating nature and low seed multiplication ratio of most legumes lead to market failure as these factors render

them non-attractive for the commercial seed industry. Hence, breeding, adaptation, multiplication and dissemination of improved legumes often rely on publicly funded international agricultural research and government systems. Overcoming seed system constraints has the potential to increase impacts of agricultural research significantly.

This chapter therefore analyzes more closely the underlying governance issues in seed systems for legumes at national level. Empirical analysis was undertaken at the program for legume at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in three countries that differ in NARS capacity and the state of their seed systems: India, Malawi and Ethiopia. Even though other modes of seed delivery exist, such as private companies or informal farmer-farmer exchange, we focused on the formal public seed system.

This chapter shows that even in locations where the agro ecological suitability of improved legumes is high, actual spillovers are limited by political and institutional constraints. International agricultural research centers are therefore forced to apply different strategies across countries, depending on the context, sometimes engaging in downstream activities of seed production and promotion in order to achieve impact.

In section 6.2, relevant literature is reviewed on the how the public seed sector functions. Based on this review, section 6.3 presents a conceptual framework that identifies different types of governance challenges and their underlying reasons. In section 6.4, the methodology is explained followed by the results in sections 6.5 and 6.6 where the innovation processes for improved groundnut and chickpea varieties in the three countries are presented followed by the governance challenges in the seed delivery systems. The results are analyzed and discussed in sections 6.7 and 6.8, with implications on the strategic role of international agricultural research centres.

6.2 Literature review

In this section, we review how the formal seed sector is organized and how market failure leads to a situation where seed production for legumes has to be mainly carried out by public agencies. We also look at the governance challenges that are generally associated with these public sector agencies, and give an overview of the research, extension and seed systems in India, Malawi and Ethiopia.

6.2.1 Organization of the formal seed sector

Farmers have for centuries selected locally adapted plant materials based on characteristics such as yield or grain quality, and shared improved seed locally. The science of plant breeding developed with the advent of Mendelian genetics and in the late nineteenth century, systematic crop improvement started in Europe and North America (Cromwell et al., 1992).

Over the last few decades, the CGIAR centres have produced improved seed varieties in partnership with NARS in developing countries. The centres collect and maintain germplasm accessions, carry out crosses depending on breeding objectives and release advanced breeding lines which are then incorporated into national breeding programs for evaluation. Based on performance data, varieties are released at the national level upon approval by a varietal release committee. The centres establish regional breeding programmes to support NARES depending on their capacity while the headquarters carry out research that requires more sophisticated techniques. At ICRISAT for example, genomics research and sequencing of germplasm, marker genotyping services and capacity building in modern genomics and molecular breeding and transgenic platforms are mainly at the central unit in India.

The need to process and distribute improved seed led to the establishment of organized seed production and distribution in developing countries. The seed sector comprises a network of institutions that are involved in or influence the production and distribution of improved seed

(Walker, 1980). The formal institutions involved in these activities may be identified as public seed organizations, private seed companies or community-oriented seed organizations. There is also a wide range of linked institutions that influence the performance of the seed sector.

Public seed organizations include departments of line ministries or parastatal enterprises with financial autonomy but whose operational strategies are still determined by the government rather than market forces. Even though many of these organizations pursue full cost-recovery strategies, pricing policies are often set to serve seed users that are unable to participate in commercial seed markets. Examples include the National Seed Company (NSC) or state seed companies such as the Andhra Pradesh State Seeds Development Corporation (APSSDC) in India. Private seed companies focus on the types of seed that are profitable to produce and have demand such as hybrids. Some of the private companies operate in multiple countries, such as Pioneer which operates in Malawi and other African countries.

The third category of seed organizations are community-oriented, organized around co-operatives and other existing local groups. They exist mainly to fill a gap in the seed market not served by public or private seed organizations and are often supported by non-governmental organizations (Jones et al., 2006).

Seed multiplication can be organized in a different ways. Breeder seed and foundation seed production always has to be centralized to ensure adequate control and it is the latter stages, the bulking up of certified seed, for which different organizational opportunities exist. Seed company farms represent the most centralized form whose feasibility depends on whether agro-ecological conditions permit all production to take place in one location, and on the level of market dispersion, and therefore the cost of serving the market from one location. Another option is the use of contract growers under strict control by the company and by the national seed quality control authorities. The growers are paid a premium price for the extra effort in producing a seed, rather than grain. This can be more costly to administer since seed

inspection takes place over a much wider area and it involves the added cost of growers' premiums.

Decentralized seed multiplication involves bulking of certified seed by small farmers. The seed is usually sold within the same zone as it is produced and can be a useful means of reducing transport costs and increasing the availability of seed in more remote areas. It also enables small farmers to share in die returns to seed multiplication. Both contract growing and decentralized seed production also serve a promotion role in enabling nearby farmers to see good crops of improved varieties growing for seed.

Since the majority of seed quality attributes are not outwardly visible, farmer's demand depends on their expectations of how the seed will perform. Information asymmetries are likely as knowledge on seed quality is retained by sellers and it is difficult for farmers to make assessments at the time of purchase (Byerlee et al., 2007). In order to maintain confidence among farmers, the seed sector should constantly supply good quality improved seed. Seed certification, involving field inspections and laboratory tests, is used as a means of quality control. Laboratory tests check for attributes such as germination percentage, purity, seed health and moisture content. Inspections of the seed crop in the field are necessary to guarantee the identity of the variety.

There are two major nomenclatures for generation control used in different countries[27]; the Organization for Economic Co-operation and Development (OECD) classifies seed into breeder, pre-basic, basic and certified, while the Association of Official Seed Certifying Agencies (AOSCA) classifies them into breeder, foundation and certified seed.

The informal seed sector, comprising retaining of seed on-farm after harvest and farmer-to-farmer exchange, is a significant contributor in the diffusion of legume seeds in many

[27] The AOSCA system is used in India and Malawi while Ethiopia uses the OECD system.

developing nations (Macharia et al., 2012; Gaur et al., 2010; Belay, 2004). Asfaw et al (2010) found that own saved seed was used by over 70 percent of chickpea farmers in Ethiopia. In Malawi, two studies (Simtowe et al., 2010; Asfaw and Shiferaw, 2009) found that about 60 percent of groundnut seed used by farmers came from own saved seed, while about 16 percent to 18 percent of farmers acquired seed from local markets and farmer-to-farmer seed exchange.

There are, however, limits in the extent to which informal systems can support wide diffusion considering that it involves small seed quantities and is limited to farmers within close social networks (Trip, 2011; Freeman et al., 2002). Farmers may also consume or sell their seed stock as grain to satisfy subsistence needs. For the purpose of this chapter, we will focus on public sector seed production and discuss how legume intensification is constrained by ineffective systems for delivering improved seed.

6.2.2 Market failure in legume seed systems

A key challenge in the seed system is how to maintain the genetic integrity of a variety. It is especially problematic for cross-pollinated varieties and usually requires that the seed crops be sufficiently isolated to avoid the risk of contamination by foreign pollen. Self-pollinated crop varieties such as groundnuts and chickpea are easier to handle and maintain in good condition for many years. This is however a disincentive for private seed companies since farmers can request seed of improved varieties from the earlier adopters. This kind of free exchange is embedded in the culture of most farmer seed systems even in developing countries (Brennan and Byerlee, 1991). Farmers can also save seed and may therefore not need to purchase for each successive planting. It would then be very difficult to claim legal rights for the variety since it may involve checking the fields of hundreds of smallholder farmers and bringing them to court.

Such problematic property rights reduce ability of breeders to appreciate gains from research investments (Byerlee et al., 2007; Loch and Boyce, 2003; Tripp and Louwaars, 1997). "The central argument of market failure theory is that, where the gain from R&D cannot be captured by private industry, it can only be produced with the support of public funding" (Barnes, 2001 p. 664). For the case of hybrids, intellectual property rights can be enforced since reusing the seed reduces its biological properties.

Once a variety is released, plant breeders generate new stocks of breeder seed each year based on estimated demand for certified seed. Several generations of multiplication are required to meet seed requirements. The number of generations required to produce seed in usable quantities depends on the net increase achieved in each generation i.e. the multiplication factor. Compared to crops such as maize or sorghum, grain legumes have a lower seed multiplication factor and are therefore more challenging to deal with for the formal seed sector. This is also correlated with seed size and sowing rate per hectare. Groundnut is the extreme case with a seed requirement as high as 80-120 kg/ha, and a lower seed multiplication ratio of about 1:10. When sowing rates are high, the cost of seed relative to other inputs is higher. This lends crops such as groundnut, with a bulky seed and multiplication factor less than 10, non-attractive to commercial seed producers (Birthal et al., 2010; Asfaw et al., 2010).

Agricultural innovation policy has increasingly been viewed from a national innovation system perspective (Lundvall, 2007). Following this approach, Dodgson et al. (2011) find that national innovation systems adopt two broad policy approaches; the free-market view where government plays a minor role except in ensuring market failures are dealt with, and the contrasting approach where government has a major role in facilitating technological competitiveness, social inclusion and equity. While private sector integration is of increasing interest among researchers and policy makers, developing countries face significant

challenges on how to operationalize private sector involvement in national efforts to accelerate agricultural productivity growth while protecting farmer and consumer welfare (Spielman et al., 2014; Spielman et al., 2010).

6.2.3 Governance challenges in national seed systems

National agricultural research and seed systems in many developing nations face challenges in adaptation of technologies from international agricultural research and dissemination of these products to farmers. Mausch et al. (2013) estimated welfare benefits from ICRISAT groundnut research in an ideal world with perfect adaptive research capacity and full adoption potential across countries, and compared this with the realistic scenario, with at times very low adoption and/or adaptive research capacity levels. The total welfare benefits were found to double if the capacity constraints were lifted, with the effect being more pronounced in many African countries (Figure 6-1).

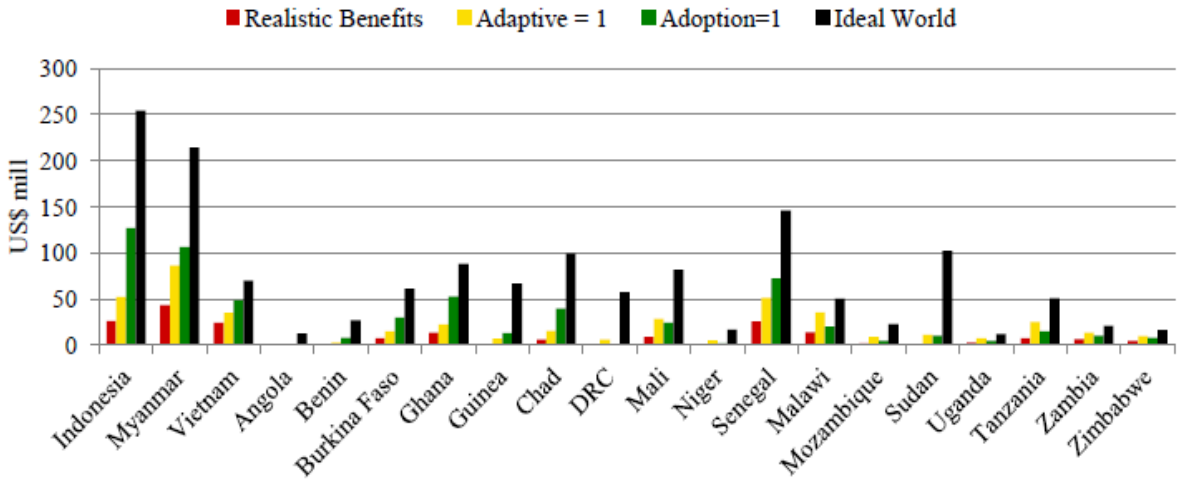

Figure 6-1 Welfare Benefits from Groundnut Research by Country under Different Capacity Scenarios.
Source: Mausch et al., 2013

In legume seed systems, certain characteristics lead to market failure driving private seed producers to focus on crops such as hybrid cereals. In Ethiopia for example, over 90 percent of seed sales by the Ethiopian Seed Enterprise (ESE) have been dominated by wheat and maize (Byerlee et al., 2007). This means that seed of self-pollinating legumes must either continue to be produced by public sector agencies where they are cross-subsidized by other profitable products, or must be produced by farmers themselves. The national seed systems also have certain governance challenges which are reviewed in the next sub-sections.

Governance challenges in breeding and varietal release processes

In the national systems, the fact that research and extension are commonly placed in different divisions of the Ministry of Agriculture means that plant breeders may not necessarily get the required feedback from farmers to guide their research (Cromwell et al., 1992). Most often, breeding objectives target yield improvements even though other characteristics are also important to the farmers and other value chain actors. Even though some of these factors such as disease resistance may be interrelated with yield, there is likely to be a mismatch between the type of varieties favoured by researchers and those required by farmers (Abate, 2012). The fact that trials are carried after most of the selection process has been completed does not allow for timely feedback (Freeman et al., 2002).

During evaluation of varieties for release, trials are put together in one calculation and the variety with highest mean yield is taken to be the best even though it is not be the best in any of the testing locations or the one specifically adapted to particular conditions (Louwaars, 2005). In addition, varieties released by other organizations face difficulties in getting approved as the results from trials that were privately run or those from neighbouring countries with similar agro-ecologies are not considered (Tripp and Rohrbach, 2001).

A setback that has reduced the spectrum of varieties available to farmers in Africa is the slow variety testing and release processes. Varieties proposed for release will already have gone through a long testing period by breeders, but they usually spend more years in performance testing (Tripp and Louwaars, 1997). The prolonged variety release process leads to instances where the same variety is released many years apart in neighbouring countries (Abate, 2012). Ndjeunga et al. (2000) also found that the uptake of modern varieties has been limited by irregular meetings of national variety release committees. Another issue faced in Ethiopia is that seed is not distributed in time for planting (Byrelee et al., 2007; Dadi et al., 2005).

Governance challenges in seed production and certification

The structural adjustment programs in the 1980s and 1990s contributed to a shift in seed production focus toward few commercially interesting crops such as hybrid maize seed. Some NGOs started operating in this vacuum and research centres chose to work directly with farmers in disseminating their varieties (Louwaars and de Boef, 2012). Shortage of pre-basic and basic seed still presents challenges in the seed industry in Ethiopia (Thijssen et al., 2008; Byrelee et al., 2007). The production and distribution of improved chickpea seed by ESE is small and inconsistent and can cover not more than 1 percent of total chickpea area, and. (Dadi et al., 2005).

Certified seeds are comprise less than 5 percent of the grain legumes in the major producing countries such as Ethiopia, Morocco, Iran, Syria and Turkey (Bishaw et al., 2008). Thus farmers mainly depend on the informal seed system, seed that they get by hosting on-farm or demonstrations, and the seed distributed for promotion purposes. Ndjeunga et al. (2000) also found that uptake of modern groundnut varieties in Senegal was constrained mainly due to limited and inconsistent supply of breeder seed of varieties preferred or required by the markets.

Considering that breeders are mostly rewarded for additional releases, rather than seed multiplication, they have no incentive systems to maintain large quantities of seed and often send requests to IARCs for the same germplasm (Tripp and Rohrbach, 2001).

Seed certification to ensure quality is also a major challenge in national seed systems. Where salaries of inspectors are poor, their rent seeking behaviour might compromise transparency in acceptance or rejection of seed production fields or seed lots (Tripp and Louwaars, 1997). There are also insufficiencies in funds for transportation to carry out required inspections. Decentralization through small seed laboratories that are more widely dispersed and closely associated with each production centre would provide rapid response required by production and marketing managers. However, such a strategy is likely to raise the problem of maintaining quality standards (Cromwell et al., 1992).

Market for seed and distortions by subsidies and relief seed

Seed corporations and even farmers may be reluctant to incur the costs of producing seed if there is no assured market. Abate (2012) found that farmers were keen to produce seed as long as arrangements were made to procure it through state seed agencies. When the contractual agreement is not binding, farmers get the temptation to sell to a third party who is offering a higher price at the time of harvest time (Thijssen et al., 2008). For the case of groundnut seed production in India, Rukmani and Manjula (2009) found that contracts between seed agencies and farmers were often not binding and when there were delays in declaring the procurement price, farmers went ahead and sold the produce off as grain.

Many developing countries, especially those faced with droughts or conflict, have also witnessed a lot of donor investment in community-based seed projects, delivery of subsidized seed or distribution of relief seed for free. The political value of attached to handing out free agricultural inputs has led to the continuation of free seed delivery after the crises are over

(Tripp and Rohrbach, 2001). This might result in disincentives against private sector involvement in the production of certified seed due to uncertainty regarding the consistency of seed demand. The development of local seed channels is also curtailed by the likelihood that government or NGOs may suddenly initiate free seed distribution programs.

Performance of extension services

Lack of awareness by farmers on available new varieties and non-availability of the seed are key factors that contribute to low adoption rate of improved legume varieties (Abate, 2012, Dadi et al., 2005). The agricultural extension system is meant to play a key role in filling this gap. However, the hierarchical top-down culture underlying extension systems does not help in allowing extension agents be creative in working with rural communities and promote reliable knowledge transfers among actors in the agricultural sector. Besides extension workers being assigned other responsibilities, backlogs in filling up sanctioned posts also affects provision of extension services in India as *Adarsha Ryuthus* (model farmers) take up responsibilities meant for field-level extension officers (Rukmani and Manjula, 2009).

6.2.4 Research, extension and seed systems in India, Malawi and Ethiopia

In India, agricultural universities hold the main responsibility for identification and testing of new varieties (Shiyani et al., 2002). Popularization is the function of the Department of Agriculture (DoA), directorates of extension in universities as well as the Krishi Vigyan Kendras (KVK) (farm science centres). The Department of Agriculture (DoA) is headed by a Joint Director at the district level. Aside from Agricultural Extension Officers, DoA uses model farmers referred to as Adarsha Ryuthus. Seed production, certification and distribution is undertaken by the universities and various state and national seed agencies. Some farmers also multiply seed, maintaining sufficient purity, and sell it as Truthfully Labelled (TL) seed.

Chickpea is a very important legume in India country accounting for 38 percent of the total pulse production (Trip, 2011). Over the last few decades, there has been a shift in its production from the north to the central and southern parts of the country. Adoption of wilt-resistant, earlier- maturing chickpea varieties in central and southern India, between 1985 and 2004, contributed to an annual increase in area, production and yield of 2.13 percent, 3.94 percent and 1.77 percent respectively (Gowda et al., 2009). For the last three decades, Annegiri variety continued to take up much of the area under chickpea in AP. However, in recent years another desi variety known as JG 11 has taken up much of the area in South India, especially AP where it covers about 75 percent of the area (Satyanarayana, 2013).

ICRISAT conducts research on groundnut in both Asia and Africa. Groundnut research began at Patancheru (in India) in 1976, southern Africa since 1982 and West Africa in 1986. The Institute supplies improved genetic material to national programs and assists them adaptive research, varietal release and seed production (Shiferaw et al., 2004).

Groundnut is among the most important oilseed crops of India, after soybean and rapeseed-mustard. It is cultivated in about 6.0 million hectares, which is about one-fifth of the total area under oilseeds in the country. However, 75 percent of the total groundnut area is in the high-risk semi-arid tropics with by low and erratic rainfall and poor soils. Anantapur district of AP is an important groundnut producing area in the country. In 2006-08, groundnut was cultivated on 819 thousand hectares, which is equivalent to 75 percent of the cropped area in the district, and 15 percent of India's total groundnut area (Birthal et al., 2012). Since 1971, ANGRAU in collaboration with ICRISAT have released over thirty improved varieties of groundnut. However, an outdated cultivar TMV 2, released in Tamil Nadu in 1942, remains the ruling variety in Anantapur. It is estimated to occupy 75-80 percent of groundnut area in the district (Rukmani and Manjula, 2009). Kadiri 6 and JL24 varieties are also favored in parts of the district**.**

Groundnut is a widely cultivated legume crop in Malawi that contributes significantly to household's agricultural income. Simtowe et al. (2012) report that groundnut area for the period 1991-2006 averaged 171,000 hectares annually, accounting for 27 percent of the total legume land. The southern and central Agricultural Development Divisions (ADDs) of Lilongwe, Kasungu, Machinga, and Blantyre accounted for more than 75 percent of the groundnut area. To improve groundnut productivity and competitiveness, ICRISAT has collaborated with national systems to develop and release a number of groundnut varieties such as CG7, JL 24 (Kakoma), ICGV-SM 90704 (Nsinjiro), and IGC 12991 (Baka). Other varieties released earlier are Manipintar, Chalimbana, Mawanga, Chitembana and RG 1.

Despite the importance of groundnut as well as availability of new technologies, adoption rates remain low leading to low productivity. Simtowe et al. (2012) found that during the 2004/05-2007/08 period, only 26 percent of the farmers adopted improved groundnut varieties. Among the improved varieties, about half of the area (53 percent) was under Chalimbana and 27 percent under CG7. The main constraint identified was the lack sufficient quantities of improved seed. Part of this has been because of low participation by the private sector. Following the market liberalization in the 1980s, a number of selling points for Agricultural Development and Marketing Corporation (ADMARC) were also closed. Extension services were also affected by reforms that saw the government cut down expenditures including funding to the Ministry of Agriculture (Simtowe et al., 2010).

Ethiopia is the largest producer of chickpea in Africa contributing about 46 percent of production during the period 1994–2006 (Asfaw et al., 2012). Worldwide, it is the seventh largest producer accounting for approximately 2 percent of production. The formal seed system for chickpea began as an extension activity by Jimma and Alemaya universities (Thijssen et al., 2008). The Ethiopian Institute of Agricultural Research (EIAR) continued to distribute seed when it was established in 1966. Private commercial farms emerged in the late

1960s and early 1970s but these were later nationalized by the government. The government also established new state farms and producer cooperatives and launched farmer resettlement projects. To enhance the supply of improved seed, the Ethiopian Seed Corporation (now the Ethiopian Seed Enterprise) was set up in 1979.

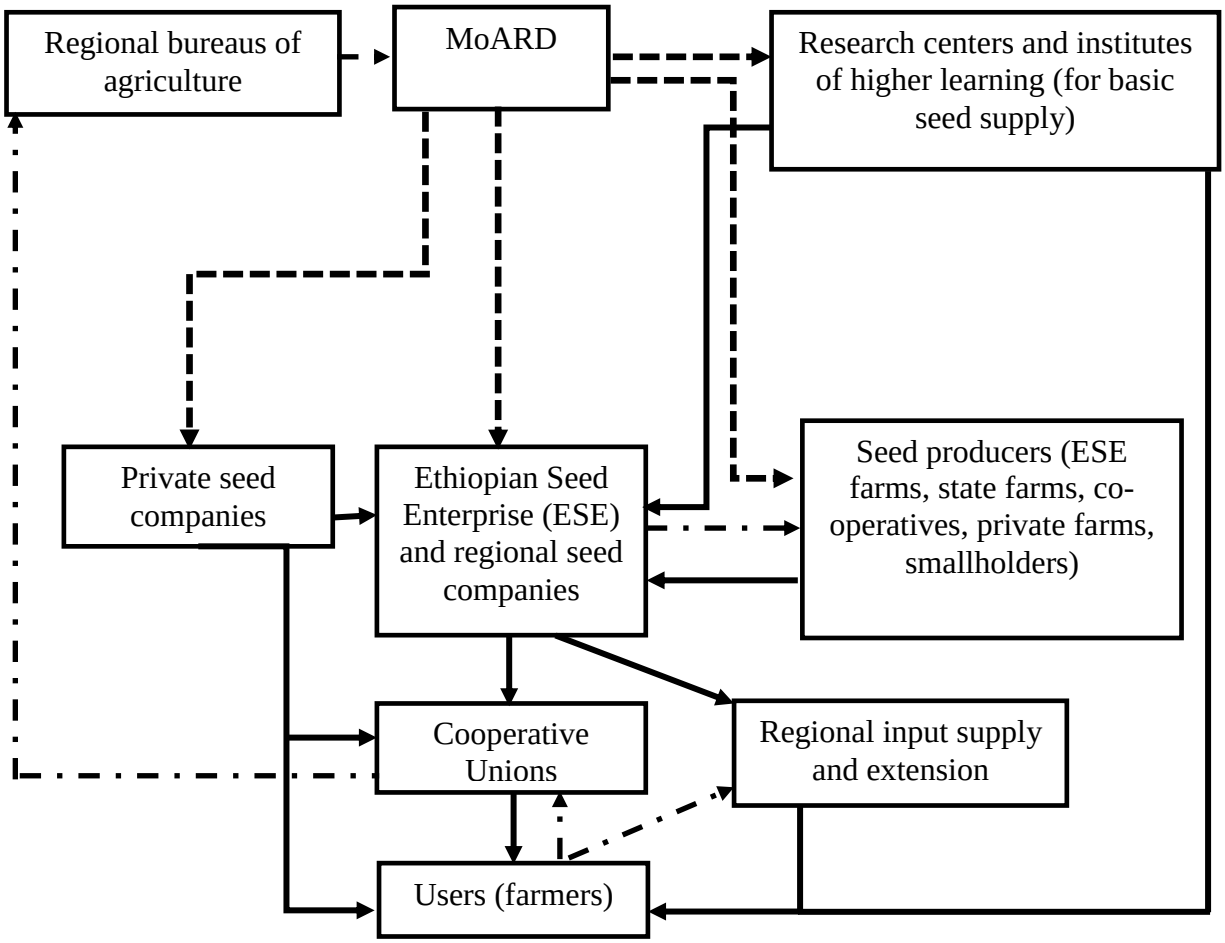

Figure 6-2 A schematic of the Ethiopian seed system.
Source, Spielman et al., 2012

EIAR has the responsibility to coordinate agricultural research in Ethiopia and operates several Regional Agricultural Research Institutes (RARIs). Variety development is responsibility of the EIAR with RARIs and agricultural universities increasingly developing varieties suitable for their regions (Thijssen et al., 2008). Since 1972, the Debre Zeit Agricultural Research Centre (DZARC) is been the main institute for research and breeder seed production of chickpea (Dadi et al., 2005).

Currently, several other stations like Holetta, Debre Berihan, Sirinka, Sinana and Adet also carry out chickpea research. These institutes collaborated with ICRISAT and ICARDA to develop and release eleven improved chickpea varieties between 1974 and 2005 (Macharia et al., 2012). However, adoption rates are still very low (Shiferaw et al., 2007). In 2008, only 10–15 percent of the total chickpea cultivated area was covered by improved varieties (Asfaw et al., 2012) mainly as a result of limited local supply of seed. Asfaw et al. (2010) found that among the improved cultivars, Shasho covered the largest, followed by Ejere and Arerti.

ESE is the only public seed enterprise that produces of seed for all crops (Jones et al., 2006; Spielman et al., 2012). Based on projections of seed demand by the regional bureaus of agriculture, ESE produces pre-basic and basic or foundation seed and sells it contract growers for multiplication to certified seed (Figure 6-2). This is in turn sold to the Bureaus of Agriculture and Rural Development (BoARDs) for distribution.

Ethiopia invests a lot in its public extension system including training of extension agents (also called development agents - DAs) in Technical and Vocational Education Training (TVET) programs. The extension approach emphasizes the distribution of packages to farmers including seeds, fertilizer, training and demonstrations. The DAs are themselves are involved in the distribution of these inputs and also collect credit repayments. They also train farmers within peasant associations at Farmer Training Centres (FTCs) in the kebeles (sub-district). Byerlee et al. (2007) estimated that these programs amount to over 50 million US dollars annually, almost 2 percent of the agricultural gross domestic product and 4-5 times of the agricultural research investment.

6.3 Conceptual framework

The literature reviewed in the previous section identifies several governance challenges in formal seed systems, some of the underlying reasons and the conditions under which they are expected to be particularly pronounced. This section presents a conceptual framework that summarizes how the seed sector is organized and the different types of governance challenges that occur at different stages (Figure 6-3).

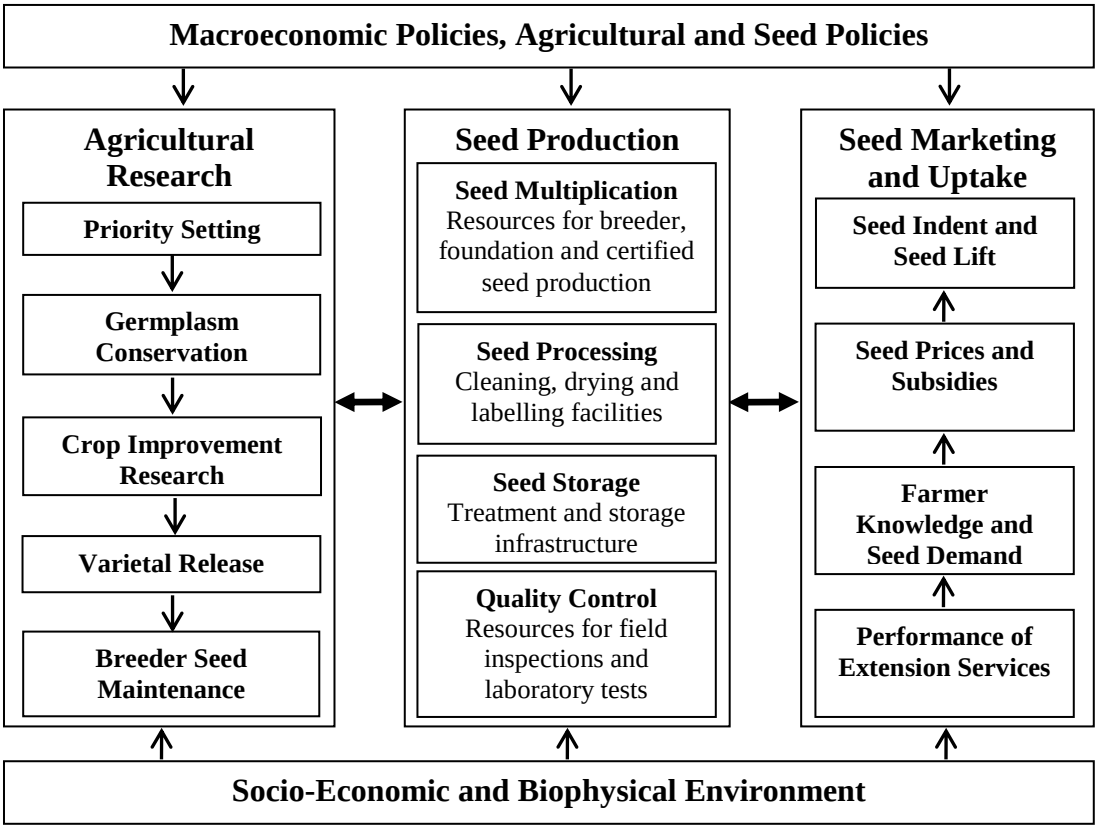

Figure 6-3 The Seed Sector and Associated Governance Challenges
Source: Authors

The main cause of market failure in seed systems is the inability to claim proprietary rights when farmers can save their own seed or borrow from neighbours and therefore do not need to purchase in subsequent years. This has led seed companies to shun legumes seeds that are self-pollinated and focus more on focus on crops such as hybrid cereals.

Public sector agricultural research institutions therefore have to fill this gap in many developing countries. Priorities for research conducted by IARCS and national research institutes need to set bearing in mind the needs of end users. However, breeding objectives most often target yield improvements placing less emphasis on other characteristics that are important to farmers and the market. Performance data for varietal release is also mainly the yield advantage over the best existing variety. Varietal testing and release processes also take a long time in many developing countries.

Seed of improved varieties that have been released need to be multiplied so as to obtain sufficient quantities that meet demand. The seed also needs to be processed by cleaning, drying to the right moisture content and labelling before storage and distribution. Public sector agencies often lack the financial resources, staff, facilities and infrastructure to conduct these operations. Since the main incentive to plant breeders is to release new cultivars, breeder seed production is not often high in the agenda of agricultural research institutes.

Seed multiplication is even more problematic for grain legumes like groundnut and chickpea because they have a lower seed multiplication factor and high seeding rate making them non-attractive to seed companies. Since farmers cannot determine seed quality just by observation, information asymmetries arise as only the seed seller knows the product. Seed certification that is meant to ensure quality is often affected by lack of resources to field inspections and laboratory tests. Transparency in certification is also likely to be compromised if inspectors have poor compensation which might lead then to resort to rent seeking.

On the demand side, seed corporations determine their production estimates based on projected demand from farmers. This is to ensure that the volumes they produce are lifted. This in turn reflects on the volume of breeder seed to be produced research institutes i.e. the breeder seed indent. The demand for seed may be influenced by farmers knowledge about the new varieties and seed prices. The performance of agricultural extension services and the

availability of subsidies will therefore determine seed demand. On the other hand, while subsidies and relief seed are important political tools in many nations, they distort seed markets and reduce incentives for private sector agencies.

6.4 Methodology

Empirical analysis for this study was conducted at the ICRISAT breeding program for improved legume varieties with case studies in three countries that differ in the capacity of their agricultural research systems and the state of their seed systems; India, Malawi and Ethiopia. The three countries are also leading producers of groundnut and chickpea. Among the mandate crops of ICRISAT, the two legumes; groundnut and chickpea were chosen as their seed systems have not been adequately developed.

The complexity of innovation processes implies that a single method cannot be used to analyze them effectively (Spielman et al., 2009). This study therefore used an innovative mapping tool that combines social network analysis tools and innovation histories (Douthwaite and Ashby, 2005). As explained in chapter 3, the participatory mapping technique called Net-map (Schiffer and Hauck, 2010) involved asking a series of questions to map the main actors in the research process and dissemination of improved groundnut and chickpea varieties. These actors were written on post-it notes with different colors indicating the type of actor such as government, private sector, NGO, IARC and so on.

Once the whole list of actors was exhausted, we then mapped the innovation process step-by-step starting with the first activity, for example related determination of breeding objectives for the varieties that were studied. Arrows were used to indicate how the actors are linked with each other. The arrows were numbered to represent each step in the process, and the numbers and step they represent were written at the border of the paper (Figure 6-4).

Once the mapping of the process was completed, respondents were asked to gauge the level of influence of each actor (on a scale of 1-8) on the intended outcome that a new legume variety is widely adopted. To visualize the levels of influence, poker chips were stacked up to form influence towers that were then place next to the respective actors. The actors with the tallest towers were the ones perceived to be most influential in achieving the desired outcomes. Follow-up questions were then asked on governance challenges in the research, seed production and dissemination process of the improved cultivars.

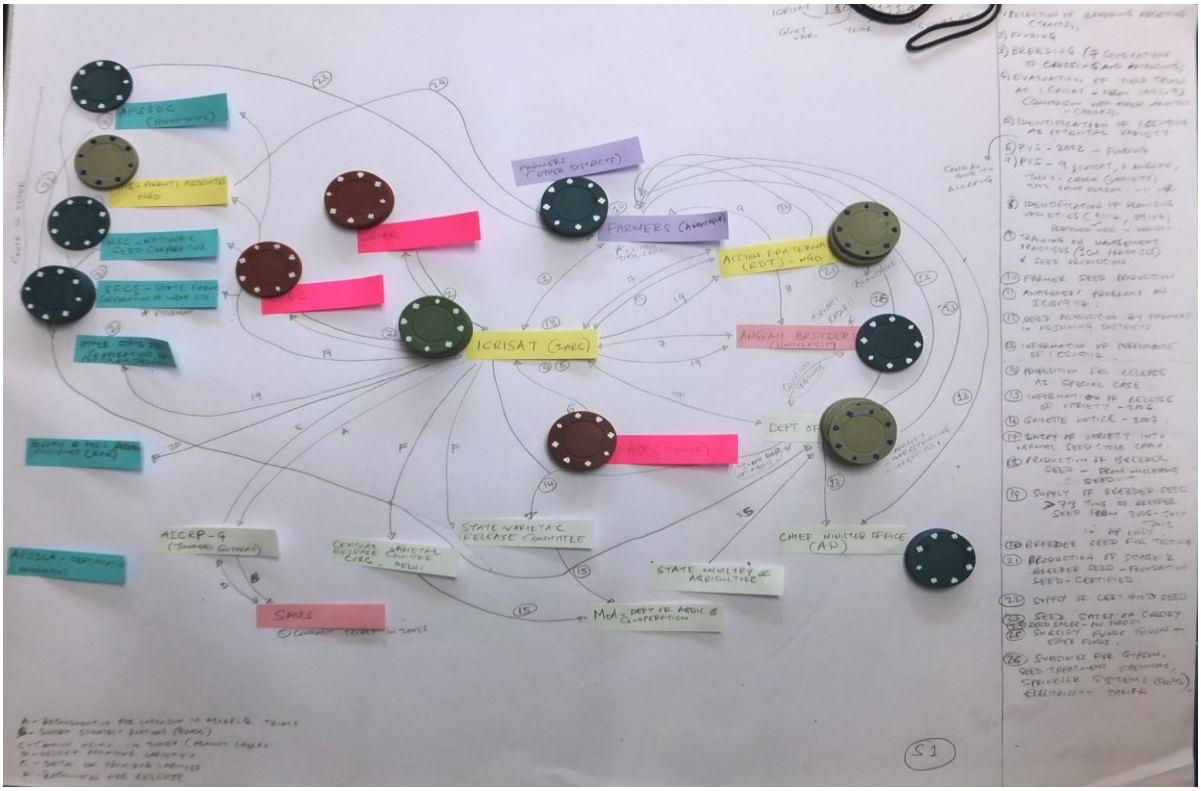

Figure 6-4 Process Influence Mapping
Source: Authors

The Net-map exercise was first conducted with respondents who understood the process best, then with different stakeholders to get their perspectives and capture any information that may have been missed out. Since there was a high level of agreement on the levels of influence on intended outcomes, the average level of influence was taken. The intensive interviews from

the Net-map exercise were recorded and transcribed to provide qualitative information for further analysis using NVivo software.

Data was also collected through extensive review and synthesis of relevant literature to provide a baseline understanding on adoption of improved legumes, in-depth key informants interviews and focus group discussions. A total of 71 respondents were interviewed (Table 3-1) including ICRISAT scientists, NARS partners at different levels, non-governmental organizations (NGOs), seed corporations and certification agencies and other stakeholders involved in the research and promotion of improved groundnut and chickpea varieties. A total of 13 FGDs were also conducted (Table 3-1). The respondents were purposively selected based on their understanding and involvement in the research and uptake process of the two legumes and guided by the mapping of stakeholders during the Netmap exercise.

The information collected from the interviews was supplemented by review of relevant supplementary documents including project reports, working papers, journal articles, conference presentations and workshop proceedings.

In chapter 3, details were provided on how the interviews were conducted, recorded and transcribed. The process by which the transcribed data was imported into NVivo and analyzed was also explained. For this chapter, the analysis focused on the codes that related to governance challenges in the seed systems. These were aggregated into categories reflecting the types of governance challenges where they occur in the innovation process. In the next section we describe the innovation history for each case followed by a more detailed discussion of the governance challenges that emerged.

6.5 Research and seed systems for chickpea and groundnut

To understand the steps involved in the research and uptake of improved legumes, we will use examples of chickpea varieties JG11 in India and Shasho in Ethiopia, and groundnut varieties ICGV9114 in India and CG 7 in Malawi. The Net-maps presented in Figure 5-1, Figure 6-5,

Figure 6-6 and Figure 6-7 show the actors involved including ICRISAT, donors, NARS and agricultural universities, relevant ministries, extension, seed companies, NGOs, farmers and farmer organizations. The arrows indicate linkages between the actors and the numbers show the sequence of activities. The circles indicate the level of influence of actors (on a scale of 1-8) on the final outcome that improved seed varieties actually reach farmers. The stars represent governance challenges in extension and seed systems.

6.5.1 Chickpea research and seed systems in India

The research and uptake process for JG11 (ICCV 93954) chickpea variety in India (Figure 6-5) comprised the following; (i) the first step was planning where the production constraints faced by farmers and breeding objectives to be pursued were identified (ii) the variety was bred at the ICRISAT headquarters in India with the initial cross between Phule G-5 x Narsingpur bold and JG 74 (iii) breeding lines were sent to partners under a collaborative satellite program with several State Agricultural Universities (SAUs) in Jabalpur, Akola and Sihore (iv) It was proposed by Jabalpur agricultural university to the All India Coordinated Research Project on Chickpea (AICRP-C) and evaluated for 3 years, first year throughout India, second and third year in the southern zone where it performed well (v) JG11 was released in 1999 upon approval by a central varietal release committee based on superior performance in the southern zone compared to existing released varieties and notified under the Seeds Act (vi) From 2002/2003 crop season, since no one was growing the variety, ICRISAT and the extension wing of Acharya N G Ranga Agricultural University (ANGRAU)

university conducted participatory trials in farmers' fields with 32 varieties where JG 11 ranked the first thus creating demand (vii) breeder seed was produced mainly by Jabalpur university and also small quantities from ICRISAT (viii) ICRISAT collaborated with NARS partners such as the Nandyal agricultural research station under Tropical Legumes II (TLII) project where further participatory varietal selection (PVS) trials were conducted in 2007/2008 with promotion activities like farmer's fairs (Kisanmela), distribution of small seed samples, use of electronic and print media in Telugu (local language in AP), and training for NARS scientists and research technicians, farmers, seed producers/ traders and extension workers on production, storage and post-harvest handling (ix) as demand grew the seed corporations i.e. National Seed Corporation (NSC), APSSDC and State Seeds Corporation of India (SFCI) started producing large quantities of foundation and certified seeds (more than 50,000 ton seeds were produced in three years) (x) the variety got included in the government subsidy program and some progressive farmers also started producing seed and selling to other farmers without certification.

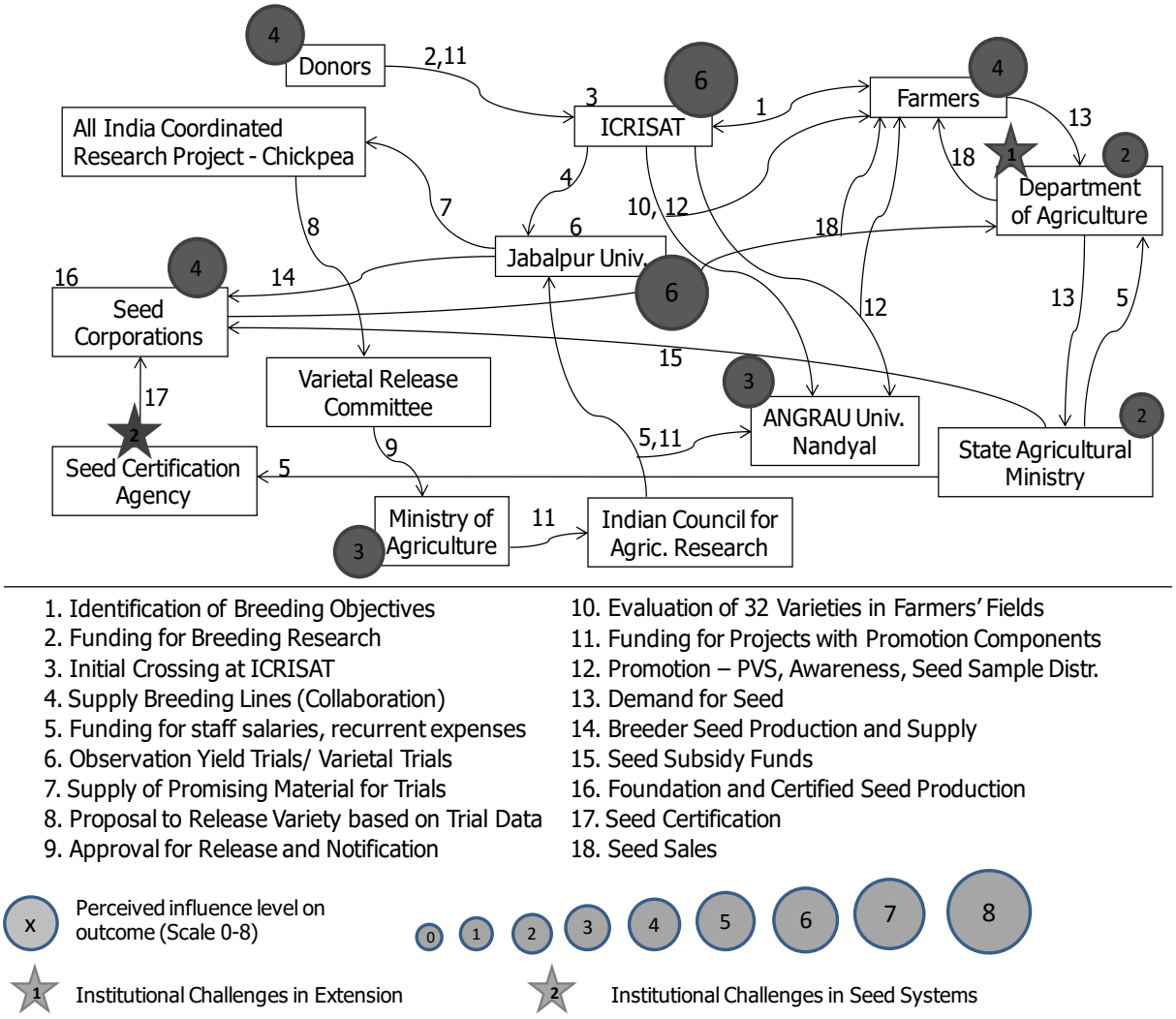

Figure 6-5 Process-Influence Map for Research and Promotion of Chickpea Variety JG11 in India.
Source: Authors

6.5.2 Chickpea research and seed systems in Ethiopia

The research and uptake process for Shasho (ICCV93512) chickpea variety in Ethiopia (Figure 6-6) comprised the following; (i) the variety was bred at the ICRISAT headquarters in India with the initial cross between L144 x E100Y(M) and ICCC 33 (ii) breeding lines for a number of varieties including Shasho were sent to partners in EIAR (DZARC and regional agricultural research centres in Gondar, Melkassa, Debre Birhan and Sirinka) and evaluated in different agro ecologies in Ethiopia (iii) The improved varieties were evaluated at farmers' fields. (iv) After testing for three years, Shasho was found to have superior performance over

the others varieties and was released by the National Varietal Release Committee (NVRC) in 1999 (v) The varieties were also promoted through the extension activities and NGOs leading to increased demand; some farmers visited research centres and received limited amounts of the seeds for their preferred varieties. (vi) EIAR and the ESE supplied pre-basic and basic seed supply which was distributed to regional BoARDs for distribution to farmers. (vii) Some NGOs (Orthodox Relief Agency, Sasakawa Global, World Vision) helped farmers in informal seed production and supply and also via emergency seed programs. Technoserve in collaboration with DZARC and the ministry of agriculture trained farmers on seed business (viii) Under TLII project and other projects, the research and extension wings of DZARC collaborated with ICRISAT and the BoARDs in conducting awareness activities for farmers and extension personnel through field days, farmers' fairs, the media (in Amharic, Oromifa and English) and training on seed production. (ix) Farmers saved seed for the next production and also exchanged with other farmers or sold it via seed grower associations of co-operatives. (x) The Agricultural Transformation Agency was established through funding from United States Agency for International Development (USAID), UNDP, World Bank and Rockefeller Foundation to provide overall guidance and system level transformation of the agricultural sector in Ethiopia.

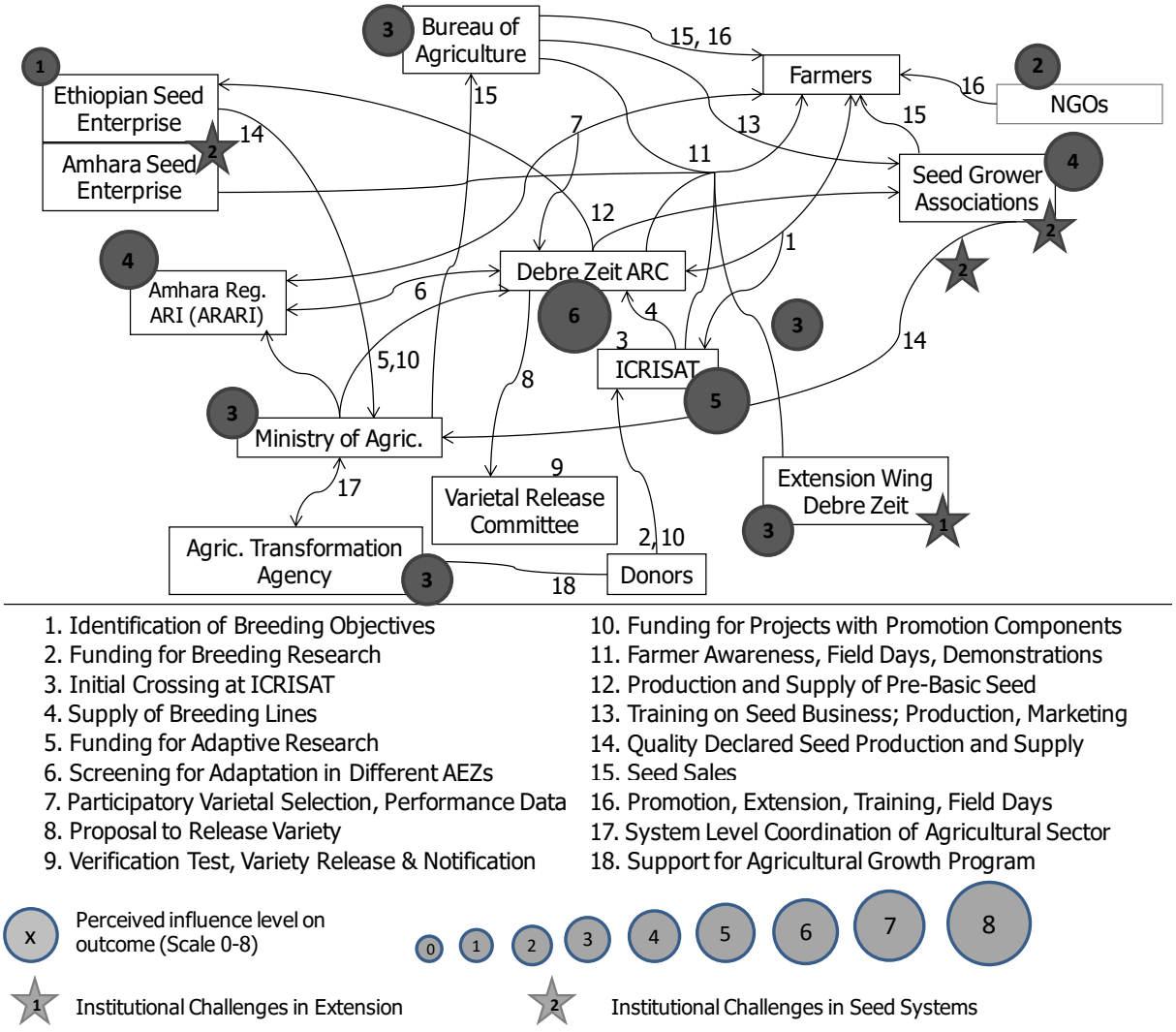

Figure 6-6 Process-Influence Map for Research and Promotion of Chickpea Variety Shasho in Ethiopia.
Source: Authors

6.5.3 Groundnut research and seed systems in India

The ICGV91114 research and uptake process in India (Figure 6-7) comprised the following; (i) the variety ICGV 91114 was bred at ICRISAT headquarters, India from an initial cross between ICGV 86055 and ICGV 86533 (ii) On-station trials were carried out at ICRISAT-Patancheru between 1992-1994 and several other agricultural universities AP, Orissa and Bangalore where the pod yield superiority of ICGV 91114 over TMV 2 (the ruling variety that was released in 1940) ranged between 16 and 40 percent. (iii) In farmer participatory on-

farm trials funded by International Fund for Agricultural Development (IFAD) (2002-2006) and conducted in collaboration with Rural Development Trust (RDT[28]) during the rainy (kharif) season in Anantapur, nine improved varieties were tested where ICGV 91114 showed the best pod and haulm yield superiority over TMV 2. Feeding of ICGV 91114 fodder to milch cattle resulted in increased milk yields of 11 percent per day. (iv) Convinced of its consistent better performance especially under drought conditions, farmers from 23 villages in 10 mandals (administrative sub-divisions) of the Anantapur district and two villages each from the adjoining Chittoor and Kurnool districts took up seed production (v) Based on these performance data and intervention of the then Chief Minister (YSR Reddy), the variety was proposed by ICRISAT and released in 2006 at the state level as a special case, and notified in The Gazette of India in July 2007, bypassing the All India Coordinated Research Project on Groundnut (AICRP-G). It was officially released in Orissa in 2008 and in Karnataka in 2009. (vi) breeder seed was produced by ICRISAT (73,000 tonnes between 2007-2012) while SFCI and Aakruthi Associates (an NGO) played a major role in foundation and certified seed production (vii) ICRISAT and partners created awareness about the variety through activities such as minikit trials organized through the directorate of groundnut research to help popularize the variety and evaluate the response of farmers. (viii) ICGV91114 faced a backlash from the national partners who have been reluctant to promote it alongside other varieties such as K6 that were released by the universities.

[28] A local NGO also called Accion Fraterna (AF)

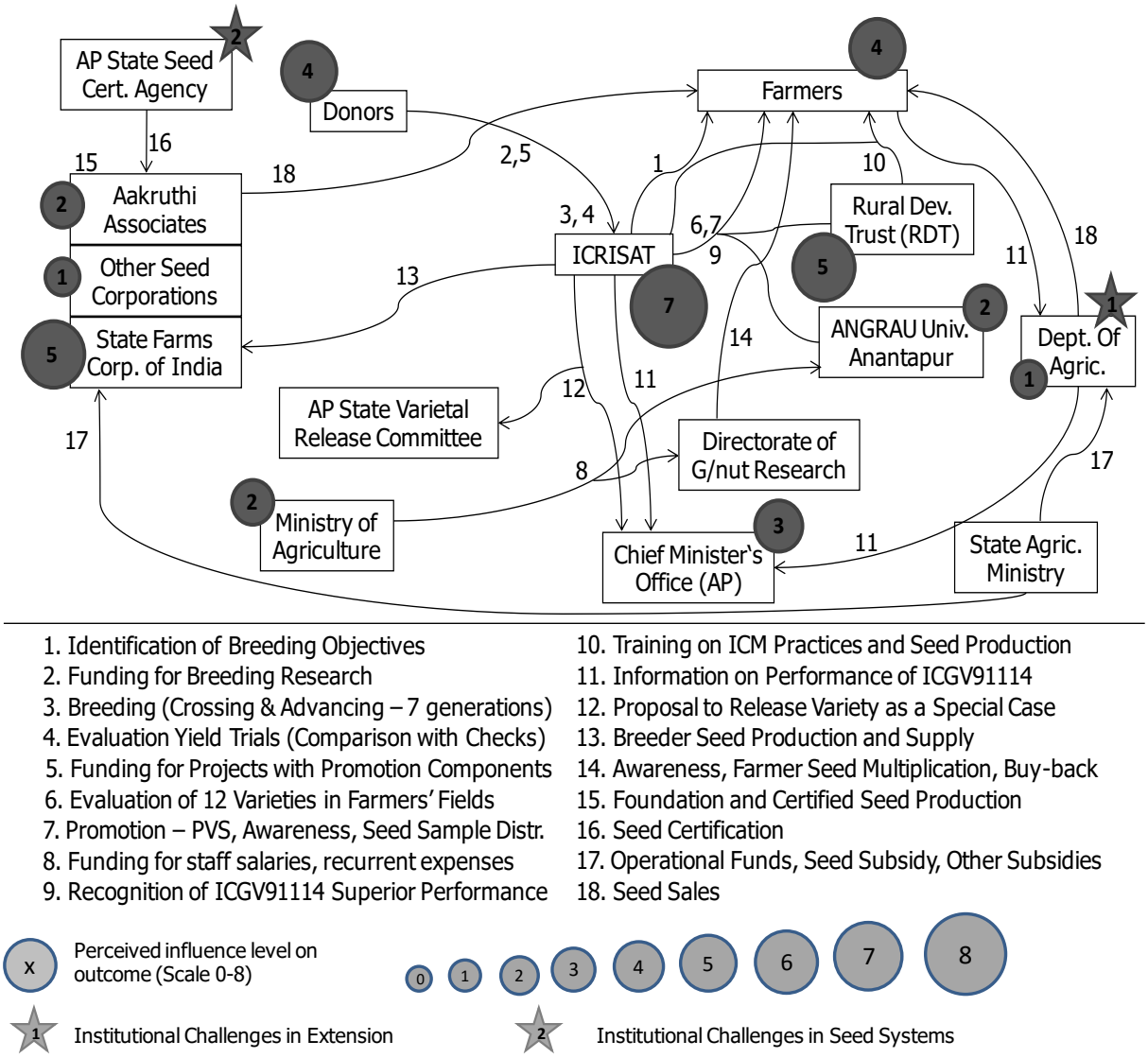

Figure 6-7 Process-Influence Map for Research and Promotion of Groundnut Variety ICGV91114 in India.
Source: Authors

6.5.4 Groundnut research and seed systems in Malawi

The CG7 (ICGMS42) research and uptake process in Malawi and Netmap (Figure 5-1) were already presented in chapter 5.

6.5.5 Level of influence of ICRISAT versus national systems

During the Net-map exercise, respondents were asked to rate the level of influence (on a scale of 1-8) of different actors on the outcome that improved seed of the variety was available and

adopted on a large scale. The ranking that was given to different stakeholders was related to the context (Table 6-1). In the case of chickpea in India, both ICRISAT and the Jabalpur agricultural university were ranked as equally important because of the fact that the later played a key role in adaptive research and the release of JG11 variety (Figure 6-5). In Ethiopia, DZARC was even ranked higher than ICRISAT in their role in adaptation and release of Shasho (

Figure 6-6).

Table 6-1 Perceived Level of Influence of ICRISAT versus NARS

Actors	India Chickpea	India Groundnut	Malawi Groundnut	Ethiopia Chickpea
ICRISAT	6	7	7	5
NARS	6	2	3	6
Extension	2	1	3	3

Source: Authors based on process influence mapping (Net-map)

However, there is a difference on how ICRISAT was ranked against national systems in groundnut both in India and Malawi, but for different reasons. In India, the higher ranking of ICRISAT compared to the university (Figure 6-7) was because of the fact that ICGV91114 was released as a special case implying that SAUs played a lesser role in adaptive research, even though they had the capacity to do so.

In Malawi (Figure 5-1), ICRISAT was perceived to have a higher level of influence compared to the Department of Agricultural Research Services (DARS) because of its role in adaptive research, seed multiplication and promotion. We also note a striking feature that extension systems were ranked low in all the case study countries because of existing governance challenges, which we will further discuss in the next section.

6.6 Analysis of governance challenges in legume seed systems

The findings in the previous section show that activities across countries were different depending on the problems that needed to be addressed to realize the desired benefits. The conceptual framework (Figure 6-3) that was presented in section 6.3 summarized the key governance issues that are likely to arise in seed systems. Table 6-2 highlights the governance challenges in agricultural research, seed production and seed marketing and uptake of grain legumes in the three countries. The sub-sections examine in more detail the underlying reasons why these problems arise by looking at specific examples from the case studies.

Table 6-2 Governance challenges in the seed systems for groundnut and chickpea in India, Malawi and Ethiopia

	India	**Malawi**	**Ethiopia**
Agricultural research	Top-down research priority setting, delays in varietal release processes	Top-down research priority setting, Lack of adequate staff and funding for research, delays in varietal release processes	Top-down research priority setting, delays in varietal release processes
Seed production	Low seed multiplication ratio, challenges in maintaining seed quality	Low seed multiplication ratio, challenges in maintaining seed quality, inadequate processing, storage and distribution infrastructure	Low seed multiplication ratio, challenges in maintaining seed quality, inadequate processing, storage and distribution infrastructure
Seed marketing and uptake	Self-pollinating nature of grain legumes, governance challenges in extension	Self-pollinating nature of grain legumes, distortions by subsidies and relief seed, governance challenges in extension	Self-pollinating nature of grain legumes, governance challenges in extension

Source: Authors

6.6.1 The nature of legume seed

In section 4.3, we discussed the characteristics of legumes that lead to market failure in their seed systems. In this study, the self-pollinating nature and low seed multiplication ratio of chickpea and groundnut were common challenges mentioned by respondents as slowing down adoption of improved varieties. A former director of extension in an Indian university argued "*There is seed multiplication inertia as chickpea requires high seed rate, but the seed multiplication ratio is low. If you get small quantities of breeder seed to the seed production cycle to start with, it may take number of years to get an impact*".

The seed of these legumes has therefore continued to be produced by public sector agencies or by farmers themselves in all the countries that were studied. A former NARS official in India pointed out "*so when they (farmers) ask some relatives or friends, they say that the seed at one place is better than the other areas. So some people will go and get the seeds and that will be multiplied and used by other farmers*". However, this kind of informal diffusion involves small seed quantities and is limited to farmers within close proximity.

6.6.2 Human resource and funding for research and seed production

Breeder seed for multiplication is, in most developing countries, still obtained from NARS as a service function of public sector plant breeders. However, they often lack the resources to perform properly in practice. Maintenance of breeder seed is not separately financed in the NARS budgets and breeders have to make a decision about how much they should put into seed production and how much for breeding activities. A NARS plant breeder in India stated "*We have problems like lack of land and shortage of funds and personnel for taking up breeder seed production*".

In the case of CG7 in Malawi, as can be seen in Figure 5-1, donors provided more resources for seed multiplication and promotion and it took further interventions by ICRISAT and

partners to get the variety taken up. Progress of varietal development and seed dissemination was constrained by insufficient numbers of research and seed technicians. ICRISAT had to post a groundnut breeder from its headquarters who took with him some 2000-3000 breeding populations for selection and coordinated regional testing of material and facilitated varietal release. In addition, incentives for NARS scientists are poor as one ICRISAT technician noted "*In Malawi there are many challenges including lack of capacity whether it is infrastructure, human capacity, high turnover of the staff*". A breeder in the DARS, Malawi added "*About the salaries in Malawi - as far as I am concerned - it does not matter whether you have a PhD or not. It also doesn't depend on whether you are a legume breeder or not - we are called Agricultural Research Scientists - we have same grades as all other civil servants in various ministries. I started working over 10 years ago in the Ministry of Agriculture with a Bsc at the grade called PO level. I got my Msc 3 years later, my grade was not changed but my salary rose a bit. I found workmates whom I left when I went for the masters degree - all promoted to grades higher than mine - but most have Bsc degrees up to now. After I attained my PhD last year - nothing changed. Still at PO grade - same salary. All am saying is, promotion depends on interviews and most of the times politics as you may well know. My salary as of now is about $225 after tax. Anyone at my grade from any ministry in Malawi is getting that whether you have a Diploma, Bsc, Msc or PhD*".

6.6.3 Seed quality

Seed quality assurance is one of the main concerns of the formal seed production sector. The responsibility for seed certification was placed on independent seed certification agencies in India (APSSDC) and Malawi (Seed Services Unit - SSU) while in Ethiopia a quality assurance department was set up within the ESE itself. While the separation of seed quality control agencies from the seed production and marketing organizations is intended to avoid the former being compromised, we noted that this did not guarantee quality. In Ethiopia, there

have been concerns on quality of seed that the ESE provides. There is a gap between the guidelines and what is done in practice. For example, most of the seed production plots are visited fewer number of times than what is stipulated in the regulations, as the resources available are inadequate.

In India, the ruling variety TMV 2 was released six decades ago and it is likely that the purity of the seed has worn down (Rukmani and Manjula, 2009). A plant breeder in India mentioned "*TMV2 has recently not been in the pure condition and lot of mixing was going on because of the heavy demand for subsidy seed. The government could not produce the seed actually and they were purchasing it from the local markets, just passing it through the procedure, packing it and giving it so the quality was not good and the farmers were at a loss*". A former DoA official in India also added "*This is almost exploitation of farmers, a glaring example. If you open the seed bag which has been supplied by the government on subsidy, you will find at least three varieties*".

Seed certification requires regular monitoring, especially if it is done by smallholder farmers or when there is a large network of outgrowers with limited experience. The fact that seed quality control agencies are mostly funded by the government makes their services vulnerable to budgetary constraints. The situation is more problematic if the road infrastructure is poor or the fields are scattered making inspection expensive and time consuming.

At the local level, there is competition with other government departments for resources such as vehicles and fuel to be used for field inspections. Inadequate transport to carry out field inspections, sampling and seed monitoring limited the ability of the SSU in Malawi to perform efficiently. Transport costs in moving seed from multiplication site to processing and distribution points also contributes significantly to seed production costs and is associated with the spatial organization of processing plants and seed distribution outlets. Delays in seed field inspection was one of the major challenges faced by ICRISAT's seed growers, which led

to ICRISAT providing a vehicle to the SSU under the MSID project to improve mobility in the unit.

Another factor linked to quality is the extent to which farmers themselves actually know the characteristics of the varieties being developed and released. While knowledge of varieties can facilitate decisions about adoption, farmers do not often know the names. With the complicated number and letter combinations often allocated to varieties, farmers may assign a local name based on the seed characteristics, the extension worker who introduced it or nearest village where it was first grown. ICRISAT groundnut variety ICGV9114 was for example was named *Anantha Jyothi* in Anantapur.

6.6.4 Varietal release process and competition between different sources

Public sector plant breeding and varietal release procedures mainly use the yield advantage as a measure of variety performance. However, characteristics such as product quality, time to maturity, disease resistance and other characteristics preferred by the market such as seed size, colour and shape are also important. The extent to which the demand side is involved in setting research objectives is therefore one of the main factors that determine the probability of success of the resulting technologies. Nonetheless, the target traits of plant breeders are often driven by several other factors. As an ICRISAT scientist stated "*Short duration and drought tolerance have been identified as the major focus areas of ICRISAT groundnut breeding because we cater to the rainfed cultivated areas, where the rainfall is low, with erratic distribution and end of the season drought is quite common. Since 1976, drought has been stated as an important target area of research for the groundnut breeding programme to develop varieties and even today it still remains important*".

Participation of farmers in varietal selection may reduce time required for varietal testing and lead to earlier adoption. However, choice of farmers for PVS is often based on their capacity

to demonstrate i.e. have a field where several varieties can be grown, can take care of a trial, have the required implements, irrigation and other infrastructure and are leader or role models that other farmers follow. The concern is whether the views of these progressive farmers represent those of the larger farming community.

The application of tight controls on variety release and seed trade is viewed as necessary for the protection of the farmer. These seed regulations however support a system that protects monopolies in publicly funded plant breeding and seed production from outside competition as only varieties cleared by the varietal release committee can be sold. The committees are controlled by officials from the same monopolies with approvals for release being based on yields that have been documented in trials run by the government.

Public breeders in most countries still see themselves as being in competition with those from the private sector and IARCs. A senior NARS official in India also said "*ICRISAT should promote their own variety just like we promote ours. We are stationed in more remote areas but we are not less of scientists, we are all working for farmers*".

In the case of groundnut variety ICGV91114 in India, the variety may not have been released without data from farmer participatory trials led by ICRISAT and a local NGO in Anantapur, and the intervention of the Chief Minister. There were NARS with capacity but lacked the will to engage in seed production and promotion. The variety was proposed by ICRISAT and released in 2006 at the state level as a special case bypassing the All India Coordinated Research Project on Groundnut (AICRP-G). Although the performance of the variety is evident (Birthal et al., 2012), it faced a backlash from the national partners who have been reluctant to promote it alongside other varieties such as K6 that were released by the universities. A former ICRISAT scientist mentioned "*when I was not there they (NARS partners) would not mention about this variety but in my presence they would say this is a good variety this and that*". Efforts have been made to promote it through NGOs but it still

faces an adoption lag and has not been taken up on a large scale in the formal seed production process. A former NGO official in India remarked "*As a matter of fact, farmers doesn't have any preference. They don't know what is K6, what is JL24 or ICGV91114. They want to take a variety which gives them good yields. But government supplies variety which has been mostly developed by them just to show this is our variety. That is almost you can say it is their self pride. Most of the meetings I have attended, I have got into arguments with the NARS scientists and generally they will be defending their variety*".

This trend is likely block other players, including the private sector, and maintain the existence of inefficient public sector seed agencies. Other players face additional costs of competition with the extension systems that is publicly funded and accounts for a significant percentage of seed sales in developing countries. An official from the DoA in India said "*The role of the department in terms of ICGV91114 is nothing, it even discourages the promotion of this variety*".

In India, centrally released varieties are also not automatically accepted by all states. Plant breeders in state agricultural universities may not favor a variety from another state because it puts in question their own output. In addition, state released varieties take a longer time to be notified as they undergo a much more rigorous procedure than centrally released varieties; rigorous multi-locational testing within the state followed by testing across the country. There has also been a tendency to impose restrictions on the state release system on the grounds that some states release an excessive number of varieties. These issues have often led to cases where the state resorts to the production of Truthfully Labelled Seed (TLS) for varieties that have not been notified. The use of simpler standards like Quality Declared Seed (QDS) also enhanced chickpea and groundnut seed availability and adoption in Ethiopia and Malawi.

6.6.5 Processing, storage and distribution infrastructure

Processing, storage and distribution conditions have physiological effects on seed quality e.g. through biological deterioration and loss of germination. Depending on where the facilities are located relative to the seed farms, the physical and logistical aspects may also cause damage and increase costs of transportation especially to seeds like groundnut. An official from the SSU in Malawi stated "*Groundnut seed production is not profitable to the private sector. It occupies a lot of space, so transportation and storage is costly. That's why usually it keeps going through government agencies*".

Most NARS in developing countries cannot bear the cost controlled environment stores as it is difficult to pass on these costs to poor farmers. For example, while the amount of groundnut seed supplied by the DoA in India increased nearly thirtyfold between 1995 and 2008, the infrastructure required to produce additional seed has not been expanded to the same extent (Rukmani and Manjula, 2009). An ICRISAT scientist stated "*DoA is not keen on including ICGV91114 for subsidy for the reason that they will have to produce seeds which they are not interested in. They don't have enough farms, enough infrastructure, so there is so much of increase in the seed supply to farmers without any increase in farms or storage structures nothing. How they are doing is a big mind boggling question. Which means that it is clear enough that they just buy it from traders, pack it and sell it*".

ICRISAT under the TLII project identified lack of proper processing and storage facilities as a major constraint hampering seed production by individual farmers in Ethiopia. The project also identified the need for off-season seed production with supplemental irrigation to facilitate quicker varietal spread and developed an irrigation facility at DZARC. In India, the TLII project funded the installation/ renovation of existing seed processing and storage structures and purchase of several other equipment (motorbikes, electronic weighing balances, threshers, sprayers etc) at national partner sites in Nandyal, Darsi, Dharwad and Gulbarga

(Abate, 2012). In Malawi, ICRISAT was responsible for post harvest handling of groundnut seed and established seed storage and processing facilities in their premises. The institute also set up a laboratory for testing for aflatoxin contamination in groundnuts.

6.6.6 Subsidies and relief seed

Input subsidies are commonly used by governments as a poverty alleviation policy instrument to lower the prices that farmers pay for inputs, such as seeds or fertilizer, below their market prices. While the intention is to enable farmers to use these inputs for increasing productivity, they also promote the adoption of certain varieties at the expense of other promising ones that are not issued under subsidy. A former NGO official in India noted that "*whenever the planting season starts people will be standing in long queues for hours together and if the seed gets exhausted, people become very agitated and the police enters the scene. Sometimes the scorching sun made them to seek some shade under the trees keeping their footwear in the queue*".

In AP, the adoption of recently released groundnut and chickpea varieties was hindered by the fact that outdated cultivars TMV 2 and Annigiri dominated the seed issued to farmers under subsidy. TMV 2 occupied 75-80 percent of the total groundnut area in Anantapur even though its desired traits have degenerated considerably (Rukmani and Manjula, 2009). To address such problems and promote the adoption of new cultivars, the government instituted a rule that only varieties having a period below 10 years from the date of notification will be subsidized.

The private sector may produce seed of legumes where there is sufficient demand to make it financially attractive such as when there is a steady demand from relief agencies or government subsidies. In Malawi inclusion of legumes in the coupon-based farm input subsidy program created demand for improved groundnut varieties. An official from the SSU

stated "*Because of the high demand for seed, but at the same time because of the subsidy programme, it's like it is creating a market for it. We have so many actors, upto 30 small-small seed companies*". However, there is concern about the quality of seed as companies rush to meet this demand.

In India, the different state and central government subsidies cause market distortions even between the state corporations. An NSC official in India stated "*Since we are not getting subsidy facilities at par with SFCI or the state government, we are unable to produce and sell seeds the way SFCI are. We produce JG11 but due to that problem, we are unable to sell in the state and are making supply to other states like Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand and Maharashtra*".

6.6.7 Seed demand and contractual relations

Demand and supply in the seed sector is linked through demand estimates of seed companies. In India for example, based on information from the DoA on certified seed requirements on the ground, the Indian Council for Agricultural Research (ICAR) determines the breeder seed indent for each variety and directs the universities and seed corporations on aggregate seed production targets. When new varieties are released, seed producers often take time before producing large volumes as they are unable to estimate the demand from farmers who may still be unaware of the new cultivars.

Dorward et al. (2004) refer to transaction risks, which buyers and sellers face that a transaction may fail leading to loss of any investments. They need to incur costs to protect themselves against transaction failure e.g. the transaction costs of gathering information on projected seed demand. Seed corporations in India have also had to also conduct awareness activities for new seed varieties using their branch network. An NSC official in India stated "*We have created one separate wing for only extension and business development"*. Farmer

demand is also driven by the market as a farmer in India complained "*sometimes we have selling problems for new chickpea varieties as they are initially offered less price and 'Dal' millers don't want to change equipment*". An ICRISAT official in Malawi recalled "*CG7 was initially rejected by farmers because of its red color*".

6.6.8 Performance of the agricultural extension system

Developing and releasing varieties is not enough and one needs to go that extra mile. Access to extension services is strongly associated with farmers' awareness and adoption of improved varieties. Extension workers therefore need to be updated of new varieties as a plant breeder in India NARS noted "*Most of the time I have observed that even department (DoA) people are not even aware of good varieties*". An ICRISAT scientist added "*I went to one place where I met the agricultural officer and he says we have big money to promote improved varieties and when I asked him which varieties you are going to promote he gave me the name of 40 year old varieties*". In many places, linkage between breeders and the extension department is not very good as each works in isolation. Plant breeders in Indian SAUs are now forced to engage in extension activities through frontline demonstrations.

Insights from the case studies show that because of poor incentives, many of the extension workers don't go to villages themselves but live in cities and run businesses like fertilizer shops on the side. There are challenges in monitoring many extension workers spread across the country and farmers do not hold them accountable either.

Extension workers are also assigned tasks such as involvement in input and credit distribution. A former ICRISAT scientist stated "*They (extension workers) are assigned so many things, polio vaccination programme, subsidy distribution, census, any scheme that the government wants to implement*". A NARS plant breeder in India added "*Extension workers will not implement anything whole hearted because they are involved in so many activities*

and some political pressures will be there on them. If a new thing is given, the political people would want it to grab it and have it given to their area".

In Malawi, we noted that CG7 variety for a long time was a typical case of a good variety that remained on the research station shelf after its release. To date, even though government institutions like the Extension Department and DARS do exist, capacity gaps still remain and the ICRISAT Malawi office together with NGOs are engaged in promotion activities. This explains why ICRISAT was ranked highest in terms of level of influence on the desired outcome i.e. wide adoption of CG7 among farmers (Figure 5-1).

6.7 Discussion

Since legumes are important for in the well-being of farmers, incentives are required to ensure that the need for improved seed is met. Poor public-sector performance and lack of interest by the private has led to a void in seed supply systems. We have seen that because of the nature of legume seed, biases in varietal release processes, and distortions by subsidies and relief seed, the seed system for legumes is mainly dominated by public sector agencies. These agencies have the main responsibility for addressing constraints in seed availability and providing extension advice on available varieties. However, they face shortages in funding, infrastructure and skilled staff for research and seed production, processing, storage and distribution. Their ineffectiveness in estimating demand and delivering seed on time coupled with poor performance of extension systems reduces the availability of quality seed.

Findings from this study confirm those of other authors (Thijssen et al., 2008; Byrelee et al., 2007; Dadi et al., 2005; Bishaw et al., 2008; Ndjeunga et al., 2000) that shortage of funds poses a major setback for seed production in many developing countries. As Tripp and Rohrbach (2001) suggest there is a need to reconsider the allocation of funds between

breeding of more varieties and breeder, foundation and certified seed production as well as awareness creation.

Regional approaches and seed policies that encourage regional releases and regional variety registration could reduce the need for independent breeding programs in each country. Seed companies would then be encouraged to pursue regional markets instead of small national markets. Seed policy harmonization discussions have been supported by ICRISAT and other players in the Southern African Development Community (SADC) and West African regions to facilitate seed trade between countries. If successful, the harmonization is also likely to reduce the time lag before varieties are tested and released (Tripp and Louwaars, 1997; Abate, 2012; Ndjeunga et al. 2000).

Farmer based seed production programs and revolving seed schemes have played a significant role in seed diffusion and growth of the seed sector (Almekinders and Louwaars, 1999). An example that this study came across is the seed revolving fund managed by ICRISAT in Malawi that has contributed a lot in the adoption of CG7. Besides, its contribution in making new varieties available to the farming community, the project also generates income for ICRISAT, which is an incentive for the institute to continue producing and selling seed.

There is still a wide range of efforts being made in promotion of legumes such as community seed banks, exchange models, seed fairs and small seed packs indicating there is more to learn about what it would take to get legumes adopted sustainably on a large scale. In addition, as we have seen from numerous projects for seed multiplication and dissemination that come and go in Malawi, it is not sustainable to rely on NGOs as donors may change their focus anytime. What we observed in the case studies is that donors pursue easier alternatives to channel their resources, such as through IARCs. An example was the withdrawal of EU funding for the ASSMAG seed production project in Malawi when failures occurred due to inefficiencies leaving ICRISAT to be the major producer of foundation seed in the country.

From the three case studies we recognize that NARS have extremely variable capacity necessitating different approaches of support to different countries. Countries such as Malawi that have weak national systems find it difficult to tap spill-in opportunities from IARCs. Thus, as Shiferaw et al. (2004) also note, the comparative advantage and role of IARCs varies across countries. Complementary activities such as technology promotion are important in regions with adaptive capacity and adoption blocks.

6.8 Conclusions and policy implications

Agricultural development requires not just technical innovations but an identification and assessment of effective mechanisms for addressing barriers to adoption. A major role of IARCs should be to identify major institutional constraints to achievement of development goals, and seek alternative solutions. However, technical innovations are still often highlighted while institutional innovations are rarely reported. Analyses of research impacts and spillovers across locations have often taken into account agro biological characteristics and yield gains without much attention to the prevailing context that shape actual benefits.

Through a case study approach, this chapter shows that even in locations where the agro ecological suitability of improved legumes is high, actual spillovers are limited by political and institutional constraints. While downstream activities continue to be criticized in the CGIAR, the question still remains as to whether the centres are only focused on producing technologies, and not on their application.

In countries with capacity gaps such as the case of Malawi, the centres may have to engage in collaborative complementary activities with NARS such as adaptation, promotion while building capacity of the national systems. As we have seen from the case of ICGV91114 in India, technologies viewed as competing with those from the national system have low

chances of being taken up. Therefore, it is recommended that where there is adaptive research and extension capacity such as India and Ethiopia, the centres should focus more on supply of breeding lines and advocacy. Besides strategic research to lift productivity potentials, capacity building through collaborative research is required to exchange knowledge and technologies for wider utilization and closing of existing yield gaps. In addition, as demonstrated by the ICRISAT's involvement with the FISP program of Malawi, engagement with national policy can rapidly scale up the impacts from smaller projects.

Overall, legumes particularly require integrated seed systems development including enhancement of decentralized seed enterprises, capacity building of public and private seed organizations and enabling seed policies. National government need to invest more in seed production especially for grain legumes, which are not attractive for the commercial seed sector, if the benefits from new varieties are to be achieved. The costs of seed production and delivery therefore need to be taken into account when assessing impacts. Strategies are required to lift the entry barriers for private seed industry participation, such as prolonged subsidies and relief programs. The efficiencies of seed production in the public sector, objectivity of regulatory regimes in variety testing and release, and effectiveness of relief seed distributions programs also need to be re-examined. Regional harmonization of regulatory systems for seeds, such as the variety release system, seed certification scheme and phytosanitary measures, have a potential for making new varieties available more quickly across countries. However, such arrangements can only be beneficial in moving legume seeds if traders and other actors are made aware of its provisions. In the case of India, inconsistencies in the central and state release systems need to be addressed.

CHAPTER 7

GENERAL DISCUSSION AND CONCLUSIONS

7. GENERAL DISCUSSION AND CONCLUSIONS

International agricultural research is important for reducing poverty and food and nutrition insecurity, and sustaining natural resources. Since the world food price crisis of 2007-2008 and concerns over the ability to feed 9 billion people by 2050, donors have increased investment in agricultural research. The need for a more systematic basis for making resource allocations is therefore greater. The CGIAR reform process also calls for a thorough analysis of how research funds should be allocated on a global or regional basis, and the level of decentralization in the activities of the centers.

The last three chapters of the thesis have critically analyzed this issue through case studies of legume improvement at ICRISAT, complemented by a review of relevant documents. This chapter sums up the key findings and offers final conclusions and recommendations for international agricultural research management. Section 7.1 summarizes the main results from chapters two to four, addressing each of the research objectives and drawing implications on the CGIAR's comparative advantage. Section 7.2 focuses on the complementary role of the centers as boundary organizations and section 7.3 presents some recommendations for the CGIAR in locations with low capacity of national systems.

7.1 Comparative advantage of the CGIAR

Chapters 4, 5 and 6 have tackled the three objectives of the thesis: (i) To analyze perspectives of different stakeholders on the dilemma regarding focus of the CGIAR on international public goods versus downstream uptake-oriented work. (ii) To develop a framework to guide decision making on how the CGIAR centers should position themselves in relation to national systems. (iii) To examine the underlying issues at the national level that drive CGIAR centers

to conduct activities for which they may not have a comparative advantage. This section provides a summary of the key findings.

7.1.1 What are the perspectives of stakeholders on IPGs in the CGIAR?

The narrative policy analysis confirms that there are contrasting views among centre scientists and national system partners on whether the CGIAR should primarily focus on the production of IPGs, or also conduct more uptake-oriented activities. The dominant story, which has been advocated for at the CGIAR system level, is that the main challenge in agricultural development is lack of new technologies, and the IPG concept is ideal for framing CGIAR research in a niche that may not be served by national systems or the private sector. The counterstory is that technologies exist on-the shelf but the problem lies in their delivery. This opposing narrative argues that the CGIAR can only achieve its goals if attention is paid to both research and development-oriented activities that enhance uptake. These divergent views and the interest of CGIAR scientists to obtain funds that will maintain their jobs have been reflected in the activities of the centers as donors increasingly drive the research agenda.

The polarized narratives show that there is still a knowledge gap in objectively tackling the dilemma on what activities the CGIAR should actually do, and what the role of national partners should be. The actions of stakeholders also illustrate that their ideas and interests are important in determining what policies eventually get implemented and the likelihood that the policies will be adhered to. There is thus a need to develop practical criteria for assessing comparative advantage. Chapter four therefore proposed the use of a cost-effectiveness approach in allocating research and development activities among actors in order to get maximum welfare gains from available resources.

7.1.2 How should the CGIAR position itself relative to national systems?

The most cost-effective arrangements for achieving a given outcome from agricultural R4D can be assessed using transaction costs economics. In Williamson's (1991) discriminating alignment hypothesis, transactions that differ in their attributes are aligned with governance structures that differ in their costs and competence. Chapter five used this framework, conducting empirical work at the ICRISAT legume improvement program so as to specify the transactions involved in the development and uptake of groundnut and chickpea varieties. Using illustrations from the case studies, propositions were derived on the attributes of transactions for which IARCs have a comparative advantage over national systems.

Consistent with the literature on international public goods, it was found that basic and strategic research transactions that have high economies of scale and spillover potential should be ideally assigned to a centralized institution (IARC). Adaptive research, field testing, varietal release, seed multiplication, certification and promotion activities have low economies of scale and spillover potential and should be carried out by a more decentralized institution (NARS or other partner).

Besides these two attributes it was also found that transaction intensity and the scope for elite capture and corruption influenced the role that CGIAR centers played in different countries. However, the case studies showed that drawing implications on the comparative advantage of the CGIAR vis-à-vis NARES was not straightforward as contextual factors, especially capacity of national systems, were also critical. It is therefore proposed that CGIAR centers may have to apply different positioning strategies because of variations in the institutional environment across locations and commodities.

7.1.3 What drives CGIAR centers to conduct downstream activities?

The case studies in India, Malawi and Ethiopia show that even in locations where the agro ecological suitability of improved legumes is high, actual spillovers are limited by political and institutional constraints. National systems have extremely variable capacity, which means that the comparative advantage and role of IARCs varies across countries.

Activities such as adaptation, technology promotion and seed production have been important in regions or countries with adaptive capacity and adoption blocks, such as the case of Malawi. However, this should not be done to extent where they compete with those from the national system, as was seen from the case of ICGV91114 in India. This case also shows the need to follow national protocol as the special release, bypassing normal procedures, led to universities perceiving it as a threat and not supporting its promotion.

Where there is adaptive research, seed production and extension capacity, the centers should play more of a facilitation and advocacy role rather than conducting these activities themselves. Centers should avoid crowding out national researchers or reducing incentives for governments to address existing gaps.

7.2 Complementary advantage of the CGIAR

The literature on international public goods views the IPG delivery system as having two components; the zone of control for which the CGIAR is directly accountable, and the zone of influence that lies beyond its direct control (Sagasti and Timmer, 2008). However, it is evident from the case studies that ICRISAT had to move into more development-related activities where state systems had low capacity to undertake adaptive research and promotion such as the case of CG7 in Malawi. Even in the case of India where NARES have good capacity, ICRISAT had to conduct promotional activities for ICGV91114 groundnut variety

because of governance challenges within the public sector.

Thus, as Biggs (1990) notes, technology development and dissemination activities take place in a in a context that is historically defined in political, economic, agroclimatic and institutional terms. The CGIAR centers have to exercise their "complementary advantage" by making trade-offs and playing a catalytic, facilitative or advocacy role depending on the context where they work. Depending on the relative capacity of the CGIAR and national systems, the centers have to take advantage of both their comparative and complementary advantages Ryan (2006).

To activate uptake of their products and realize impact from research, CGIAR scientists may have to take up an activist role and mobilize public, private and NGO partners to invest time and resources. The literature on innovation brokers or champions (Klerkx and Aarts, 2013; Ekboir, 2009; Klerkx et al., 2009) and institutional entrepreneurship (DiMaggio, 1988; Fligstein, 1997; Perkmann and Spicer, 2007) defines the role of personal, professional and institutional relationships as well as leadership characteristics to induce other actors, mobilize resources and catalyze the innovation process.

With the experience and contribution of CGIAR scientists in different regions, they have earned respect of various groups and have the resources required to act as innovation champions. As we saw from the cases studies, all the groundnut and chickpea varieties in the case studies faced an adoption lag after release until ICRISAT engaged different stakeholders to produce large quantities of seed and create awareness about the varieties among farmers. Many of the respondents identified individual agents (Banerjee, 2013) or champions (Klerkx and Aarts, 2013) from different organizations and the role of particular ICRISAT scientists in managing this network of champions to get the varieties widely adopted. Social science research in within the CGIAR has a good potential for contributing to the above literature and understanding of innovation processes. This potential has not been fully tapped to date since

very little emphasis has been placed on the social, political and institutional aspects of agricultural development.

In most instances, the centers act as boundary organizations (McNie, 2007; Klerkx and Leeuwis, 2008) and bridge between donors and other actors. Most of the ICRISAT projects reviewed were designed in such a way that donors acted as principals to ICRISAT, which in turn acted as a principal to national systems. ICRISAT was simultaneously an agent to the donor and a principal to the national partners. Besides the oversight role of the centers to ensure the projects achieve the intended outcomes, this mediation structure could provide an opportunity for building capacity of national systems and helping them overcome their governance challenges.

Since developing delivery systems for particular countries may involve high transaction costs, science-based advocacy and lobbying with governments and donors is required to fill performance gaps (Sagasti and Timmer 2008; CGIAR Science Council, 2006; Sumberg, 2005). The release of groundnut variety ICGV91114 in India and the inclusion of groundnut in the Farm Input Subsidy Program (FISP) of the Malawian government were both due to the advocacy role of ICRISAT.

7.3 Recommendations

To achieve sustained agricultural development, international agricultural research centers should contribute to the development of national agricultural research and extension systems rather than undermine them. In order to achieve this, systematic means should be sought to assess the capacity gaps and develop the required capacity based on this information. At the same time, the centers should draw institutional lessons that can be applied in other locations.

7.3.1 Priority setting for the CGIAR Research Programs (CRPs)

Priority setting and resource allocation within the CGIAR have mostly been guided by quantitative ex ante impact analysis. This has served well for decision making on which crops, production environments or countries to invest in so as to achieve the maximum possible returns to investment. However, the question of how the IARCs should position themselves relative to other players in conducting complementary activities along the impact pathway such as technology promotion, dissemination and seed production is still open.

Taking the example of the grain legumes CRP (CGIAR, 2012), the proposal identifies major constraints to adoption as inadequate dissemination of information to farmers, varieties lacking key traits desired by the farmers, inadequate availability of seed, and lack of access to inputs and output value chains by farmers. The same CRP document proposes that production of breeder and foundation seed would mainly be handled through NARS, foundation and certified seed by the public and private seed sectors, and extension services would promote the new cultivars. As we have seen from the case study of Malawi, this assumption is not always valid and CGIAR centers have had to seek alternative options to address the above constraints and make new technologies available to the farming community.

As established in chapter 5, an important aspect determining the strategic role of the CGIAR centers in the CRPs is the capacity of national partners. Priority setting and targeting of research activities should therefore include assessment of NARES capacities. Existing capacities should be reviewed for all activities along the research-development continuum so as to identify where constraints need to be addressed and who to collaborate with. This will also allow the centers to effectively target their capacity building efforts.

7.3.2 Determining agricultural innovation capacity and its drivers

The achievement of welfare outcomes from international agricultural research depends on whether the research effort will succeed in meeting its intended objectives. There are significant differences in the countries served by the CGIAR centers, which affect the probability of success in generating knowledge and transforming it into the desired productivity gains among farmers. Science and technology indicators (Beintema and Stads, 2011) can guide decision making by providing information on the state of agricultural science and technology. Reliable statistics on the state of national systems and thorough analysis of capacity constraints are important for priority setting purposes.

There have been some efforts to develop indicators of institutional capacity or capacity to innovate (Spielman and Birner, 2008; Pardey and Roseboom, 1989). Before its closure, the International Service for National Agricultural Research (ISNAR) had the mandate is to assist developing nations with organizational issues related to agricultural research. The institute began efforts to document agricultural research personnel and expenditure indicators for national systems (Pardey and Roseboom, 1989). The Agricultural Science and Technology Indicators (ASTI) initiative, now led by the International Food Policy Research Institute (IFPRI), continued with this work. The personnel indicators record researchers according to degree status and in-full time equivalent units while the expenditure data attempts to measure actual research expenditures.

Despite these attempts and use of other measurements such as market access (Omamo et. al, 2006), data describing these indicators are patchy and of questionable quality in many developing countries. In addition, these aggregate indicators do not take into account differences between commodities in a given country. Different technologies have different spillover patterns calling for strategies that are tailored to the crop. It is therefore important

that CGIAR centers makes efforts to develop national innovation capacity indicators depending on their mandate in terms of crop and region.

Ex-ante impact assessment studies conducted to guide priority setting and targeting decisions take into account agro-ecological conditions, such as the length of growing period (LGP), with assumptions regarding the adaptive capacity and adoption parameters. These additional parameters depend on local conditions. Where resources are not available to conduct extensive surveys, the capacity estimates are elicited as expert judgments. These are worked out implicitly in the experts mind based on their internalized experience. However, this knowledge is likely to be lost when they leave the organization. Case studies, such as the ones conducted in this thesis, will help understand the R&D process and institutional drivers of uptake and impact for different crops and in different regions and make this implicit knowledge more explicit for future use. This would reveal the considerations that underlie expert judgments, which are often not well documented in adoption studies.

Additional data can be collected and used to verify and adjust the expert opinions such as research expenditure and staffing data from ASTI, number of trials conducted in the country for the crops of interest, number of releases in the country and number of national system scientists trained on the crop by the center. In addition, considering that the centers now work together under the CRPs, collection of such data can be organized and budgeted for at the CRP level. In cases where resources have been devoted to capacity building, ex-post impact studies should also consider the contribution of these project capacity building elements to welfare benefits and to other research projects (for examples see Gordon and Chadwick (2007) and Ryan (1999)).

7.3.3 Capacity building and documentation of institutional lessons

Taking into account the wide variations in capacity of national systems across the countries studied, capacity building should be part and parcel of CGIAR centre activities to ensure sustained impact in the long run. The centers should also develop systematic ways to draw lessons from successful activities as well as those that faced limiting governance and institutional challenges. As the CGIAR centers cannot substitute for weak national systems forever, developing countries must take responsibility for public agricultural research and extension. However, we have seen from cases such as Malawi that donors often avoid the tedious and long-term task of capacity strengthening and instead drive the centers downstream. This is a shift from the overseas work of foundations, prior to establishment of the CGIAR system, that aimed to eventually turn over responsibility to nationals of developing countries.

The CGIAR centers can help strengthen national or regional systems by engaging in joint activities. ICRISAT's collaborative satellite program involving several SAUs in Jabalpur, Akola and Sihore that led to the testing and release of JG11, is one such example. As discussed in chapter three, comparative advantage is not fixed as capacity building would shift the respective cost-curve downwards. As the regional and national organizations develop their own institutional capacities, the comparative advantage of the CGIAR will also shift. This would enable the centers to transfer some research components to the national systems and make strategic choices according to partner strengths. In India and Ethiopia, ICRISAT mainly performed a facilitation and advocacy role and in the case of groundnut variety ICGV91114, their involvement in activities that could be performed by the national system resulted in a backlash that hindered adoption of the variety. In Malawi, substantial capacity building is still required.

The CGIAR centers are also mission oriented and part of their responsibility is to understand what is needed to achieve impact and the major institutional bottlenecks in different contexts. Hence, research must go beyond the typical adoption studies to include institutional analysis of patterns of interaction and learning to address these bottlenecks. Testable proof- of-concept hypotheses on scaling up processes should be identified and tested in subsequent interventions (Figure 7-1). However, research managers within the CGIAR have often highlighted technical innovations, and not properly documented the institutional innovations. To learn lessons from areas where uptake of technologies is low, research that helps in understanding of the intermediate governance and institutional challenges should be recognized by the CGIAR.

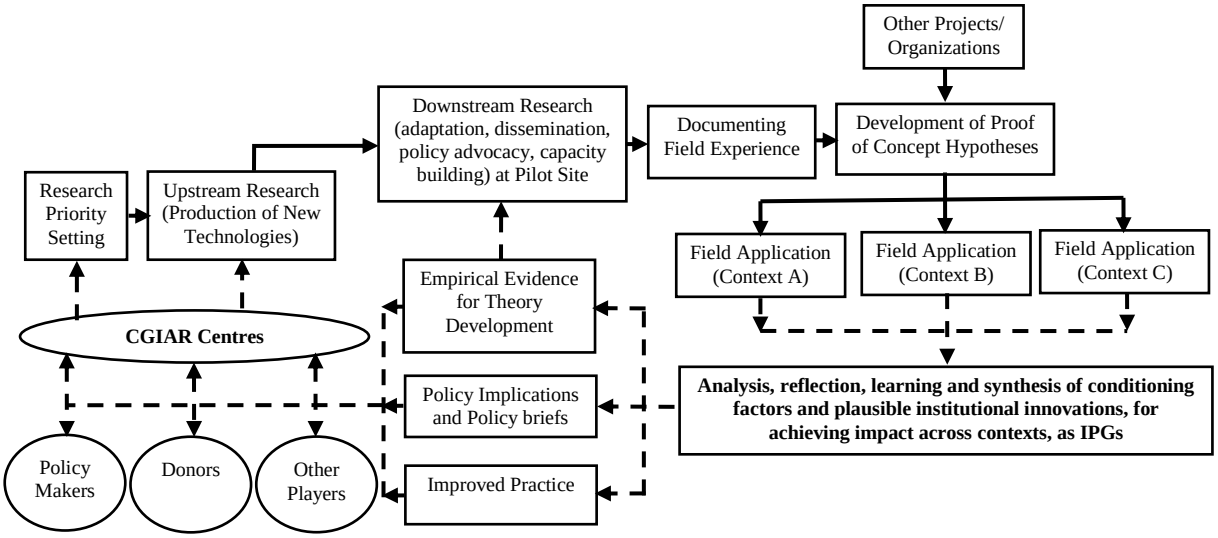

Figure 7-1 Learning and documentation of institutional lessons.
Source: Author based on learning alliance concept (Lundy et al., 2005)

To realize the full benefits of international agricultural research, investments are required at the international, regional and national levels. There is a trade-off between focusing on upstream research to raise productivity and institutional building that will help close existing yield gaps. While the CGIAR centers should be careful about placing too much emphasis on downstream activities with high transactions costs, their ability to manage learning from such activities can generate lessons on how best to put knowledge into use. In order to better understand how impact is achieved, the role researchers in facilitating it needs to be continuously examined.

8. REFERENCES

Abate T. (ed.). 2012. Four Seasons of Learning and Engaging Smallholder Farmers: Progress of Phase 1. PO Box 39063, Nairobi, Kenya. International Crops Research Institute for the Semi-Arid Tropics. 258 pp.

Alston, J.M., G.W. Norton, and P.G. Pardey. 1998. Science under scarcity: Principles and practice for agricultural research evaluation and priority setting. CAB International, Wallingford, UK.

Alston, J.M., Norton, G.W., Pardey, P.G. 1995. Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting. Cornell University Press, Ithaca.

Alston, J.M., Pardey P.G. and Ruttan V.W. 2008. Research Lags Revisited: Concepts and Evidence from U.S. Agriculture. Staff Paper P08-14, InSTePP Paper 08-02, University of Minnesota, December, 2008.

Alston, J.M., Pardey, P.G., Smith, V.H. 1999. Paying for Agricultural Productivity. Johns Hopkins University Press, Baltimore.

Alston, Julian M. & Andersen, Matthew A. & James, Jennifer S. & Pardey, Philip G., 2011. The Economic Returns to U.S. Public Agricultural Research. American Journal of Agricultural Economics, Agricultural and Applied Economics Association, vol. 93(5), pages 1257-1277.

Alston, Julian M., Connie Chan-Kang, Michele C. Marra, Philip G. Pardey and TJ Wyatt. 2000. A meta-analysis of rates of return to agricultural R&D, Ex Pede Herculem? Research Report 113, IFPRI, Washington DC.

Alston, Julian M., Pardey, Philip G. and Roseboom, Johannes. 1998. Financing Agricultural Research: International Investment Patterns and Policy Perspectives. World Development Vol. 26, No. 6, pp. 1057-1071, 1998

Almekinders, C.J.M. and Louwaars N. 1999. Farmers' seed production: New approaches and practices. IT Publications, London, UK. P33

Anderson, Jock R. 1998. Selected Policy Issues in International Agricultural Research: On Striving for International Public Goods in an Era of Donor Fatigue. World Development Vol. 26, No. 6, pp. 1149-1162, 1998

Anderson, J.R., and Feder, G. 2004. Agricultural extension: Good intentions and hard realities. World Bank Research Observer 19(1): 41–60.

Asfaw Solomon and Shiferaw Bekele. 2009. Baseline Assessment of Groundnut, Chickpea and Pigeonpea for Eastern and Southern Africa: Baseline research report for Tropical Legumes-II. December 2009. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), P.O box 39063-00623 Nairobi, Kenya

Asfaw Solomon, Shiferaw Bekele, Simtowe Franklin, Lipper Leslie. 2012. Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. Food Policy 37 (2012) 283–295

Asfaw Solomon, Shiferaw Bekele, Simtowe Franklin, Muricho Geoffrey and Ferede Setotaw. 2010. Socio-economic Assessment of Legume Production, Farmer Technology Choice, Market Linkages, Institutions and Poverty in Rural Ethiopia.

Aw-Hassan A, Shideed K, Sarker A, Tutwiler R and Erskine W. 2003. Economic impact of international and national lentil improvement research in developing countries. Pages 275-291 in Crop variety improvement and its effect on productivity: The impact of international agricultural research (Evenson RE and Gollin D. eds.). CABI, Wallingford, UK. 522 pp.

Banerjee, Rupsha. 2013. The Green Revolution: The Untold Process of its Success, No 156208, 53rd Annual Conference, Berlin, Germany, September 25-27, 2013, German Association of Agricultural Economists (GEWISOLA).

Banerjee, Rupsha. 2013. The Role of the Individual Agency in Participatory Irrigation Management: Lessons from India. Paper presentation at the Tropentag 2013 Conference, 17-19th September 2013, Stuttgart Germany

Bantilan Cynthia, Templeton Debbie and Craswell Eric. 2009. Report on Master Class on Impact Assessment Concepts and Tools for Agricultural Research Evaluation and Impact Assessment. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, A.P., India 18 – 27 March 2009

Bantilan, M.C.S., and Davis, J.S. 1991. Across-commodity spillover effects of research and opportunity costs in a multiproduct production environment. ACIAR/ISNAR Project Paper Series no. 30. Canberra, Australia: Australian Centre for International Agricultural Research and The Hague: International Service for National Agricultural Research.

Bardhan, P. 2002. Decentralization of Governance and Development. Journal of Economic Perspectives, 16 (4), 185–206.

Barnes, Andrew P. 2001. Towards a framework for justifying public agricultural R&D: the example of UK agricultural research policy, Research Policy, Volume 30, Issue 4, Pages 663-672

BCG. (2009). Design and Establishment of the Consortium of CGIAR Centres Final Report. Boston: Boston Consulting Group and Alliance of the CGIAR Centres.

Beintema Nienke, Hailu Mekonnen, Haregewoin Tesfaye, Rahija Michael, and Bezabeh Eyob. 2014. Agricultural R&D Indicators Factsheet: Ethiopia. ASTI, February 2014

Beintema, Nienke and Gert-Jan Stads. 2011 . African Agricultural R&D in the New Millennium: Progress for Some, Challenges for Many. IFPRI Food Policy Report, February 2011

Belay, S. 2004. The Seed Regulations and Standards of Ethiopia: The Way Forward. Eastern and Central Africa Program for Agricultural Policy Analysis (ECAPAPA) Report. Entebbe, Uganda: ECAPAPA.

Bennett, C.F. 1995. Rationale for public funding of agricultural extension programs. Journal of Agricultural and Food Information 3(4): 3–25.

Berg, Annukka and Hukkinen, Janne I. 2011. The paradox of growth critique: Narrative analysis of the Finnish sustainable consumption and production debate. Ecological Economics 72, 151–160

Bertram R. 2006. Beyond International Public Goods: But Just How Far? Brief prepared for the Workshop on “Positioning the CGIAR in the Global Research for Development Continuum”, the Hague, Netherlands, 19 May 2006.

Bessette JM. 1980. Deliberative Democracy: The Majority Principle in Republican Government," in How Democratic is the Constitution?, eds. Robert Goldwin and William Shambra. American Enterprise Institute

Bhagat Rasheeda. 1998. A visionary and a statesman. Frontline National Magazine, from the publishers of The Hindu. Vol. 15, No. 05. March 7-20, 1998. http://www.hindu.com/fline/fl1505/15051130.htm (Accessed 1st March 2012)

Bhalla GS. and Singh G. 2001. Indian Agriculture Four Decades of Development. Sage Publications New Delhi. Thousand Oaks London

Biggs Stephen. 2008. Learning from the Positive to Reduce Rural Poverty and Increase Social Justice: Institutional Innovations in Agricultural and Natural Resources Research and Development. Expl Agric. Vol. 44, pp. 37–60 C 2008 Cambridge University Press

Biggs, Stephen D.1990. A Multiple Source of Innovation Model of Agricultural Research and Technology Promotion. World Development, Vol. 18. No. 11. pp. 1481-1499.

Binswanger, H.P and Rosenzweig, M.R. (1986). Behavioural and Material Determinants of Production Relations in Agriculture. Journal of Development Studies Vol. 22 no.3: 503539.

Birner, Regina. 2008. Can Decentralization and Community-Based Development Reduce Corruption in Natural Resource Management: Insights from Irrigation in Ghana and Forestry in Indonesia, Paper presented at the 13th International Anti-Corruption Conference organized by Transparency International. Athens, Greece October 30 – November 4, 2008.

Birner, R. and Anderson, J. R. 2007. How to make agricultural extension demand-driven? The case of India's agricultural extension. Discussion Paper 729. Washington, D.C.: International Food Policy Research Institute.

Birner Regina and Resnick Danielle. 2010. The Political Economy of Policies for Smallholder Agriculture, World Development, Volume 38, Issue 10, Pages 1442-1452

Birner Regina, Surupa Gupta and Neeru Sharma. 2011. The Political Economy of Agricultural Policy Reform in India: Fertilizers and Electricity for Irrigation. IFPRI Research Monograph

Birner, R. and Linacre, N. 2008. Regional Biotechnology Regulations: Design Options and Implications for Good Governance. IFPRI Discussion Paper 753. International Food Policy Research Institute, Washington, DC.

Birner, R. and von Braun, J. 2009. Decentralization and Public Service Provision: A Framework for Pro-Poor Institutional Design, in: Ahmad, Ehtisham and Giorgio Brosio (Eds.): Does Decentralization Enhance Poverty Reduction and Service Delivery? Edward Elgar, Cheltenham, UK, pp. 287-315.

Birner, R. and Wittmer, H. 2004. On the 'Efficient Boundaries of the State': The Contribution of Transaction Costs Economics to the Analysis of Decentralization and Devolution in Natural Resource Management, in: Environment and Planning C: Government and Policy, Vol. 22 (5), pp. 667 – 685.

Birner, R., and Wittmer, H. 2003. How to use social capital to create political capital: How do local communities gain political influence? A theoretical approach and empirical evidence from Thailand. In Crafting the commons in the new millennium, ed. N. Dolsak and E. Ostrom. Cambridge, Mass., U.S.A.: MIT Press.

Birthal Pratap, Nigam Shyam, Narayanan A.V., and Kareem K.A. 2012. Potential economic benefits from adoption of improved drought-tolerant groundnut in India. Agricultural Economics Research Review Volume 25, Issue 1

Birthal PS, Parthasarathy Rao P, Nigam SN, Bantilan MCS and Bhagavatula S. 2010. Groundnut and Soybean Economies in Asia: Facts, Trends and Outlook. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 92 pp. ISBN: 978-92-9066-531-1. Order code: BOE 050.

Bishaw Zewdie, van Gastel AJ and Bill R Gregg. 2008. Sustainable Seed Production of Cool Season Food Legumes in CWANA Region. Pages 231-257 in Proceedings of the fourth International Food Legumes Research Conference (IFLRC-IV), (Kharkwal MC. ed.). 18-22 October 2005, New Delhi, India, ISGPB, New Delhi, India.

Brennan, J.P. 1986. "Impact of wheat varieties from CIMMYT on Australian wheat production", Agricultural Economics Bulletin No. 5. Department of Agriculture New South Wales, Sydney.

Brennan, J.P.; Byerlee, D. 1991. The rate of crop varietal replacement on farms: measures and empirical results for wheat. Plant Varieties and Seeds 4 (3): 99-106.

Brennan, John P, Aw-Hassan, Aden, Nordblom, Thomas L. 2003. Influence of spillovers to Australia on impacts of the International Centre for Agricultural Research in the Dry Areas, Food Policy, Volume 28, Issues 5–6, October–December 2003, Pages 471-485.

Brennan, JP and Bantilan, MCS. 2003. Price and yield effects of spillovers in international agricultural research: Evidence from ICRISAT and Australia. Agricultural Economics 28(2): 87-97.

Bringer Joy D., Lynne Halley Johnston and Celia H. Brackenridge. 2006. Using Computer-Assisted Qualitative Data Analysis Software to Develop a Grounded Theory Project. Field Methods, Vol. 18, No. 3, August 2006 245–266. Sage Publications

Brown, T.L. and Potoski, M. 2003. Transaction Costs and Institutional Explanations for Government Service Production Decisions. Journal of Public Administration Research and Theory, 13 (3), 441–68

Byerlee Derek, Spielman David J., Alemu Dawit, and Gautam Madhur. 2007. Policies to Promote Cereal Intensification in Ethiopia: A Review of Evidence and Experience. IFPRI Discussion Paper 00707. June 2007. Development Strategy and Governance Division

Byerlee, D. and Traxler, G. 2001. The role of technology spillovers and economies of size in the efficient design of agricultural research systems. In: Alston, J., Pardey, P., Taylor, M. (Eds.), Agricultural Science Policy: Changing Global Agendas. Johns Hopkins University Press, Baltimore.

Byerlee, Derek. 2000. Targeting poverty alleviation in priority setting for agricultural research, Food Policy, Volume 25, Issue 4, Pages 429-445

Campbell, J.L. 2002. Ideas, Politics and Public Policy. Annual Review of Sociology, Vol.28, pp21-38.

CGIAR, 2012. CGIAR Research Program on Grain Legumes: Leveraging legumes to combat poverty, hunger, malnutrition and environmental degradation. Proposal submitted by ICRISAT, CIAT, ICARDA and IITA. 15 August 2012

CGIAR Financial Report. 2013. Approved by the Consortium Board on 18 June 2014 for submission to the Fund Council

CGIAR Fund Office. 2011. The CGIAR at 40 and Beyond: Impacts that Matter for the Poor and the Planet. June 2011.

CGIAR Fund. 2013. Consortium of CGIAR Centers. Available: http://www.cgiarfund.org/consortium_cgiar_centers. Last accessed 8th September, 2014.

CGIAR Independent Review Panel. 2008. Bringing Together the Best of Science and the Best of Development. Independent Review of the CGIAR System. Report to the Executive Council. Washington, DC.

CGIAR Science Council Secretariat. 2006. "Partners in Research for Development", background paper pgs. 25 - 41 in CGIAR Science Council Positioning the CGIAR in the Global Research for Development Continuum: Report of a Workshop, Ministry of Foreign Affairs, The Hague, The Netherlands, Friday 19 May

CGIAR Science Council. 2005. System Priorities for CGIAR Research 2005–2015. Science Council Secretariat: Rome, Italy. (Reprint).

CGIAR Science Council. 2006. Positioning the CGIAR in the Global Research for Development Continuum. Rome, Italy: Science Council Secretariat.

CGIAR Science Council. 2008. Workshop on International Public Goods. Special Session at AGM 08, Maputo, Mozambique, 27 November 2008.

CGIAR Science Council. 2009. Report of the Sixth External Program and Management Review (EPMR) of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), February 2009.

CGIAR SRF. 2011. Changing Agricultural Research in a Changing World. A Strategy and Results Framework for the Reformed CGIAR. (Accessed 20 June, 2012). http://cgiarweb.s3.amazonaws.com/wp-content/uploads/2011/08/CGIARSRFBrochure.pdf

Charmaz, K. 2006. Constructing grounded theory. A practical guide through qualitative research. London: Sage.

CIA, 2014. The World Factbook. Available online at <https://www.cia.gov/library/publications/the-world-factbook/>. Accessed on 27 October, 2014.

Council on Foundations, 2011. United States International Grantmaking. http://www.usig.org/basics/legal-requirements-private.asp

Craswell, Eric T. 2006 . The Research Continuum - The Case of Research on Integrated Natural Resources Management. Paper prepared for Workshop on Positioning the CGIAR in the Global Research for Development Continuum. May 2006, The Hague, Netherlands.

Cromwell Elizabeth, Friis-Hansen Esbern and Turner Michael. 1992. The Seed Sector in Developing Countries: A Framework for Performance Analysis. ODI Working Paper 65

Dadi Legesse, Regassa Senait, Fikre Asnake, Mitiku Demissie, Gaur PM, Gowda CLL and Bantilan MCS. 2005. Adoption Studies on Improved Chickpea Varieties in Ethiopia. Ethiopian Agricultural Research Organization PO Box 2003, Addis Ababa, Ethiopia and International Crops Research Institute for the Semi-Arid Tropics Patancheru 502 324, Andhra Pradesh, India

Dalrymple D. 2002. International Agricultural Research as a Global Public Good: A Review of Literature, Issues, and the CGIAR Experience. In Proceedings of the Warren E. Kronstad Symposium, Reeves J, McNab A, Rajaram S (eds). CIMMYT: Mexico, D.F.; 59–72.

Dalrymple Dana G. 2008. International Agricultural Research as a Global Public Good: Concepts, the CGIAR Experience, and Policy Issues. Journal of International Development 20, 347–379

Daokui Li, D., Feng J. and Jiang, H. 2005. Institutional Entrepreneurs. Working Paper Hong Kong University of Science and Technology

Davis, J.S., Oram, P.A., and Ryan, J.G. 1987. Assessment of agricultural research priorities: an international perspective. ACIAR Monograph No. 4, 85 p.

de Janvry A and Kassam A. 2001. Advantages and Added Value of the Regional Approach to Research for the International Agricultural Research System. Invited paper for the Reunion FORAGRO Sobre Prioridades Regionales de Investigacion. Mexico: CIMMYT.

Deb UK and Bantilan MCS. 2001. Spillover impacts of agricultural research: a review of studies. Working Paper Series no. 8. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 32 pp.

Devaux, A., J. Andrade-Piedra, D. Horton, M. Ordinola, G. Thiele, A. Thomann and C. Velasco. 2010. Brokering Innovation for Sustainable Development: The Papa Andina Case. ILAC Working Paper 12, Rome, Italy: Institutional Learning and Change Initiative.

DiMaggio, P.J. 1988. Interest and agency in institutional theory. In L. Zucker (Ed.), Institutional patterns and organizations. 3-22. Cambridge, MA: Ballinger.

Dodgson Mark, Hughes Alan, Foster John and Metcalfe Stan. 2011. Systems thinking, market failure, and the development of innovation policy: The case of Australia, Research Policy, Volume 40, Issue 9, Pages 1145-1156

Dorado, S. 2005. Institutional entrepreneurship, partaking, and convening. Organization Studies 26 (3) : 383-413.

Dorosh Paul A. and Rashid Shahidur. Food and Agriculture in Ethiopia: Progress and Policy Challenges. IFPRI Issue Brief 74, January 2013

Dorward, A., S. Fan, J. Kydd, H. Lofgren, J. Morrison, C. Poulton, N. Rao, L. Smith, H.Tchale, S. Thorat, I. Urey, and P. Wobst. 2004. "Institutions and Policies for Pro-Poor Agricultural Growth," Development Policy Review, Vol.22 (6): 611-622.

Douthwaite B., Baker D., Weise S., Gockowski J., Manyong V. M. and Keatinge J. D. H. 2005. Ecoregional Research in Africa: Learning Lessons from IITA's Benchmark Area Approach. Experimental Agriculture, 41, pp 271-298.

Douthwaite B., Keatinge J.D.H., and Park J.R. 2002. Learning selection: an evolutionary model for understanding, implementing and evaluating participatory technology development. Agricultural Systems 72 (2002) 109–131

Douthwaite, Boru and Ashby, Jacqueline. 2005. Innovation histories: A method for learning from experience. ILAC Brief 5 July 2005.

Eicher, Carl K. and Rukuni, Mandivamba. 2003. The CGIAR at 31:An Independent Meta-Evaluation of the Consultative Group on International Agricultural Research. Thematic Working Paper The CGIAR in Africa: Past, Present, and Future. The World Bank Operations Evaluation Department.

Ekboir, J. 2007. Can Impact Analysis be used for Research Evaluation? Mexico: CIMMYT.

Ekboir, J. 2009. The CGIAR at a Crossroads: Assessing the role of international agricultural research in poverty alleviation from an innovation systems perspective. ILAC Working Paper 9, Rome, Institutional Learning and Change Initiative.

Ekboir, Javier. 2003. Why impact analysis should not be used for research evaluation and what the alternatives are, Agricultural Systems, Volume 78, Issue 2, Pages 166-184

Evenson, R. E. and Gollin, D. 2003. Assessing the Impact of the Green Revolution, 1960 to 2000. Science 2 May 2003: 300 (5620), 758-762.

FAO, IFAD and WFP. 2014. The State of Food Insecurity in the World 2014. Strengthening the enabling environment for food security and nutrition. Rome, FAO.

Feder, Gershon, Jock R. Anderson, Regina Birner and Klaus Deininger. 2010. Promises and Realities of Community-Based Agricultural Extension. Discussion Paper 959, International Food Policy Research Institute, Washington, D.C. March 2010.

Feldman Martha S., Skoldberg Kaj, Brown Ruth Nicole and Horner Debra. 2004. Making Sense of Stories: A Rhetorical Approach to Narrative Analysis. Journal of Public Administration Research and Theory, Vol. 14, no. 2, pp. 147–170

Finlayson, A. 2004. Political science, political ideas and rhetoric. Economy and Society, Vol.33 (4), pp528-549.

Fischer, F. and Forester, J. 1993. 'Editors' introduction,' in F. Fischer and J. Forester, eds., The Argumentative Turn in Policy Analysis and Planning. Durham: Duke University Press, pp. 1-17.

Flaherty Kathleen and Kamangira David. 2014. Agricultural R&D Indicators Factsheet: Malawi. ASTI, June 2014

Fligstein, N. 1997. Social skill and institutional theory. American Behavioral Scientist, 40(4): 397-405.

Freeman, H.A., van der Merwe, P.J.A., Subrahmanyam, P., Chiyembekeza, A.J., and Kaguongo, W. 2002. Assessing adoption potential of new groundnut varieties in Malawi. Working Paper Series no. 11. P O Box 39063, Nairobi, Kenya: Socioeconomics and Policy Program, International Crops Research Institute for the Semi-Arid Tropics. 16 pp.

Gaur PM, Tripathi S, Gowda CLL, Ranga Rao GV, Sharma HC, Pande S and Sharma M. 2010. Chickpea Seed Production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 28 pp.

Gordon, J. and Chadwick, K. 2007. Impact assessment of capacity building and training: assessment framework and two case studies. ACIAR Impact Assessment Series Report No. 44, February 2007.

Gowda, C, Parthasarathy Rao, P, Tripathi, S, Gaur, P, and Deshmukh, R. 2009. 'Regional shift in chickpea production in India', in M. Ali and S. Kumar (eds), Milestones in Food Legumes Research, Kanpur: IIPR.

Hajer, M. A. 1995. The politics of the environmental discourse - ecological modernization and the policy process. Oxford, UK: Clarendon Press.

Hajer, M. and Wagenaar, H (eds.). 2003. Deliberative Policy Analysis. Understanding Governance in the Network Society, Cambridge University Press, Cambridge.

Hajer, M.A. 1993. Discourse coalitions and the institutionalisation of practice: the case of acid rain in Britain. In: Fischer, F., Forester, J. (Eds.), The Argumentative Turn in Policy Analysis and Planning. Duke University Press, Durham, pp. 43–76.

Hajer, Maarten and Versteeg, Wytske. 2005. A decade of discourse analysis of environmental politics: Achievements, challenges, perspectives. Journal of Environmental Policy and Planning Volume 7, Issue 3

Hall AJ, Yoganand B, Sulaiman RV, Rajeswari Raina S, Shambu Prasad C, Naik Guru C and Clark NG. (eds). 2004. Innovations in innovation: reflections on partnership, institutions and learning. Patancheru 502 324, Andhra Pradesh, India, and Library Avenue, Pusa, New Delhi 110 012, India: Crop Post-Harvest Programme (CPHP), South Asia, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and National Centre for Agricultural Economics and Policy Research (NCAP). 252 pp. ISBN 92-9066-461-4 Order Code: BOE 032.

Hall Andrew, Bockett Geoffrey and Taylor Sarah. 2001. Why Research Partnerships Really Matter: Innovation Theory, Institutional Arrangements and Implications for Developing New technology for the Poor.

Hall Andrew, Sulaiman V. Rasheed, Clark Norman, Yoganand B. 2003. From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research. Agricultural Systems 78 (2003) 213–241

Hartmann, 2009. CGIAR reforms make research decision-making distant. Science and Development Network. Opinion, 6 October 2009.

Harwood RR, Place F, Kassam AH and Gregersen HM. 2006. International Public Goods through Integrated Natural Resources Management Research in CGIAR Partnerships. Experimental Agriculture, Volume 42:375–397. Cambridge University Press.

Hayami, Y., Ruttan, V.W. 1971. Agricultural Development: An International Perspective, 1985 ed. Johns Hopkins University Press, USA.

Hazell, P., and L. Haddad. 2001. Agricultural Research and Poverty Reduction. Food, Agriculture and the Environment Discussion Paper, International Food Policy Research Institute, Washington, D.C.

Herdt W. Robert.2012. People, institutions, and technology: A personal view of the role of foundations in international agricultural research and development 1960–2010. Food Policy 37 (2012) 179–190

Horton, Douglas and Mackay, Ronald. 2003. Using evaluation to enhance institutional learning and change: recent experiences with agricultural research and development. Agricultural Systems 78 (2003) 127–142

IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for Development). 2008. Synthesis Report. Washington, DC: Island Press.

ICRISAT. 2007. Report of the Center-Commissioned External Review of Global Theme Institutions, Markets, Policy and Impacts (GT-IMPI) and Knowledge Management and Sharing (KMS), January 2007.

India Brand Equity Foundation, 2014. Agriculture Sector in India. Sectoral Report, April 2014

Jovchelovitch, Sandra and Bauer, Martin W. 2000. Narrative interviewing [online]. London: LSE Research Online. Available at: http://eprints.lse.ac.uk/2633. Available in LSE Research Online: August 2007.

Jenkins-Smith, H. C. and P. A. Sabatier. 1993. The dynamics of policy-oriented learning. In Policy change and learning: An advocacy coalition approach, ed. P. A. Sabatier and H. C. Jenkins-Smith. Boulder, Colo., U.S.A.: Westview Press.

Jones Richard, Audi Patrick, Shiferaw Bekele and Gwata Eastonce. 2006. Production and Marketing of Kabuli Chickpea Seeds in Ethiopia: Experiences from Ada District. Submitted to the project for Improving Productivity and Market Success (IPMS) of Ethiopian Farmers. May 2006

Joshi, P. K.; Jha, A. K.; Wani, S.P.; Joshi, Laxmi; Shiyani, R. L. 2005. Meta-Analysis to assess impact of watershed program and people's participation. Comprehensive assessment research report 8. Colombo, Sri Lanka: Comprehensive Assessment Secretariat.

Kanbur R. 2001. Cross-Border Externalities, International Public Goods and their Implications for Aid Agencies. Cornell University.

Kaplan, T.J. 1993. Reading policy narratives: beginnings, middles, and ends. F. Fischer, J. Forester (Eds.), The Argumentative Turn in Policy Analysis and Planning, UCL Press, London (1993), pp. 167–185

Kassam, A. H. (2006) Receptivity to social research by the CGIAR. Experimental Agriculture, 42 (2). pp. 217-228. ISSN 0014-4797

Kassam, A. H. 2003. An overview of social science research in the Consultative Group on International Agricultural Research. The International Social Science Journal 177:441–462.

Katyal JC and Mruthyunjaya. 2003. The CGIAR at 31: An Independent Meta-Evaluation of the Consultative Group on International Agricultural Research - CGIAR Effectiveness - A NARS Perspective from India. The World Bank Operations Evaluation Department.

Kelley, T.G., Ryan, J.G., Patel, B.K. 1995. Applied participatory priority setting in international agricultural research: making trade-offs transparent and explicit. Agricultural Systems 49 (2), 177–216

Kherallah, M., Kirsten. J., 2001. The New Institutional Economics: Applications for Agricultural Policy Research in Developing Countries. Markets and Structural Studies Division Discussion Paper 41. IFPRI, Washington, DC.

Klerkx Laurens, Aarts Noelle and Leeuwis Cees. 2010. Adaptive management in agricultural innovation systems: The interactions between innovation networks and their environment. Agricultural Systems 103 (2010) 390–400

Klerkx, L., A. Hall and C. Leeuwis. 2009. Strengthening agricultural innovation capacity: Are innovation brokers the answer? International Journal of Agricultural Resources, Governance and Ecology (8, 5/6: 409-438).

Klerkx, Laurens and Aarts, Noelle. 2013. The interaction of multiple champions in orchestrating innovation networks: Conflicts and complementarities, Technovation, Volume 33, Issues 6–7, Pages 193-210

Klerkx, Laurens and Leeuwis, Cees. 2008a. Delegation of authority in research funding to networks: experiences with a multiple goal boundary organization. Science and Public Policy, 35(3), April 2008, pages 183–196

Klerkx, Laurens and Leeuwis, Cees. 2008b. Institutionalizing end-user demand steering in agricultural R&D: Farmer levy funding of R&D in The Netherlands, Research Policy, Volume 37, Issue 3, Pages 460-472

Krajewski, Aleksandra and Chandawarkar, Rajiv Y. 2008. Pasteur's Quadrant: Preparing Training Programs for "Use-Inspired" Surgical Research, Journal of Surgical Education, Volume 65, Issue 4, July–August 2008, Pages 283-288

Kristjanson et al. 2008. Linking International Agricultural Research Knowledge with Action for Sustainable Poverty Alleviation: What Works? Harvard University, Center for International Development Working Paper No. 173 and ILRI Innovation Works Discussion Paper July 2008

Lawrence, T.B. 1999. Institutional strategy. Journal of Management, 25(2): 161-188.

Le Page, Lloyd. 2011. The new CGIAR structure: Perspectives on the process for CRPs and Africa Regional integration. Presented in "Supporting a Science Agenda for African Agriculture: A conversation among stakeholders". June 30 - July 1, 2011, Irish Aid Conference Center, Dublin, Ireland

Lin, Justin Yifu. 1989. An Economic Theory of Institutional Change: Induced and Imposed Change. Cato Journal, Vol. 9, No. 1. Spring/Summer 1989, Cato Institute

Linder, S.H. 1995. Contending Discourses in the Electric and Magnetic Fields Controversy: The Social Construction of EMF Risk as a Public Problem. Policy Sciences, 28: 209–230.

Liu, M. 2013. Representational Pattern of Discursive Hegemony. Open Journal of Modern Linguistics, 3, 135-140.

Loch D.S and Boyce K.G. 2003. Balancing public and private sector roles in an effective seed supply system, Field Crops Research, Volume 84, Issues 1–2, Pages 105-122

Louwaars, Neils. 2005. Biases and bottlenecks: Time to reform the South's inherited seed laws? Article in Seedling July 2005, GRAIN's quarterly magazine.

Louwaars, Niels P. and de Boef, Walter Simon. 2012. Integrated Seed Sector Development in Africa: A Conceptual Framework for Creating Coherence Between Practices, Programs, and Policies, Journal of Crop Improvement, 26:1, 39-59

Lundvall, B.-A. 2007. National Innovation Systems—analytical concept and development tool. Industry and Innovation, 14 (1), pp. 95–119

Lundy Mark, Maria Gottret Veronica and Ashby Jacqueline. 2005. Learning alliances: An approach for building multistakeholder innovation systems. ILAC Brief 8 August 2005.

Lynam John, Beintema Nienke, and Annor-Frempong, Irene. 2012. Agricultural R&D: Investing in Africa's Future - Analyzing Trends, Challenges, and Opportunities: Reflections on the Conference. International Food Policy Research Institute and Forum For Agricultural Research In Africa.

Macharia Ibrahim, Orr Alastair, Simtowe Franklin and Asfaw Solomon. 2012. Potential Economic and Poverty Impact of Improved Chickpea Technologies in Ethiopia. Selected Poster prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil 18-24 August, 2012.

Maredia, M.K., Byerlee, D. (Eds.) (1999). The Global Wheat Improvement System: Prospects for Enhancing Efficiency in the Presence of Spillovers, CIMMYT Research Report No. 5. International Maize andWheat Improvement Centre (CIMMYT), Mexico, DF.

Maredia, Mywish K. and Raitzer, David A. 2006. CGIAR and NARS partner research in sub-Saharan Africa: evidence of impact to date. Science Council Secretariat October 2006

Mausch K., Chiwaula L., Irshad A., Bantilan C, Silim S. and Siambi M. 2013. Strategic Breeding Investments for Legume Expansion: Lessons Learned from the Comparison of Groundnut and Pigeonpea. Contributed paper prepared for presentation at the 57th AARES Annual Conference, Sydney, New South Wales, 5th-8th February, 2013

McAllister, K. and Vernooy, R. 1999. Action and reflection: A guide for monitoring and evaluating participatory research. Working Paper 3, Rural Poverty and the Environment Working Paper Series. Ottawa: International Development Research Centre.

McCalla, Alex F. 2014. CGIAR Reform - Why So Difficult? Review, Reform, Renewal, Restructuring, Reform Again and then "The New CGIAR" - So Much Talk and So Little Basic Structural Change - Why?. UC Davis: Department of Agricultural and Resource Economics, UCD. Retrieved from: http://escholarship.org/uc/item/7h04960c

McNie, Elizabeth C. 2007. Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature, Environmental Science & Policy, Volume 10, Issue 1, Pages 17-38

Mrema, G.C. 2001. "Interaction Between International Centers, National and Regional Agricultural Research Organisations in Africa." Paper presented at Conference on "The Role of Research in the Development of African Agriculture with Special Focus on the International Agricultural Research Centers – CGIAR," June 19, 2001, Eigtveds Pakhus, Asiatisk Plads 2, Copenhagen V, Denmark.

Muraguri, L. 2006. Private rights and Public goods: conflicts in agriculture R&D. Queen Mary Intellectual Property Research Institute, University of London, August 2006.

Ndjeunga, J., Anand Kumar, K., and Ntare, B. R. 2000. Comparative analysis of seed systems in Niger and Senegal. Working Paper Series no. 3. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 36 pp.

North, Douglass C. 1981. Structure and Change in Economic History. New York: Norton.

Oates, W. E. 1972. Fiscal Federalism, New York: Harcourt Brace Jovanovich.

Omamo Steven Were, Diao Xinshen, Wood Stanley, Chamberlin Jordan, You Liangzhi, Benin Sam, Wood-Sichra Ulrike and Tatwangire Alex. 2006. Strategic Priorities for Agricultural Development in Eastern and Central Africa. IFPRI Research Report 150.

Ozgediz, Selcuk. 2012. The CGIAR at 40: Institutional Evolution of the World's Premier Agricultural Research Network

Pal Suresh, Rahija Michael, and Beintema Nienke. 2012. India: Recent Developments in Agricultural Research. ASTI and ICAR Country Note. June 2012

Pardey, P. G., J. M. Alston, and R. R. Piggott, eds. 2006. Agricultural R&D in the developing world: Too little, too late? Washington, DC: International Food Policy Research Institute.

Pardey, P.G., Alston, J.M., Christian, J.E., Fan, S. 1996. Hidden Harvest: U.S. Benefits from International Research Aid, Food Policy Report. International Food Policy Research Institute (IFPRI), Washington, DC.

Pardey, Philip G and Johannes Roseboom. 1989. ISNAR Agricultural Research Indicator Series – A Global Data Base on National Agricultural Research Systems, Cambridge University Press ISBN: 9780521543330

Parthasarathy Rao P, Birthal PS, Bhagavatula S and Bantilan MCS. 2010. Chickpea and Pigeonpea Economies in Asia: Facts, Trends and Outlook. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 76 pp. ISBN: 978-92-9066-530-4. Order code: BOE 049.

Pauw Karl and Thurlow James. 2014. Malawi's farm input subsidy program: Where do we go from here? IFPRI Policy Note 18, March 2014

Perkmann, M. & Spicer, A. 2007. Healing the Scars of History: Projects, Skills and Field Strategy in Institutional Entrepreneurship. Organization Studies, 28(7): 1101-1122.Gardiner P and Chapman R. 2006. Partners in Research for Development. Science Council Secretariat. Background paper for a workshop on Positioning the CGIAR in the Global Research for Development Continuum, held in The Hague, 19 May 2006.

Pineiro M. 2007. Agricultural technology transfer to developing countries and the public sector. Science and Development Network, Policy Brief.

Pingali Prabhu and Kelley Tim. 2007. The Role of International Agricultural Research in Contributing to Global Food Security and Poverty Alleviation: The case of the CGIAR, In: R. Evenson and P. Pingali, Editor(s), Handbook of Agricultural Economics, Elsevier, 2007, Volume 3, pp 2381-2418.

Pritchett, Lant and Woolcock, Michael. 2004. Solutions When the Solution is the Problem: Arraying the Disarray in Development, World Development, Volume 32, Issue 2, pp 191-212

Raina, Rajeswari S. 2003. Disciplines, institutions and organizations: impact assessments in context. Agricultural Systems 78 (2003) 185–211

Raitzer, David A. and Kelley Timothy G., 2008. Benefit–cost meta-analysis of investment in the International Agricultural Research Centers of the CGIAR, Agricultural Systems, Volume 96, Issues 1–3, March 2008, Pages 108-123, ISSN 0308-521X

Reifschneider F.J.B. and Hussain S. 2004. Research Organizations of the World / CGIAR, In Encyclopedia of Grain Science, edited by Colin Wrigley, Elsevier, Oxford, 2004, Pages 26-36,

Renkow Mitch and Byerlee Derek. 2010. The impacts of CGIAR research: A review of recent evidence, Food Policy, Volume 35, Issue 5, October 2010, Pages 391-402, ISSN 0306-9192.

Roe, E., 1994. Narrative Policy Analysis. Duke University Press, Durham.

Roemer, John E. 1985. Rationalizing revolutionary ideology. In Econometrica 53 (1): 85-108.

Rogers, E. M. 2003. Diffusion of innovations, Fifth edition. Free Press, New York, U.S.A.

Rukmani R. and Manjula, M. 2009. Designing Rural Technology Delivery Systems for Mitigating Agricultural Distress: A study of Anantapur District. M S Swaminathan Research Foundation, MSSRF/RR/10/24.

Ryan J. 2006. International Public Goods and the CGIAR Niche in the R for D Continuum: Operationalising Concepts. Revised draft of a discussion paper prepared for a brainstorming session between some members of the Science Council of the CGIAR and the Centre Deputy Directors' Committee (CDDC) of the Future Harvest Centers of the CGIAR at the CGIAR Annual General Meeting in Morocco, 3 December 2005.

Ryan, J.G. 1999. Impact Assessment Discussion Paper No. 11. Washington D.C.: International Food Policy Research Institute.

Sabatier, P.A. and Jenkins-Smith H.C. (eds.). 1993. Policy Change and Learning: An Advocacy Coalition Approach, Boulder, CO: Westview Press.

Sagasti F and Timmer V. 2008. An Approach to the CGIAR as a Provider of International Public Goods. Paper submitted as a contribution to the work of the Independent Review Panel (IRP) of the CGIAR.

Sagasti, F. and Bezanson, K. 2001. Financing and Providing Global Public Goods: Expectations and Prospects. Prepared for the Ministry of Foreign Affairs, Sweden, November.

Samuelson PA. 1954. The Pure Theory of Public Expenditure. The Review of Economics and Statistics, 36:4 (November 1954): 387-389.

Satyanarayana A. 2013. Chickpea in Andhra Pradesh: Milestones in adoption process of short duration varieties leading to silent revolution. Presentation at ICRISAT, 3 December 2013.

Schiffer, E., and J. Hauck. 2010. Net-Map: Collecting Social Network Data and Facilitating Network Learning through Participatory Influence Network Mapping. Field Methods August 22: 231-249.

Schön, D.A. and Rein M. 1994. Frame Reflection: Toward the Resolution of Intractable Policy Controversies, New York: Basic Books.

Shambu Prasad C, Hall Andrew and Thummuru Laxmi. 2006. Engaging scientists through institutional histories. ILAC Policy Brief 14. November 2006

Shambu Prasad C, HallAJ and Wani SP. 2005. Institutional history of watershed research: The evolution of ICRISAT's work on natural resources in India. Global Theme on Agroecosystems Report no. 12. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 40 pp.

Shelanski, H.A. and P.G.Klein. 1995. Empirical Research in Transaction Cost Economics: A Review and Assessment. Journal of Law, Economics and Organization, 11 (2), 335–61.

Shiferaw B, Bantilan MCS, Gupta SC and Shetty SVR. 2004. Research spillover benefits and experiences in interregional technology transfer: An assessment and synthesis. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 140 pp. ISBN 92-9066-469-X. Order Code: BOE 033.

Shiferaw B, Jones R, Silim S, Tekelewold H and Gwata E. 2007. Analysis of production costs, market opportunities and competitiveness of Desi and Kabuli chickpeas in Ethiopia. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working

Paper 3. ILRI (International Livestock Research Institute), Nairobi, Kenya. 48 pp.

Shiyani R.L, Joshi P.K, Asokan M, Bantilan M.C.S. 2002. Adoption of improved chickpea varieties: KRIBHCO experience in tribal region of Gujarat, India, Agricultural Economics, Volume 27, Issue 1, May 2002, Pages 33-39

Simtowe F, Asfaw S, Shiferaw B, Siambi M, Monyo E, Muricho G, Abate T, Silim S, Ganga Rao NVPR and Madzonga O. 2010. Socioeconomic Assessment of Pigeonpea and Groundnut Production Conditions - Farmer Technology Choice, Market Linkages, Institutions and Poverty in Rural Malawi. Research Report no.6. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 92 pp.

Simtowe Franklin, Kassie Menale, Asfaw Solomon, Shiferaw Bekele, Monyo Emmanuel and Siambi Moses. 2012. Welfare Effects of Agricultural Technology adoption: the case of improved groundnut varieties in rural Malawi. Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012

Spielman D., 2005. Innovation Systems Perspectives on Developing-Country Agriculture: A Critical Review. ISNAR Discussion Paper 2.

Spielman David J., Byerlee Derek, Alemu Dawit and Kelemework Dawit. 2010. Policies to promote cereal intensification in Ethiopia: The search for appropriate public and private roles, Food Policy, Volume 35, Issue 3, Pages 185-194

Spielman David J., Ekboir Javier and Davis Kristin. 2009. The art and science of innovation systems inquiry: Applications to Sub-Saharan African agriculture. Technology in Society 31 (2009) 399–405

Spielman David J., Kelemwork, Dawit and Alemu, Dawit, 2012. Seed, fertilizer, and agricultural extension in Ethiopia. In Paul Dorosh and Shahidur Rashid (eds.) "Food and Agriculture in Ethiopia: Progress and Policy Challenges". IFPRI 2012. University of Pennsylvania Press

Spielman David J., Kolady Deepthi E., Cavalieri Anthony and Chandrasekhara Rao N. 2014. The seed and agricultural biotechnology industries in India: An analysis of industry structure, competition, and policy options, Food Policy, Volume 45, Pages 88-100

Spielman, David J. 2007. Pro-poor agricultural biotechnology: Can the international research system deliver the goods? Food Policy 32 (2007) 189–204

Spielman, David J. and Birner Regina. 2008. How Innovative Is Your Agriculture? Using Innovation Indicators and Benchmarks to Strengthen National Agricultural Innovation Systems. World Bank Agriculture and Rural Development Discussion Paper 41.

Srivastava, S, Sivaramane, N, Mathur, V. 2010. 'Diagnosis of pulses performance in India', Agricultural Economics Research Review 23: 137-148.

Stake, Robert F. 2005. Qualitative Case Studies. In Norman K. Denzin and Yvonna S. Lincoln (Eds.). (2005). The Sage Handbook of Qualitative Research. 3rd Ed. Thousand Oaks. CA: Sage

Stokes, D. 1997. Pasteur's Quadrant: Basic science and technological innovation. Washington, DC: Brookings Institution Press

Strauss, A. and Corbin, C. 1998. Basics of Qualitative Research Techniques and Procedures for Developing Grounded Theory. Sage Publications, Thousand Oaks.

Stroud, Ann. 2003. Transforming Institutions to Achieve Innovation in Research and Development. Published as Chapter 5 in Pound, B., S. Snapp, C. McDougall and A. Braun, eds. (2003) Managing Natural Resources for Sustainable Livelihoods: Uniting Science and Participation, pp. 88-112. London: Earthscan Publications.

Sumberg, James. 2005. Systems of innovation theory and the changing architecture of agricultural research in Africa. Food Policy 30 (2005) 21–41

Teshale A, Rubyogo JC, Sperling L, Amsalu B, Abate T, Deressa A, Reda F, Kirkby R and Buruchara R. 2006. Creating partnerships for enhanced impact; bean variety delivery in Ethiopia. Journal of Crop science society of Ethiopia 12: 1-19.

Thijssen, M.H., Z. Bishaw, A. Beshir and W.S. de Boef. 2008 (Eds.). Farmers, seeds and varieties: supporting informal seed supply in Ethiopia. Wageningen, Wageningen International. 348 p.

Tripp Robert and Rohrbach David. 2001. Policies for African seed enterprise development. Food Policy 26 (2001) 147–161

Tripp, R. & N. Louwaars. 1997. Seed regulation: choices on the road to reform. Food Policy Vol.22, (5): pp. 433-446.

Tripp. 2011. The Impacts of Food Legume Research in the CGIAR: A Scoping Study. Commissioned by the CGIAR Standing Panel on Impact Assessment (SPIA), February 2011

Twomlow, S., Shiferaw, B., Cooper P., and Keatinge JDH. 2008. Integrating Genetics and Natural Resource Management for Technology Targeting and Greater Impact of Agricultural Research in the Semi-Arid Tropics. Experimental Agriculture Volume 44, pp. 235–256.

Umali, D. L., and Schwartz. L. 1994. Public and private agricultural extension: Beyond traditional frontiers. Washington, D.C.: The World Bank.

van Eeten, Michel M.J. 2007. 'Narrative Policy Analysis', in Frank Fischer, Gerald j. Miller and Mara S. Sidney, (ed.), Handbook of Public Policy Analysis: Theory, Politics and Methods, No. 3, Cheltenham.

von Braun Joachim, Fan Shenggen, Meinzen-Dick Ruth, Rosegrant Mark W and Pratt Alejandro Nin. 2008. International agricultural research for food security, poverty reduction, and the environment: What to expect from scaling up CGIAR investments and "Best Bet" programs. Issue briefs 53, International Food Policy Research Institute (IFPRI).

Walker T, Maredia M, Kelley T, La Rovere R, Templeton D, Thiele G and Douthwaite B. 2008. Strategic Guidance for Ex Post Impact Assessment of Agricultural Research. Report prepared for the Standing Panel on Impact Assessment, CGIAR Science Council. Rome, Italy: Science Council Secretariat.

Walker, J.T. 1980. Philosophies affecting the spread and development of seed production. In Hebblethwaite, RD. Seed production Proceedings of Twenty-Eighth Easter School in Agricultural Science, Notungham, U K.

Watts, J., Mackay, R., Horton, D., Hall, A., Douthwaite, B., Chambers, R. and Acosta, A. 2003. Institutional Learning and Change: An Introduction. ISNAR Discussion Paper no. 03–10. The Hague, the Netherlands: International Service for National Agricultural Research.

Williamson, O.E. 1991. Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. Administrative Science, Quarterly, 36 (2), 269–96.

Wittmer, H. and R. Birner. 2005. Between Conservationism, Eco-Populism and Developmentalism - Discourses in Biodiversity Policy in Thailand and Indonesia. CAPRi Working Paper. IFPRI, Washington, DC.

World Bank 2007. Agriculture for Development: World Development Report, 2008. Agriculture for Development. The World Bank. Washington, DC

World Bank, 2006. Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. Economic and Sector Work. The World Bank, Washington, D.C.

Wright, Brian D. 2012. Grand missions of agricultural innovation, Research Policy, Volume 41, Issue 10, Pages 1716-1728

Yin, R K. 2003. Case Study Research: Design and Methods. Thousand Oaks, CA: Sage.

Zeigler, Robert S and Mohanty, Samarendu. 2010. Support for international agricultural research: current status and future challenges, New Biotechnology, Volume 27, Issue 5, 30 November 2010, pp 565-572.

9. APPENDIX A: CGIAR RESEARCH PROGRAMS (CRPs)

1.1 CRP on Dryland Systems

1.2 CRP on Integrated Systems for the Humid Tropics (Humidtropics)

1.3 CRP on Aquatic Agricultural Systems (AAS)

2 CRP on Policies, Institutions and Markets (PIM)

3.1 CRP on Wheat (WHEAT)

3.2 CRP on Maize (MAIZE)

3.3 Global Rice Science Partnership (GRiSP)

3.4 CRP on Roots, Tubers and Bananas (RTB)

3.5 CRP on Grain Legumes

3.6 CRP on Dryland Cereals

3.7 CRP on Livestock and Fish

4 CRP on Agriculture for Nutrition and Health (A4NH)

5 CRP on Water, Land and Ecosystems (WLE)

6 CRP on Forests, Trees and Agroforestry (FTA)

7 CRP on Climate Change, Agriculture and Food Security (CCAFS)

CRP for Managing and Sustaining Crop Collections (Genebanks)

10. APPENDIX B: TOPIC LIST

i. Please describe the history and stages of how this technology was developed, diffused and taken up.

ii. Who were all the actors involved? What were their roles?

iii. How were the breeding objectives decided? How were farmers involved?

iv. Where do farmers mainly get seed for this variety from?

v. Among the actors, who had the most influence on likelihood of achieving wide adoption and impact from this technology? Why?

vi. Has this variety been adopted in other countries? How does the level of success compare in different countries? What can you attribute the differences to?

vii. What constraints were faced in the development and uptake of this variety?

viii. What challenges do the national research and seed systems for this variety face? Why are private seed companies not very active in legume seed systems?

ix. What challenges are there in the agricultural extension system?

x. What role should ICRISAT and national systems play in the technology development and uptake process?

xi. Should ICRISAT only focus on producing international public goods? Why?

xii. What would happen if ICRISAT engages / does not engage in technology promotion and seed multiplication?

xiii. What lessons have been learnt from working directly with farmers?

xiv. What incentives should farmers be given to adopt this variety?

xv. What conditions should be in place for sustainable adoption on a large scale?

11. APPENDIX C: COURSES TAKEN DURING THE PHD

MODULES TAKEN AT THE UNIVERSITY OF HOHENHEIM

i. 4902410: Applied Econometrics

ii. 3000820: Methods of Scientific Working

iii. 4301410: Knowledge and Innovation Management

iv. 4901810: Interdisciplinary Aspects of Food Security

v. 4903480: Governance, Institutions and Organizational Development

vi. Qualitative Research & Developing Grounded Theory (Prof. Vera Bitsch, Technische Universität München)

SHORT COURSES MAINLY ORGANIZED BY THE FOOD SECURITY CENTRE

i. Leadership

ii. Intercultural Competence

iii. Ethics of Food Security and Development Research and Action

iv. Working Within Political Contexts: Strategies and methods for implementation-oriented research

v. Intensive German Language Course ““Deutsch im Ländle von Porsche und Schiller”

12. CURRICULUM VITAE OF JOSEY ONDIEKI KAMANDA

EDUCATION

2014 (expected) **PhD in Agricultural Sciences (Dr. sc. agr.)**

University of Hohenheim, Food Security Centre (FSC) - Stuttgart, Germany

Division of Social and Institutional Change in Agric. Development, Institute of Agric. Economics and Social Sciences in the Tropics and Sub-Tropics

2008 **MSc. in Technology Management**

University of Surrey (UniS) - Guildford, United Kingdom

Faculty of Engineering and Physical Sciences, and School of Management

- Dissertation "*Inventory Optimization within Commercial Supply Chains*"

2005 **BSc. in Agricultural Engineering (First Class Honors)**

Jomo Kenyatta University of Agriculture and Technology - Nairobi, Kenya.

Department of Biomechanical and Environmental Engineering

- Dissertation "*Risk-Based Decision Making for Wastewater Re-Use in Peri-Urban Agriculture*"

PROFESSIONAL EXPERIENCE IN DEVELOPING COUNTRIES

2011 - 2014 **Malawi and Ethiopia**

Research on influence of institutional context on the development, adaptation and uptake of new technologies from international agricultural research

2008 - 2014 **India**

Analysis of impact pathways for ICRISAT innovations, analysis of village poverty dynamics, studies on role of institutions in climate change adaptation

2010 **China and Vietnam**

Studies on international applicability of ICRISAT's strategic approaches to participatory natural resource management research on watershed development

2005 - 2007 **Kenya**

Private sector experience in banking and equipment sales and service

EMPLOYMENT

Oct 2011 - Dec 2013 Doctoral Research Fellow

Division of Social and Institutional Change in Agricultural Development (490c) and the Food Security Centre (FSC), University of Hohenheim, Stuttgart, Germany)

- Analyzing pathways and suitable governance structures by which agricultural research can be effective in achieving impact
- Exploring how existing policies and institutions and governance challenges affect the development and uptake of technologies

Dec 2008 - Sep 2011 Associate Professional Officer (Institutional Innovation Specialist)

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT - Hyderabad, India)

Associate Professional Officer (APO) - Institutional Innovation Specialist in the Global Theme on Institutions, Markets, Policies and Impact (IMPI):

- Documentation of ICRISAT downstream interventions, their IPG attributes and synthesis of lessons learnt
- Micro-level studies on the dynamics of household livelihoods in rural areas by analyzing data from Village Level Studies (VLS)
- Research on vulnerability of farmers to climate variability and potential adaptation, identifying the role of institutions in shaping adaptation

Jul 2007 - Aug 2007 Sales Engineer

Davis & Shirtliff Group Limited (Nakuru, Kenya)

- Sale of pumps, swimming pool and water treatment accessories and other water related equipment:
- Customer development and retention, designing of system configurations, managing customer orders and supervising installations and maintenance

Jul 2006 - Jun 2007 Management Trainee, Service Advisor and Sales Consultant

CMC Motors Group Limited (Nairobi, Kenya)

- Planning of day-to-day workshop scheduling of time and labour
- Providing management recommendations for improving sales and service

Dec 2005 - Jun 2006 Outward Clearing Assistant

Collections and payments department of Citigroup (Nairobi, Kenya)

AWARDS

2011 - 2014 Excellence Scholarship, PhD Program "Global Food Security" (Hohenheim)

2007 - 2008 Commonwealth Shared Scholarship Scheme (CSSS) Award for Msc. (Surrey)

2001 - 2005 Annual Japanese Babaroa Award of Academic Excellence (JKUAT)

SELECTED PUBLICATIONS

Banerjee Rupsha, **Kamanda Josey**, Bantilan Cynthia and Singh Naveen. 2013. Exploring the relationship between local institutions in SAT India and adaptation to climate variability. Natural Hazards Volume 65, Issue 3, Page 1443–1464. DOI: 10.1007/s11069-012-0417-9

Kamanda Josey and Regina Birner. 2013. Governance challenges in legume seed systems: What role can the International Agricultural Research Centres play? Poster presented at Tropentag 2013 Conference, University of Hohenheim, September 17 - 19, 2013

Kamanda Josey, Birner Regina and Bantilan Cynthia. 2013. Strategic positioning of CGIAR centres: Comparative advantage and trade-offs from a transaction cost economics perspective. 57th AARES Conference, Sydney, New South Wales, Australia. 5th - 8th February, 2013

Kamanda JO, Bantilan MCS, Erkossa T, Pathak P and Mausch K. 2012. Internationality and public good nature of downstream research: Lessons from ICRISAT's experiences with natural resource management technologies. Research Program Markets, Institutions & Policies. Policy Brief No. 16, March 2012, ICRISAT

Banerjee R. and **Kamanda J**. 2011. Electrification in the agricultural development of India, in G. Pancaldi (ed), Electricity and Life, episodes in the history of hybrid objects. BSHS 13.

Banerjee Rupsha, Kamanda Josey, Singh NP and Bantilan MCS. 2011. Local perceptions on climate change and adaptive capacities: Lessons learnt from Villages in the Semi-Arid Tropics of India. The International Conference on Gender and Climate Change: Women, Research and Action, 15th -16th September 2011, Prato, Tuscany, Italy

Kamanda JO and Bantilan MCS. 2010. The Strategic Potential of Applied Research: Developing International Public Goods from Development-oriented Projects. Working Paper Series no. 26. Patancheru 502 324, AP, India: ICRISAT 32pp

Parthasarathy Rao P, **Kamanda Josey** and Bhagavatula S. 2009. Technology transfer through innovation systems: Linking small-scale sorghum and pearl millet farmers to commercial end-users. Presented to the Social Science Stripe Review of the CGIAR Panel. July 2-4, 2009. ICRISAT, Patancheru 502 324, AP, India

Hohenheim / July, 2015

(Place / Date) Kamanda, Josey Ondieki

13. AUTHOR'S DECLARATION

I hereby declare that this doctoral thesis is a result of my own work and that no other than the indicated aids have been used for its completion. All quotations and statements that have been used are indicated. Furthermore, I assure that the work has not been used, neither completely nor in parts, for achieving any other academic degree.

Hohenheim / July, 2015 

(Place / Date) Kamanda, Josey Ondieki