Towards an Agroecological Framework for the Evaluation of Community Seed Banks: A Case Study of Nepal

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Cover Photo: Inside the community seed bank of the Agriculture Development and Conservation Society in Kachorwa, Bara
Credit: Monserrat Gómez César

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Abstract

This study explores how farmers in three different communities of Nepal are influenced by the establishment of community seed banks (CSBs). Their effectiveness as an *in situ* conservation strategy is evaluated by assessing, through semi-structured questionnaires, focus groups and key informant interviews, the changes perceived by those involved in CSBs. These evaluations were put in context of the stated target areas of community seed banks and community-based biodiversity management (CBM): on-farm plant diversity, household economic and livelihood gains and increases in community welfare, organisation and autonomy. Findings suggest that in these respective areas: (i) Access to seed encouraged farmers to experiment with different varieties and their alternation over time. (ii) Greater household-level income and access to loan mechanisms appears to have provided an economic incentive to maintain local crop diversity. (iii) The tasks inherent to planning, forming and running a CSB creates a space which necessitates the intensification of local social cooperation and mutual learning. Aggregate social benefit and greater autonomy from both input pressures and market dynamics appears to be an emergent property of this cooperation. A secondary aim of this study was to devise the first, to our knowledge, framework for the evaluation of CSBs. After a review of CBM, CSBs and on-farm conservation strategies, we propose their integration with agroecology as a theoretical construct that is able to unify all of their respective approaches and values, as well as weaknesses and contradictions, reflecting the needs of, and potential pressures, on present and future generations of Nepalese smallholders.

Abbreviations

ABS	Access and Benefit Sharing
ACDS	Agriculture Development and Conservation Society
ADCFC	Agriculture Development and Conservation Farmers' Committee
ATK	Associated Traditional Knowledge
APP	Agriculture Perspective Plan
BCAC	Biodiversity Conservation Agriculture Cooperative
CBD	Convention on Biological Diversity
CBM	Community Biodiversity Management
CBM fund	Community Biodiversity Management fund
CBR	Community Biodiversity Register
CBS	Central Bureau of Statistics
CSB	Community Seed Bank
DADO	District Agriculture Development Office
DDC	District Development Committees
EDW	Elevation-Dependent Warming
FGD	Focus Group Discussion
FYM	Farm Yard Manure
GDP	Gross Domestic Production
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IPCC	Intergovernmental Panel on Climate Change
IPES-Food	International Panel of Experts on Sustainable Food Systems
JTA	Junior Technical Assistant
LI-BIRD	Local Initiatives for Biodiversity Research and Development
masl	Meters above sea level
MoAC	Ministry of Agricultural Development
NARC	Nepal Agricultural Research Council
NGO	Non-Governmental Organisation
PAR	Participatory Action Research
PGR	Plant Genetic Resources
SD	Standard Deviation
SPG	Seed Producing Groups
UNEP	United Nations Environmental Programme
VDC	Village Development Committee

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1. Introduction

1.1 Background

Climate variability impacts the production of agricultural systems as increased temperatures, changes in precipitation and transpiration cycles, an increased frequency of extreme events, and a shift in pest, pathogen and weed occurrence, exert different abiotic and biotic stresses to which farming systems are originally adapted to (Altieri et al., 2015: IPCC, 2014: Lobell et al., 2012). At a global scale, climate change 'hotspots' are characterized by locations where a "strong climate change signal is combined with a large concentration of vulnerable, poor, or marginalized people" (Souza et al., 2015). Within this definition, those living in Himalayan glacier and snowpack -dependent basins have been identified as amongst the three most vulnerable biophysical biomes (Souza et al., 2015). In Nepal these climate change risks are multiplied, since national-scale food production occurs mostly in lowland basins vulnerable to mountain hydrology, while the majority of its land area lies in highland areas that are disproportionately subject to temperature increases (Mountain Research Initiative EDW Working Group, 2015) and subsequent hydrological dynamics (e.g. Beniston and Stoffel, 2014). This is already becoming apparent in Nepalese agriculture, where erratic monsoons (i.e a higher intensity of rain through fewer numbers of rainy days) have already caused a decline in cereal production (Regmi, 2007). Responding to environmental changes requires a shift towards heterogeneous and genetically diverse agroecosystems and a paradigm which allows for livelihood-based management of agrobiodiversity (IPES-Food, 2016: Altieri et al., 2015).

Agroecosystems, like all ecosystems, require a diversity of species for the enhancement and maintenance of ecosystems functions (Altieri et al., 2015: Koohafkan and Altieri, 2010).When the diversity of agroecosystems is narrowed, it limits the system's capacity to respond to changes and continue its provisioning of ecosystem services (Altieri et al., 2015). A diversity of species creates a safeguard against system collapse, by having several organisms within the agroecosystem contribute to specific ecosystem functions, so that when abrupt environmental changes take place, there are organisms which can compensate and continue the functions that other species are no longer able to provide (Altieri et al., 2015). Diversity in agroecosystems thus provides greater stability, even in changing conditions. As such, one of the founding principles of agroecology involves the incorporation of diversity into agricultural fields, so as to mimic the complexity of natural ecosystems and to promote self-regulating ecological properties capable of maintaining soil fertility, crop productivity, and pest management (Altieri et al., 2015). It is these ecological properties intrinsic to diverse cropping systems which currently enable sustained smallholder productivity and resilience while providing viable alternative management systems (Altieri et al., 2015).

Globally, smallholder farming communities continue to sustain a diversity of local crop varieties on farm (Jarvis et al, 2008). This maintains crop evolution and thus the conservation of genetic and phenotypic variation, which sustains the coping and adaptation abilities of crops to abrupt changes in abiotic and biotic stresses (Jarvis et al., 2016; Bellon et al., 2015a). The continued evolution of agricultural biodiversity (henceforth agrobiodiversity), is a function of the dynamic on-farm management by people and the constantly changing relations between plants, animals, other organisms, and the environment (Jarvis et al., 2011; Thijsse et al., 2013). Genetic diversity within agricultural systems allows for regeneration and reorganisation, following a disruption in the system's flows (Folke, 2006). In this logic, a system's resilience and conservation of its diversity becomes a matter of its adaptive capacity, seeing disturbances to the system as opportunities to transform, and innovate upon previous structures and processes (Folke, 2006). Farmers traditionally maintain crop diversity for specific-value uses, consisting of preferred traits for pest resistance, labour management, cultural or spiritual importance, or adaptation to a heterogeneity of agroecosystems (Sthapit et al., 2008). However, the diversity maintained within these farming systems is threatened by (i) socioeconomic pressures (ii) an increased frequency in extreme climatic events (Vernooy et al., 2015) and (iii) a growing presence of intellectual property rights genetic resources which limit access. Socioeconomic pressures are those which discourage the conservation of biodiversity through the expansion of the industrial food sector and the commodification of agriculture (Vernooy et al., 2015), which incorporates diverse farming systems into market-based livelihoods, where agricultural specialisation is encouraged and made possible through the 'cheap' supply of market alternatives that replace the function of crop diversity, increasing the opportunity cost of maintaining diversity as commodity food markets also decrease the viability of local niche markets (Bellon et al., 2015a). Additionally, climatic events disrupt the seasonal crop growth as their increased occurrence threatens the customary regeneration of seed post-harvest. The distribution of genetic diversity, specifically, in areas where local crop variety is

maintained, is shaped by farmer-managed seed systems (Coomes et al., 2015). These seed systems are the major channel through which local seeds and planting material are seasonally maintained at community level (Coomes et al., 2015: Vernooy et al., 2014). If harvests fail, or varieties maintained only by a few farmers are replaced by commercial varieties, the planting material and genetic diversity will cease to be accessible or available to farmers in the community (Chaudhary, 2015: Sthapit, 2013; de Boef et al., 2010; Shrestha et al., 2007).

The ratification of the Convention on Biological Diversity (CBD) in 1993 established a framework under which organisations of different backgrounds began carrying out on-farm conservation projects, in an effort to counterbalance threats to agrobiodiversity as a whole, as well as to farmer managed seed systems (Thijsse et al., 2013). These projects fall under the *in situ* (as opposed to frozen, *ex situ* specimens) conservation strategy, which is defined as "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated and cultivated species, in the surroundings where they have developed their distinctive properties" (UNEP, 1992). Under this strategy, conservation of plant genetic resources (PGR) should actively encourage dynamic and adaptive interaction of plants within the context of small-scale farmer livelihoods and their agricultural systems (Jarvis et al., 2011; Thijsse et al., 2013). This should give equal focus to both ecosystem functioning and maintenance of the natural habitat under which crops have developed (UNEP, 1992) while ensuring rural society's capacity to cope with and absorb socio-economic shocks (Folke et al., 2006). Ultimately, these sought to ensure that changes in human society did not come at the expense of the ecosystem's capacity to sustain its own adaptation, while at the same time benefitting farmer livelihoods (Folke, 2006; Smit and Wandel, 2006).

Community seed banks (CSB) are a part of this *in situ* conservation strategy, as well as a set of practices within the Community Biodiversity Management (CBM) methodology, which aim to contribute specifically to the on-farm management of plant genetic resources through safeguarding farmer's access to seeds, and in particular, those of local crop varieties (Jarvis et al., 2011; Subedi et al., 2013a). During the last thirty years, nongovernmental organisations (NGO) and farming communities have strengthened farmer managed seed systems through the establishment of community seed banks (Chaudhary, 2012; Vernooy et al., 2015). As their name entails, these seed banks embody collective community-driven efforts to manage seeds and biodiversity for local use (Sthapit et al., 2015; Vernooy et al., 2014). To do so, the seed bank must conserve local seed, facilitate access and availability to it at the community-level, thereby building capacity for community-level seed and food sovereignty (Vernooy et al., 2015). A community seedbank is thus a local institution that provides the means, structure, and organisational space through which to safeguard local seed diversity and even revive lost or waning cultural and/or cultivation practices (Vernooy et al., 2014).

At present, most available information on CSBs comes from the grey literature, which tends to describe the evolution of specific individual seedbanks through the use of case studies. Even in those countries with a large number of CSBs, review articles for these projects had not been published until very recently. Further, these tended to have a focus on establishing an institutional framework for the different functions within a seed bank, by compiling information on management and governance structures (Vernooy et al., 2015; Shrestha et al., 2013). Although CSBs have become more common over the last decades, there are no in-depth systematic or comparative studies on how these projects effect on-farm management. As such, there has lacked any coherent information regarding the impact of seed banks on the integration and use of plant diversity, and whether and how they have maintained benefits to the livelihoods and collective organisation of communities. These are all crucial facets which enable and affect the continued maintenance of a diversity in varieties of cultivated crops, and the natural habitats which gave rise to their unique characteristics (Thijsse et al., 2013).

Exploring how seed banks influence farming communities can provide insight into the dynamics and potential of this specific agrobiodiversity conservation strategy. Moreover, information on the impacts that local-level institutions which support farmer managed seed systems have on farming communities can further illustrate the viability of diverse farming systems in the context of changing socio-economic and environmental conditions. As such, the following study will present and analyse data on the impacts of community seed banks. In addition, it will seek to evaluate and build on a systematic framework under which to assess CSBs. Doing so will facilitate the development of a narrative through which to discuss and improve CSB contributions to *in situ* conservation of agrobiodiversity.

1.2 Research objectives

1.2.1 General objective

The objective of this study, which was undertaken in collaboration with Bioversity International and Local Initiatives for Biodiversity Research and Development (LI-BIRD), is to add to the current body of knowledge on community seed banks by addressing the knowledge gap on how farmers and communities are influenced and stimulated by the establishment of a seedbank in order to explore their effectiveness as an *in situ* conservation strategy.

1.2.2 Specific objectives

In order to understand the ways in which community seed banks impact different aspects of farmer's livelihoods and how these play into broader rural dynamics, this study will address the following:

- Understand how individual farming communities have experienced changes in their farming systems due to the seedbank. The purpose of this is to explore any changes in the use of agrobiodiversity in the overall farm management and structure.
- Document the observed effect the seedbank has on farmers' private livelihoods and the community's overall economic development.
- Explore the perceived changes brought on by the establishment of the seed bank in relation to how it has impacted the social functioning of communities.
- On a broader scale, the study will also reflect on how the impacts found actually and potentially contribute to the agroecology and food sovereignty movements, including suggestions for challenges that arise with respect to the three aspects mentioned above.
- Lastly, evaluate and explore possible methods and frameworks by which to assess the impacts of community seed banks in the future environmental, social and political contexts.

1.2.3 Research questions

(i) How have seedbanks influenced farm management and contributed to farmer's (increased) use of local varieties in field? In turn, how has the use (and thus conservation) of local varieties led to the diminished use of inorganic or increased use of on-farm specific resources, and other agroecological practices, at community level?

(ii) What are the perceived impacts of seedbanks on the private livelihoods of individual farmers and the community? Have they allowed for household gain based on crop diversity and for greater autonomy in community-level economic development?

(iii) How have farmers seen the community transform both during the process of establishing a seedbank and thereafter; how does this institution serve to facilitate social cohesion, capable of helping the community adapt and cope with change? How are the functions and impacts of a seedbank implicit to supporting communities in creating a space for sovereign and agroecological food systems?

(iv) Which framework can provide a holistic understanding impacts of seedbanks and by which methods can in depth information be collected? In doing so, the community's involvement in the research process will be considered, as will the national and political and general legislative framework in which these occur.

1.3. Literature Review

1.3.1 Nepal's Agriculture and diversity

The multicultural nation of Nepal contains a range of different agro-ecosystems which have given rise to a great diversity of local crop varieties. As a mountainous country, its topographic elevation creates sharply contrasting climatic zones (Dahal, 2006), allowing for different farming systems to exist at each range of elevation. The tropical climate zone occurs in what is known as the *terai* region (60-300 masl), stretches across the southern-most part of the country, bordering India. The *terai* is made up of flat land where water availability has, up until the recent past, not been a limiting factor for the customary rice-based cropping patterns. Elevations of between 300 to 2,000 masl are classified as the 'mid-hill region', characterised by a subtropical climate in which a cereal-based cropping system dominate but includes cereals other than rice such as maize, wheat, and millet. Lastly, there is the mountainous region of temperate climate at elevations above 2,000 masl, where cold-tolerant varieties of rice, maize, wheat, barley, and deciduous fruit and nut trees are cultivated. Agricultural production across the three zones is conducted mostly by smallholder farming systems, and contributes to more than a third of the country's GDP, serving as the employment and means of livelihood for more than two-thirds of its population (CBS, 2001; Deshar, 2013).

The Nepalese agricultural sector has experienced a shift towards market-orientation and an overall intensification of production; shifting from an average of 1.3 to 1.6 crops per year in the 1980s to 2.2 to 2.7 in the 1990s (Brown and Shrestha, 2000; c.f. Riley, 1991: Brown, 1997). Intensive market-oriented cultivation led to the planting of high yielding varieties and inherently, rendered Farm Yard Manuer (FYM) insufficient, increasing dependence on inorganic fertiliser, and chemical pesticides (Brown and Shrestha, 2000). The transition to a reliance on external inputs was endorsed by the 1995 Agriculture Perspective Plan (APP) which asserts inorganic fertiliser as the key stepping stone for agricultural growth (Raut and Sitaula, 2012). It targets to increase the use of fertiliser from 31kg nutrient/ha of 1995 to 131kg nutrient/ha by 2017 (Raut and Sitaula, 2012; c.f. APP, 1995). In 2009, the Ministry of Agricultural Development (MoAC), reinstated a subsidising scheme for fertilisers (Raut and Sitaula 2012) yet, due to a lack of timely distribution, sufficient quantity and appropriate information on application and management changes in crop yields have been small (Brown and Shrestha, 2000; c.f. Chitrakar, 1990; FAO, 2000). The shift in cultivation practices has led to the use of nitrogenous fertilisers such as urea, with a decrease in the use of FYM, and a consequent acidification of soil (Raut and Situla, 2012; c.f. Raut et al., 2011: Raut et al., 2012). This is but one example of the different but intersecting changes which contribute to the loss of agrobiodiversity currently underway in Nepal.

There exists a general lack of information and appreciation for the value and future potential of local crop diversity amongst farmers which coupled with external pressures facilitates the abandonment of local crop diversity (Shrestha et al., 2015a). The increasing influence of modern[1] value chains, not only renders local niche markets uncompetitive but facilitate the access and availability of commercially bred varieties creating economic incentives for the cultivation 'improved' varieties at the expense of local ones (Shrestha et al., 2015a: Bellon et al., 2015a; c.f. Tisdell &Seidl, 2004; van de Wouw et al., 2010). Public sector support in the form of subsidised or free handouts of improved varieties and its associated inorganic inputs likewise put pressure on the continued sowing of traditional local varieties (Shrestha et al., 2015a). An increase in off-farm revenue and out migration allows for alternative sources of income which replace the risk-managing function of crop diversity (Rana et al., 2007; Bellon et al., 2015a). These factors for change in crop diversity are exemplified in the *terai*, where market accessibility and road infrastructure facilitates the integration of farmers in this area into market-based livelihoods which alter agricultural practices towards the adoption of modern agricultural technologies and management. This shift is readily apparent in the replacement of local rice varieties by commercial ones, and an increased reliance on external inputs (Chaudhary et al., 2003: Chaudhary, 2015). As a result, farming communities in Nepal are vulnerable to the loss of crop diversity: where once over 2,500 varieties of rice alone were cultivated, today it is estimated that only a few hundred persist (Shrestha et al., 2015a).

[1] The term modern here is not to be equated with progressive but rather reflect the present-day direction of agriculture to ward capitalist and industrialist modes of production.

1.3.2 LI-BIRD's approach to community seed banks

The histories of seedbanks supported by LI-BIRD began with a programme titled 'Strengthening the scientific basis for *in situ* conservation of agrobiodiversity' which was part of a global effort in 1995 between Bioversity International and nine other countries – Nepal being one of them (Subedi et al., 2013a). This programme sought to establish an understanding of the dynamics that influence and encourage the on-farm conservation of agrobiodiversity. Over a decade of learning from community-based conservation projects, programmes and experience resulted in the development of a 'Community Biodiversity Management methodology'. This was defined as a community-level participatory methodology which strengthened farmers' and farming communities' capacity to manage biodiversity for the benefit of both households and communities. This "results in autonomy in decision-making on agrobiodiversity conservation and use at the community level; stimulates ownership; and supports community-based conservation and sustainable livelihood options, with minimal external inputs and risks" (Subedi et al., 2013a pp. 16).

An integral part of this learning process came from an agrobiodiversity project in the Bara eco site in Nepal, which revealed that, despite the best efforts of the project and farmers, local crops, and varieties were being lost (Subedi et al., 2013a). The outcome of this study catalysed farmers' interest in local diversity and community mobilisation led to the creation of a local institution, the Agriculture, Development and Conservation Society (ACDS). One of the first efforts of the ACDS was the establishment of a community seed bank to which the ACDS integrated several other practices. These events led to CSB becoming an integral component of the CBM methodology and to the formation of LI-BIRD's current approach for facilitating the establishment of CSBs throughout Nepal.

Community seed banks transcend national boundaries, and as such each has a physical appearance, management, scope, technical aspects, and history particular to the community in which it arose, regardless of its general principles and functions, of which CSB have three at their core: (i) Conservation; (ii) Access and availability of diverse range seed, and (iii) Seed and food sovereignty as shown and expanded in Table 1, which provides a brief overview of the benefits associated with these three main functions (Vernooy et al., 2014).

Table 1. Functions and benefits of community seed banks

Function	Services and Benefits
Conservation	Short-term storage of widely used local varieties, while maintaining the long-term conservation of rare varieties Replenishing seed stock of "lost" varieties Local community established forms of management for conservation of healthy seed and reproduction
Access and availability	Provides seed at low cost and in case of acute shortage Allows access to seed of both novel diversity and seed adapted to local environment Encourages exchange in and outside community
Seed and food sovereignty	Enables local control, exchange, and production of seeds and its associated knowledge Allows for the continuance locally rooted cultural practices of food and farm management Seed sales generates income

In what follows the details on the process of establishing a seed banks, its governance and structure, and its financial mechanism are explained. This pertains specifically to CSBs in Nepal, whose establishment has been facilitated by LI-BIRD.

LI-BIRD's approach to CSB centres on the building of 'social capital', which involves the mobilisation of advancement of trust, social networks, and customary practices (Sthapit et al., 2015). This is done in order to create a space for community-driven efforts to integrate new knowledge and practices of seed saving into local social norms and customs (Sthapit et al., 2015). As such the first step in all of this is to build awareness within the community about the value and importance of biodiversity. This is then followed by a series of practices which facilitate the collection and documentation of local diversity. These efforts continue by setting out rules and regulations for their collection, distribution, and use, as well as financial mechanisms to ensure that the CSB can function properly. The construction

of the physical seed bank and its seed-storing facilities can occur at varying points throughout this process and is not considered to be a priority in itself. Indeed, although such a space for community-gathering is needed, it is the process of building social capital which then leads to the construction and functioning of a seedbank that is more crucial.

1.3.3 Community biodiversity management practices linked to community seed banks

The following practices form part of the CBM methodology (and so CSB formation) as they contribute to raising awareness and sensitizing the community to the value of local biodiversity (Shrestha et al., 2013b). The organisation of diversity fairs, diversity blocks, a community biodiversity register (CBR), and diversity kits form the bedrock for future efforts in the collective conservation and sustainable utilisation of PGR (Sthapit et al., 2008: Shrestha et al., 2015), and are described below.

The *diversity fair* serves as a collective and competitive event in which farmers display their plant propagating material: vines, tubers, seed, fruits, as well as traditional food made from these. It creates a space in which farmers share information on local biodiversity and its associated traditional knowledge (ATK) through the displays set up and via oral communication (Shrestha et al., 2013b). Organisation of the fair is performed by the farming communities themselves, which create subcommittees to ensure the readiness of all required tasks and preparations for the evaluation of the stalls and the general organisation of the day's event (Shrestha et al., 2013b). This practice allows for: an initial basis for the building of organisational capacity, building awareness of local agrobiodiversity, documenting and exchanging seeds, ATK, and it custodians (Shrestha et al., 2013b).

The *diversity block* is a plot established and managed by the farmer groups, usually near roadsides or public places to reproduce several varieties of a single crop type (Shrestha et al., 2013b). It is a tool for testing the consistency of names given to farmers' varieties, evaluating and comparing varietal performance, as well as regenerating seeds of local varieties, and is a key component of any CSB (Shrestha et al., 2013b). For an example reference Appendix 6.1: *Figure 11, Figure 12,* and *Figure 13*.

The *community biodiversity register* is a practice and tool through which a farmer's or community's information database is created. Again, its exact contents and format are unique to the community it originates from. However, a minimum data set is recommended and would provide information on the availability of local biodiversity, as well as data on its diverse uses. For an example reference Figure 14 in Appendix 6.2 (Paudel et al., 2015). The register works to establish a formal record that documents and monitors PGR and ATK, whilst protecting farming communities against potential bio-piracy (Subedi et al., 2013b)

Finally, *diversity kits* are a tool used for the distribution of small samples of planting material to increase crop diversity within a community (Shrestha et al., 2013b). It a process of quality seed production and distribution in the form of a packet containing a selection of crop varieties which come from either the diversity fair, diversity block, CBR, or varieties considered to be endangered (Shrestha et al., 2013b). Information sheets for these varieties, which list varietal characteristics and best practices for their cultivation are also included in the kits, which are then are then packaged and distributed to households within the community (Shrestha et al., 2013b).

1.3.4 Governance and structure of community seed banks

Each community develops a CSB governance structure, which is composed of rules and regulations for the seedbank's functioning that reflect their own values, priorities, and resources (Staphit et al., 2015). As the evolution of each seedbank is a 'learn as you go' process', these rules and regulations are ever-changing, and become more formalised with time, adapting governance to their situation (Staphit et al., 2015). Typically there is an executive committee and a management committee, to distinguish between governance and management aspects of a seedbank (Staphit et al., 2015). The elected executive committee, often with a balanced composition of men and women, has the responsibility of ensuring the organisation's transparency in its operational and management plans

and playing a leadership role whilst guided by the locally developed rules and regulations (Staphit et al., 2015). The management committee, which is also elected, is responsible for the technical aspects of seed regeneration and distribution, which include (Staphit et al., 2015: pp. 29):

- "Collection methods (e.g. through seed fairs, household seed storage, collection maintained by custodian farmers, etc.);
- Phytosanitary standards (e.g. keeping seeds free of disease and pest, removing weed seeds, sun-drying, etc.);
- Documentation methods (e.g. passport data sheets, variety catalogue, community biodiversity register, etc.);
- Seed multiplication with an evaluation (based on farmer's descriptors);
- Storage methods (e.g. short versus long term, local storage structure or scientific approach);
- Monitoring of seed samples (e.g. viability and vigour, initially and at planting time);
- Rejuvenation (e.g. annual seed multiplication in diversity blocks, decision tools to determine which seeds should have priority, pollen control in open-pollinated crops, etc.);
- Distribution (e.g. systems to improve access and availability; access for various categories of users: men or women, poor or rich, community or outsiders, researchers, private sector, etc.)."

1.3.5 Financial mechanism of community seed banks

The community biodiversity management fund (CBM fund) is a mechanism for providing access to financial resources to a community in a manner similar to other rural microfinance schemes (Shrestha et al., 2013c). Again, it is the community members who develop the guidelines for the functioning of the fund, so that they resonate with local issues and priorities (Shrestha et al., 2013c). The initial fund is set up with a combination of farmers' cash and donor funds from either governmental or non-governmental organisations (Shrestha et al., 2013c). The CBM fund will then be able to promote biodiversity-based income generating initiatives through the provisioning of a loan (Shrestha et al., 2013c). This loan does not require collateral, is paid back at less than 12% interest, and gives preference to poor and marginalised households (Shrestha et al., 2013c). Often conditions attached to the loans require the cultivation of at least one rare local variety, so as to maintain a balance between income-generation and conservation (Shrestha et al., 2013c).

In addition, some seedbanks establish a seed fund, to cover the initial costs of seed reproduction (Sthapit et al., 2015). The seed funds are not to be used for loan purposes but are rather meant to cover the costs of maintaining the seedbank and its reproduction of seed. In some cases, seedbanks also begin selling seeds, under which the revenue gained is invested back into the seed fund.

1.3.6 Community seed banks as a political institution

The Nepalese government has established policies for the benefit of agrobiodiversity conservation and farmers' rights through the policies discussed below recognise agrobiodiversity, local varieties, and farmers' knowledge, none of these legal documents explicitly mention CSBs (Chaudhary et al., 2015; Shrestha et al., 2015b).
The National Seed Act (1988) encourages the inclusion of two seed entrepreneurs, seed producers and farmers within the national seed committee (Chaudhary et al., 2015: Chaudhary et al., 2016). The body responsible for counselling on the formulation and implementation of seed-related policies (Chaudhary et al., 2015: Chaudhary et al., 2016). Even after its amendment in 2008 it has not included CSBs (Chaudhary et al., 2015: Chaudhary et al., 2016). This same regulation, however, promotes and recognises the improvement of local varieties by farmers and allows for their registration (Chaudhary et al., 2015: Chaudhary et al., 2016).

The Seed Policy (1999) provides management, technical and financial (by way of a transportation subsidy) support to famers' groups in remote areas of the country in their aces to seed (Chaudhary et al., 2015: Chaudhary et al., 2016). Although this policy directly relates to the efforts of a CSB, it has yet to make resources available for their support (Chaudhary et al., 2015: Chaudhary et al., 2016).

The Plant Variety Protection Act (2004) acknowledges the use of farmers' knowledge and resources in plant breeders' efforts to develop new varieties and allows for farmers to register, release, control and reproduce their own

varieties (Chaudhary et al., 2015: Chaudhary et al., 2016). This act was key in permitting the release and registration of a variety from the Kachorwa community seed bank (Chaudhary et al., 2015: Chaudhary et al., 2016).

To comply as a signatory to the Convention on Biological Diversity, Nepal drafted an Access and Benefit Sharing (ABS) Law in 2002 which protects the ownership rights of local communities over genetic resources and their ATK, which requires the community's prior and informed consents as well as an equal share in benefits arising from varietal development (Chaudhary et al., 2015: Chaudhary et al., 2016). Although the draft has been at a standstill, CSB can be a crucial mechanism for the practical application of an ABS system (Chaudhary et al., 2015: Chaudhary et al., 2016).

A policy document, Seed Vision 2025, strives to promote seed production pockets within the country as a means to providing farmers with high-quality seed, by explicitly acknowledging a need to support community seed banks, gene banks, community-based seed production and capacity-building amongst seed-producers and producer groups (Chaudhary et al., 2015: Chaudhary et al., 2016).

The Agrobiodiversity Policy (2007, rev. 2011, 2014) emphasises a need to enhance agricultural growth and food security through the conservation and sustainable use of agrobiodiversity through support traditional seed production, exchange and its ATK (Chaudhary et al., 2015: Chaudhary et al., 2016). Though CSBs are not explicitly mentioned as a practice which achieves the policy's goals, it implicitly protects and supports CSB efforts (Chaudhary et al., 2015: Chaudhary et al., 2016).

Community Seed Bank Guideline (2009) was the result of a collaborative effort between different government organisations and NGOs to provide a guideline for the establishment and support of CSBs, focusing on marginalised, sustenance and war-affected households (Chaudhary et al., 2015: Chaudhary et al., 2016). Though it has been used by government agencies, it has not been extensively circulated (Chaudhary et al., 2015: Chaudhary et al., 2016).

Although the above-presented policies create a political space which condones, encourages, and protects farmers' use of agrobiodiversity, they do not provide practical political support (i.e. funding, technical, managerial) for CSB to successfully operate (Chaudhary et al., 2015: Chaudhary et al., 2016). Considering, the government's recognition of the importance of agrobiodiversity and developing a resilient agricultural sector it is conflicting/contradictory/ a shortcoming that it does not actively support CSBs as an on-farm conservation effort which provides the public benefit of crop evolution to the nation (Bellon et al., 2015a).

1.4 Theoretical framework

As community seed banks are a relatively new approach for on-farm conservation, and no impact studies have been conducted, there are no frameworks within published scientific literature, which offer methods under which to conduct an assessment. Due to this, the framework used throughout this study combines the functions and benefits of CSBs with the CBM methodology, a conceptual framework for the assessment of on-farm conservation strategies, and agroecology's theoretical framework. In what follows, the focus will be on the latter two frameworks and their practical and theoretical relation to the former two, which are presented in greater detail in Section 1.3

1.4.1 Conceptual framework for the assessment of on-farm conservation strategies

Bellon et al (2015) have developed and implemented a conceptual framework under which to assess the effectiveness of projects with an array of interventions for support farming communities in the on-farm conservation of local crops. Under this framework, projects are deemed successful when they lead farmers to maintain a higher level of on-farm crop diversity, which in turn results in private livelihood benefits from maintenance of diversity, and ultimately, continues crop evolution (Bellon et al., 2015). Within this framework, project interventions are said to influence the level of diversity maintained on-farm by increasing its intrinsic value and reducing the cost of access to its planting materials, while providing private-livelihood benefits from said inclusion of diversity such as: enhanced income, increased food consumption, and improved stability and resiliency of the farming system (Bellon et al., 2015). The framework outlined by Bellon et al. (2015) provides two concrete aspects under which to generate data that supports whether or not on-farm conservation projects are successful; the first being an increase of diversity, and

the second being a positive change in private-livelihoods benefits. Although the focus is at community-level and not farm-level or regional/national scales, it provides a conceptual tool and first steps towards assessing the effectiveness of on-farm conservation projects (Bellon et al., 2015). Additionally, Bellon and colleagues (2015) make the important remark that monitoring possible changes and successes of on-farm conservation projects is necessary for securing future funding and support for the continuance of such projects.

1.4.2 Agroecology as an overarching framework

Agroecology surged as a contemporary approach and ideology to counter the industrialisation and homogenisation of agrarian rural life (Sevilla Guzman and Woodgater, 2013). Here in, the term agroecology is defined as that which:

> "promotes the ecological management of biological systems through collective forms of social action, which redirect the course of coevolution between nature and society in order to address the "crisis of modernity." This is to be achieved by systemic strategies… to change [the] modes of human production and consumption that have produced this crisis. Central to such strategies is the local dimension where we encounter endogenous potential encoded within knowledge systems … that demonstrate and promote both ecological and cultural diversity. Such diversity should form the starting point of alternative agricultures and the establishment of dynamic yet sustainable rural societies (Sevilla Guzmán and Woodgate, 1997; c.f. Sevilla Guzmán and Woodgate, 2013)."

It is an ideology which includes ecological, socioeconomic and political discourses in order to contest the reigning industrial food paradigm (Sevilla Guzmán and Woodgate, 2013). Embodying a transdisciplinary approach in which natural sciences, agrarian social thought, and politics, as well as farmer's knowledge are included to address all dimensions and complexities of today's food systems (Sevilla Guzmán and Woodgate, 2013). However, the majority of agroecological efforts, at least within academia, are confined to a technocratic and natural sciences approach in which ecological management for self-regulation of farming systems is prescribed (Gonzalez de Molina, 2013). This approach assumes changes towards sustainable food systems need only technological solutions, without challenging and addressing the socioeconomic and political structures which govern the management of natural resources and rural life (Gonzalez de Molina, 2013). In spite of its theoretical recognition of the necessity for fundamental change in economic and political structures, there are no analytical instruments, tools, or practices, within agroecology to design or establish systems of organisation and governance that would autonomously operate within the current order or outside of it (Gonzalez de Molina, 2013). Much less for them to catalyse change beyond the farm-level and into national and global spheres (Gonzalez de Molina, 2013).

Although practical application might not be fully exercised, agroecology attempts provides a useful and holistic theoretical framework under which to explore the impacts of peasant institutions on farm, community, national level and its respective changes on farming systems, socioeconomic, and cultural/political structures (Gonzalez de Molina, 2013; Sevilla Guzmán and Woodgate, 2013). Below, Table 2 briefly describes overlapping goals and approaches to livelihood-based agrobiodiversity management of the CSB functions and benefits, the CBM methodology, the conceptual framework for the assessment of on-farm conservation strategies within agroecology.

Table 2. Comparison of frameworks

Framework	On-farm biodiversity conservation	Social capital and autonomy	Development of strategies for local institutions	Livelihood development	Diversity of stakeholders and knowledge	Political change
CBM methodology	Methodology for facilitating the collective control over the conservation and use of **plant genetic resources** and agrobiodiversity through on-farm management (Shrestha et al., 2013a).	Focuses on enhancing community's knowledge on biodiversity, and social learning through mobilisation of members in decision-making processes to establish a sense of autonomy and ownership of agrobiodiversity (Subedi et al., 2013b).	Works towards the establishment of community based organisations (CBO) and their development as formal institutions; this involves community reorganisation into sub-groups, to coordinate and oversee implementation of CBM strategies (Shrestha et al., 2013b).	Market-based incentives are included as integral aspect of CBM projects, to ensure conservation efforts address livelihoods priorities of farmers and communities (Subedi et al., 2013c).	Both stakeholders and areas of knowledge encompass the range of those involved in agriculture (e.g. breeding to sociology), as well as government representatives at local, regional and national scales (Subedi et al., 2013a; Shrestha et al., 2013b).	LI-BIRD's effort in bringing together farming communities and policy-makers, to create a favourable legal environment for biological and socio-cultural diversity (Vernooy and Ruiz Muller, 2013), CBM practices mainstreamed in Nepal through CBR and CSB provide a mechanism for the application of ABS (Vernooy and Ruiz Muller, 2013).
CSB functions and Services	Allows farmers to **retain seed-stock of crop varieties** while enhancing awareness and intrinsic value of local varieties specifically (Shrestha et al., 2015 : Vernooy et al., 2014)	Enables local control, exchange, and production of seeds and its associated knowledge. Allows for the continuance of locally rooted cultural practices of food and farm management (Vernooy et al., 2014).	In Nepal's case registered farmers organisations and the community as a whole collectively decide upon forms of management for conservation of healthy seed and reproduction	Provides seeds at low cost, while seed sales generates income (Vernooy et al., 2014).	Its establishment involves, NGOS, INGOS, farming communities, local, regional and in some cases national governments (Vernooy et al., 2014).	In general policies which provide practical support and recognition are not abundant some countries with exceptions to this are: Mexico, Brazil, South Africa, and Nepal (see Vernooy et al., 2015b)
Assessment of on-farm conservation strategies	Involved the study of projects with numerous interventions to support farmers in the **maintenance of plant genetic resources on farm** (Bellon et al., 2015b)	Preservation of crop biodiversity (i.e. option values from crop evolution, Bellon et al., 2015a) safeguards a locale's natural and socio-cultural capital, and in doing so its potential future autonomy from environmental and economic homogenising forces.		Farmers and households must receive private benefits that derive from the conservation of agrobiodiversity in the form of increase income, production, stability, consumption and/or marketing of these crops (Bellon et al., 2015b)		
Agroecology	To conserve and enhance local resources, though these include not only germplasm and plant diversity, but also soil, beneficial fauna. There is an emphasis on both **inter-specific and intra-specific diversity to design associations for the better functioning of nutrient recycling and natural pest control and soil conservation**. This includes **crop-livestock** integration, hedgerows, and corridors for **landscape-level** diversity. (Altieri, 2002; Altieri et al., 2015)	Agroecological perspectives argue for collective action that can re-integrate social and biological systems (Sevilla Guzmán and Woodgate, 2013). As it understands agroecosystems to be a result of a coevolution between social and environmental dynamics (Sevilla Guzmán and Woodgate, 2013). In particular, seeking to establish a multiplicity of sovereign food systems based on cultural and environmental identity (Sevilla Guzmán and Woodgate, 2013).	Lacks practical framework for establishing and supporting institutions that enable agrarian sustainability (Gonzalez de Molina, 2013). Foresees a challenge in re-instating a social fabric that could lead to collective organisation and strategies to implement agroecological mechanism (Altieri et al., 2015)	Focuses on designing farming systems that increase the self-sufficiency of the rural poor (Altieri & Merrick, 1987)	Rooted in participatory action research as it values and incorporates farmer-generated knowledge and participation of multiple perspectives (Altieri, 2002; Méndez et al., 2013).	Argues that rules and regulations that ensure a viability of farmers' livelihoods and equal distribution to be responsibility of the state as the resiliency of farming communities depends also on it governing institutional and socioeconomic structures specially when it comes to market relations (Wenzel et al., 2016).

Below, Figure 1, shows a visual representation of the framework used to evaluate seedbanks, it attempts to harmonise the above listed frameworks. Table 3, in section 2.3.5 provides greater detail of each aspect below.

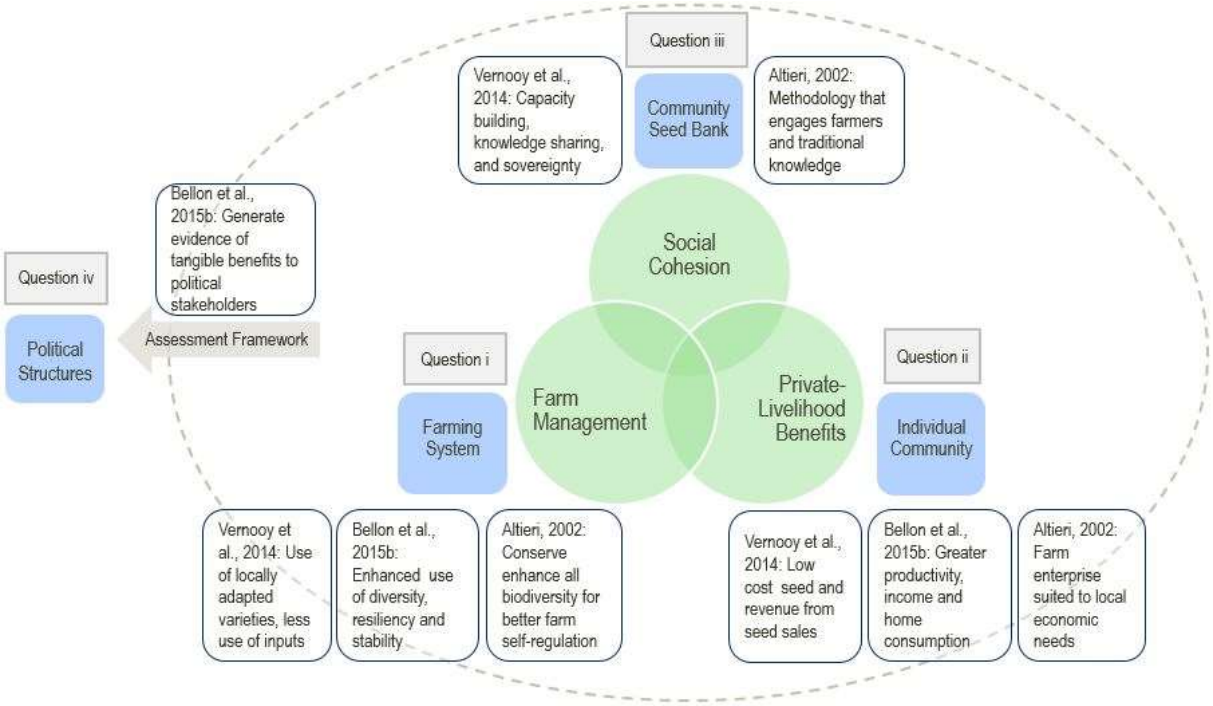

Figure 1. Theoretical framework for the evaluation of community seed banks
The green circles depict the three interrelated aspects which will be a focus of this study, showing in blue the level of analysis at which data will be gathered, and in grey the respective research question which each will answer. Additionally, the side boxes provide examples of criteria used throughout the assessment, which strives to merge both on-farm conservation and agroecological literature. The dotted line represents the framework's combination of different units of analysis and interrelated aspects included.

Farm management addresses changes at farming system level as the process of establishing seed bank is reported to influence farmer demand for diversity. By raising awareness of the importance of local agrobiodiversity, and providing means for a community to maintain and access planting material (Bellon et al., 2015b; Vernooy et al., 2014). As such, community seed banks are assumed to result in farmers incorporating more diversity on field, an assumption derived from the increase in diversity maintained at community-level (Vernooy et al, 2014). Furthermore, the use of local varieties is reported to have farmers use less external inputs when compared to modern varieties (Vernooy et al, 2014). Allowing farmers who use local varieties to also only or mostly use on-farm resources and agroecological practices. This section will foremost include the use of diversity on farmer's fields but also the benefits and services associated with the use of local varieties, exploring how access and use of biodiversity translates into a change in farm management, and possibly the adoption of agroecological practices. This aspect tries to integrate the on-far; biodiversity conservation efforts of the CBM methodology CSB functions and services, the assessment of on-farm conservation strategies and agroeocology, listed in Table 2.

Private-livelihoods evaluates the private benefits, at individual, household and community-level, resulting from the sale of seed, the lower cost of production due to a decreased cost in seed and possibly inputs, and an increase stability of productivity. Additionally, it addresses how the control over the reproduction of seed impacts farmer's economic development and the economic impact of community's access to lower cost and locally adapted seed. It also takes into account the effect of the community seed bank's financial mechanism (e.g. CBM fund, seed loan etc.) on the community's economic development. Lastly, under the economic impacts, the community seed bank's influence on market access and product diversification is explored. This section aims to combine the livelihood

benefits from Bellon et al., (2015b) framework with the different benefits that result from community seed bank functions of conservation, access, and availability, and seed and food sovereignty. As seen in table 2, private-livelihood aspect combines the livelihood development efforts of the CBM methodology CSB functions and services, the assessment of on-farm conservation strategies and agroeocology, listed in Table 2.

Social cohesion explores the community-level benefits stemming from the process of establishing and having a seed bank. Specifically, it covers topics such as community organisational skills, farmer to farmer knowledge sharing, collective action, training on seedbank management and quality seed production amongst other capacity building efforts. The process of establishing and maintaining local institution has been reported to enable collective action and community empowerment (Vernooy et al., 2014). Additionally, this aspect of the framework will look at how a seed bank contributes to seed and food sovereignty including, the community's empowerment, control over food production, and the community's ability to continue seed varieties important for traditional and culturally spiritual purposes. This aspect combines both the social capital and autonomy and strategies for the development of local institution efforts of the CBM methodology CSB functions and services, the assessment of on-farm conservation strategies and agroeocology, listed in Table 2.

As a final note, only the overlapping dimensions of political change and diversity of knowledge and stakeholders are not directly addressed within the three previously stated aspects of primary data collection. However, political change is implicitly accounted for as the data generated is targeting policymakers amongst other stakeholders to provide evidence future project support and policy making. While a diversity of knowledge and stakeholders is included within the methodology and approach to data collection of this study and further described in section 2.

2. Research design and methods

2.1 Methodology

Participatory-action research (PAR) promotes an exchange of local, scientific, cultural, and indigenous knowledge allowing for the collective development of findings (Cuéllar-Padilla & Calle-Collado., 2011; Mendez et al., 2013). This approach seeks to encourage active participation of a diversity of stakeholders to take part in an iterative research process which combines research with reflection and subsequently action (Mendez et al., 2013). As the CBM methodology, the establishment of a seedbank and agroecology principles overlap with participatory action research, it would only be appropriate to carry out its evaluation in the same manner. Reference Appendix 6.3, table 6 for a table showing PAR and agroecology overlapping principles as well as the 'new professionalism' within rural development used for enabling CBM. Additionally, by incorporating a participatory methodology, this study was able to work with farmers to collect information on the distribution of diversity (Jarvis et al., 2016). Participatory evaluation of the effectiveness of a particular intervention addresses how it was able to: represent local interest, generate desired results according to the project's own goals, strengthen organizational capacity, and encourage farmer experimentation (Vernooy, 2005). Specifically, this evaluation will focus on the outcomes and impacts of the community seedbanks so to provide a narrative on its effect as an on-farm conservation strategy, focusing on the community's felt impacts on the ecological and socioeconomic aspects of their livelihoods.

2.2 Description of study sites

Three districts were chosen as study sites, in the Central, Western, and Far Western Development Regions of Nepal, presented in *Figure 2*. As community seedbanks are specific to the community in which they were established, it was an important consideration to not limit the study to only one site but select sites with differing demographics, climates, and experiences with community seed banks. Details for each of the sites is described in further below, which will first provide insight into the agroecology of the area and information on the farming systems followed by a detailing of available information on the establishment of the seedbank.

2.2.1 Kachorwa, Bara

Located in the Central Development Region of Nepal, in the *terai* eco-zone, at an altitude ranging from 80 to 90 masl, it experiences sub-tropical climate (Rana et al., 2000). As part of the Indo-Gangetic, Kachorwa has top alluvial fertile soils (Rana et al., 2000). Although it receives 1515.2 mm of precipitation annually, they are concentrated between the months of June and September, causing water availability to constrain staple crop production within these months (Rana et al., 2000). Households engage in both on-farm and off-farm activities as sources of income, however, cereal production and sale are the main sources of income (Rana et al., 2000). Conclusively, agriculture is also the

Figure 2. Map of study sites

major land use system with land being classified as *khet*[2] and *bari*[3] (Rana et al., 2000). A rice-based cropping pattern dominates *khet* land, rice cultivation is followed by oil seeds, vegetables, pulses, wheat or maize (Rana et al., 2000). While *bari* land is predominantly occupied by a maize cropping system, whose cultivation is followed by vegetables, pulses and finger millet (Rana et al., 2000). Due to Kachorwa's access to agricultural input-technologies the use of external inputs for production is almost universal where 98% of households apply both inorganic fertiliser as well as insecticides (Yadav, 2012: Rana et al., 2000).

As part of a baseline study carried out, Kachorwa was found to have thirty-three local crop varieties. In 2003, when compiling a community biodiversity register the number of local crop varieties had decreased to fourteen (Yadav, 2012). The loss of local diversity was attributed to farmers increased cultivation of modern varieties, and prompted the project team and community to establish a community seed bank. A group of nodal farmers formed the Agriculture Development and Conservation Society (ADCS) in order to manage the seedbank and agricultural biodiversity at community level (Yadav, 2012). The seed bank and its 380 members now have a collection of over one-hundred local crop varieties (Yadav, 2012).

The community seed bank in Kachorwa, Bara was the first seedbank established with the support of the Nepal Agricultural Research Council, NARC, Local Initiatives for Biodiversity, Research and Development (LI-BIRD), and Bioversity International as part of Bioversity International Global *In Situ* Conservation project. The experiences from this project lead LI-BIRD to support the establishment of fourteen other community seed banks throughout Nepal, of which one is found in Nawalparasi and the other in Doti.

2.2.2 Aygaouli, Nawalparasi

Also in the *terai* region, Agyaouli is located in the Nawalparasi district within what is considered the Western Development Region, at an altitude from 300 to 1936 masl and an annual rainfall of 2145 mm (Subedi et al., 2009). Almost 90% of the land in Agyouli is under cultivation, with 70% being designated as *khet* and the remaining 20% as *bari* (Subedi et al., 2009). Cropping pattern for *khet* land is as follows: Rice-Wheat-Fallow, Rice-Lentil-Fallow, Rice-Vetch, Rice-Mustard, and Lentil. While *bari* land has a cropping pattern of Maize-Mustard-Fallow or Maize-Millet-Fallow. Around 83.3% of households apply inorganic fertilisers, while it was found that only 48.3% of households employ chemical pest control.

The Aygaouli seedbank was established in 2011, at first conserving only local varieties, and now also participating in the production and sale of seeds, both local and improved varieties. The seedbank is legally registered as a farmers' organisation under the name Agriculture Development and Conservation Farmers' Committee (ADCFC). Out of the 2077 households in Aygaouli, 880 households are members of the community seed bank. In 2015, the Aygaouli seedbank was instrumental in earthquake relief supplying 5.7 tons of seed produced within the seedbank to earthquake affected areas.

2.2.3 Ghanteswor, Doti

The Doti district is in the Far-Western Development Region in the Mid-hill eco-zone, at an elevation ranging from 305 to 2430 masl, it receives annual rainfall of 1145.2 mm (Subedi et al., 2009). In Ghanteswor, 50% of the total land area is under cultivation (Subedi et al., 2009). Cropping pattern for *khet* land is as follows: Wheat/Lentil-Fallow, Rice-Barley-Fallow, Rice-Maize -Fallow, and Rice-Maize/Sunflower (Subedi et al., 2009). While for *bari* it is only common to have a cropping pattern of Maize-Rapeseed/Lentil (Subedi et al., 2009). Ghanteswor has the lowest use of external inputs, partly due to the village's isolate location in the mid-hills, limiting market access. This same isolation and far distance between wards within the village had, however, limited seed access and availability, a driving factor behind the establishment of the seedbank. The community seed bank was established in 2013, under the registered farmers' organisation Biodiversity Conservation Agriculture Cooperative (BCAC) each ward forming specialised seed producing groups (SPG), so far involving 350 households. Additionally due to Ghanteswor's agro-ecological zone, the seedbank also includes a citrus and fodder tree nursery.

[2] Khet refers to bunded and irrigated or rain-fed land, mainly for rice paddy cultivation

[3] Bari refers to un-bunded land which is not irrigated and sometimes found at a higher altitude or father away from water sources.

2.3 Data collection and participants

Primary data was gathered from both users and committee members of each CSB, questionnaires were adjusted to each locality's specific circumstances. As this study aims to create a narrative of the perceived impacts of CSB, at the community and household level, it is necessary to create a knowledge-base from the perspective of different individuals through a variety of data-collecting methods in order to acknowledge local experts, explore contradictions as well as consistencies in perceptions, and validate data (Newing, 2011; Jarvis et al., 2016). A series of focus group discussions (FGD), key informant interviews, semi-structured questionnaires, were carried out. In order, to have a comparable and quantitative manner to combine all of the understandings of the different impacts, questionnaires, individual interviews, and focus group discussions were complemented with visual responses in the form of radar diagrams.

2.3.1 Secondary data collection

Secondary data sources, of community seed bank's history, the methodology for its establishment, and governance framework, as well as baseline data, was collected via reports and books published by LI-BIRD, Centre for Development and Innovation of Wageningen University and Research Centre as well as Bioversity International.

2.3.2 Focus group discussions and participants

Focus group discussions were carried out in Kachorwa and Ghanteswor. Two focus groups, of eight to fourteen participants (Newing, 2011), were carried out with one group consisting of the committee members of the CSB and the other of users and members of the seedbank. The list of participants for each group can be found in section 6.7 of the Appendix. One focus group discussed on the social impacts, relevant to research question iii, observed by the committee members. Within this discussion guiding questions inquired on the felt changes in the community's collective action, organizational skills, knowledge sharing, empowerment, as well as food and seed sovereignty. While, the other focus group with users and members of the seedbanks, discussed the perceived changes in farm management and private-livelihood, relevant to research question i and ii, brought on by the seedbank, addressing similar points as the questionnaire, but in a broader sense, since group discussions and consensus was the focus and not specificities. The guiding questions used during these discussions can be found in Appendix 6.6.

2.3.3 Key informants and participants

A total of sixteen key informant interviews were conducted to retrieve knowledge specific to the individuals, seven in Kachorwa and nine in Ghanteswor, the total list of participants can be found in section 6.7 of the Appendix. In Kachorwa, founding members of the ADCS were interviewed, along with nodal farmers, this kept an equal gender ratio amongst respondents. While in Ghanteswor, leaders of the seed producing groups and members of the BCAC were spoken with. It's important to note that due to the realities of Ghanteswor even gender ratio of respondents did not occur, this will be further expanded upon in the results. In all interviews, participants were asked to share the changes observed, at community level, that have taken place since the establishment of the seedbank with respect to farm management, private-livelihoods, and social cohesion, relevant to research questions i, ii, and iii. The guiding questions for these semi-structured interviews, found in Appendix 6.6, were similar to those used in the focus groups, yet these elicited more detailed responses and were tailored to the individual's knowledge, experience, and role within the seedbank and community.

2.3.4 Semi-structured questionnaire and participants

Questionnaires were designed to elicit specific information regarding whether or not community seedbank allows farmers to maintain higher levels of crop diversity on field, how this diversity is integrated into the farm and consequently if those farmers who maintain higher levels of diversity obtain additional private-livelihood and/or ecological benefits (i.e a self-regulating farming system). For the farmer questionnaires, a random sample of twenty-nine farmers was taken from the seedbanks list of users, users must have been loaning or buying seed for at least the last three years, the selection kept an equal gender ratio amongst participants. Questionnaires were only carried out in Agyauli and can be found in Appendix 6.4 the full list of the 29 participants can be found in Appendix 6.5

Section I served as an introduction to the questionnaire, form I. A, asked farmers to describe their understanding of the main purposes of the CSB and some of the most impactful changes experienced. This was followed by form I. B,

which elicited a general description of their farm, land availability, access to irrigation and soil quality. Form I. C, then incorporated questions on rice varietal diversity currently being cultivated and the changes of rice varieties cultivated throughout the years. This information was gathered in order to calculate the rice varietal diversity amongst Agyauli's seedbank members by measuring richness as the total number of rice varieties found to be cultivated amongst farmers as well as evenness using the following equation (Jarvis et al., 2016):

$$E = 1 - \sum p^2$$

Where evenness is equal to total area cultivated by farmers minus the total sum of the squared fractions of land allocated to each variety (that is, relative to the aggregate cultivated land). This section also elicits information on which benefits farmers see in cultivating diversity, how the seedbank has influenced their integration of diversity, and what obstacles they experience in cultivating a greater diversity of varieties. Section I generated data pertaining to research question i, specifically focusing on changes in diversity.

Section II of the questionnaire focuses on the ecological impacts farmers have experienced since being involved with the CSB. It elicited information on changes in farm management with regards to pest and disease management as well as soil fertility management. To address pest and disease management, form II. A, had farmers detailed their management practices and use of inputs, as well as the understood contribution of diversity in pest and disease management so to arrive at the perceived impact farmers' involvement in the CSB has had. Similarly, for soil fertility management, farmers were asked to describe their use of inputs and their management strategies, focusing on whether or not their involvement in the CSB, has had any effect and role they have come to understand that diversity plays in soil fertility, found in form II. B. The section concluded with a visual diagram to generate diverse forms of data on farmer management and any possible use of agroecological practices due to an increase in diversity from farmer involvement in CSB. Section II generated data for research question i, specifically focusing on changes in management.

The final section, III, of the questionnaire discussed the private-livelihoods benefits farmers have experienced from their involvement with the seedbank. Form III. A gathered data on changes experienced in labour, and overall farm productivity. While form III. B focused on personal benefits at household level, specifically changes in farm revenue or home consumption, making a distinction on whether or not farmers were involved in seed production so to differentiate private-livelihoods benefits gained by those who are seed producers and those who are only CSB members. This section also concluded with a visual diagram re-addressing earlier questions and aiming to address any perceived changes and felt impacts on farmer's livelihoods. This section of the questionnaire addresses research question ii.

2.3.5 Radar diagrams

Radar diagrams are a graphical method for presenting multivariate data in a way which is easily visualised. These specific diagrams are helpful when trying to visualise stakeholder views on several independent variables (Saary, 2007). Throughout this study, the radar diagrams served as a way of concluding sections within the questionnaires, focus group discussions, and key informant interviews. This step in the methodology allowed for data collected by different methods from different participants and territories to be comparable. Additionally, it served to validate consistencies in perceptions and data as it elicited similar information but with a visual response rather than solely a verbal one. The radar diagrams cover research questions i, ii, and iii, for Kachorwa and Ghanteswor while for Agyauli they cover questions i, and ii.

The variables used in these data charts were derived from Bellon's and colleagues (2015b) framework for assessing on-farm conservation, Vernooy's and colleagues (2014) services, functions, and benefits of community seed banks and agroecological principles. A total of five variables were chosen for each section of farm management, private livelihoods, and social cohesion. Table 2, below provides a list of the variables classified under each of the dimensions used to evaluated community seed bank and a brief description of how each was communicated and defined in survey questionnaires and discussion. Sources in the table refer to literature in which the relevant 'variable' was previously defined and applied in the same context as is found herein. An example of all three radar charts can be found in Appendix 6.4 and 6.4, reference *Figure 15*, *Figure 16*, and *Figure 17*. They consist of a total of five levels, from the inner-most centre line signifying no change, to the outermost line representing the highest

level of change with no more need or room for further improvement. In the process of filling out these radar diagrams out it was made clear that any change marked, could only be in reference to the influence the community seed banks have had and not any other factor of influence.

Table 3. List of variables used in radar diagrams as described to participants

Variable	Working Definition	Source
Farm Management		
Crop Varietal Diversity	Changes that have taken place in respect to the amount of crop varieties and crop types now grown on-farm	(Shrestha et al., 2013a,b; Vernooy et al., 2014; Bellon et al., 2015a,b;)
Use of Diversity for Pest Management	Impact on pest and disease suppression due to the use of more diversity	(Altieri, 2002; Altieri et al., 2015)
Change in Resilience of Farming System	Described in translation as the farm's 'strength" and ability to sustain sudden changes in rainfall, temperature, or sudden climatic events	(Altieri, 2002; Altieri et al., 2015; Bellon et al., 2015b)
Skills and Knowledge on Management of Diversity	In reference to the knowledge gained over how to manage different crop types and varieties	(Shrestha et al., 2013d; Vernooy et al., 2014; Bellon et al., 2015a,b
Use of Diversity for Soil Fertility Management	The observed effect a greater use of diversity has had on soil fertility	(Altieri, 2002; Altieri et al., 2015)
Private-Livelihoods		
Change in Farm Revenue	Observed change in revenue from farm production	(Shrestha et al., 2013a,b,c; Vernooy et al., 2014; Bellon et al., 2015a,b)
Change in Productivity	Observed change in the total harvest, overall stability in production	(Altieri, 2002; Vernooy et al., 2014; Altieri et al., 2015; Bellon et al., 2015a,b)
Market Access	In reference to an increased ease in accessing markets and selling farm products	(Vernooy et al., 2014: Bellon et al., 2015a,b)
Product Diversification	In reverence to a greater availability of products to either sell or for home consumption	(Altieri, 2002; Altieri et al., 2015; Bellon et al., 2015a,b)
Reduced Cost of Inputs	Changes in the cost of seed, and other inputs such as machinery, labour, inorganic fertilisers, and pesticides	(Shrestha et al., 2013a; Vernooy et al., 2014; Bellon et al., 2015a, b)
Social Cohesion		
Organizational Skills and Capacity Building	Perceived competency in retaining and improving upon skills and knowledge in respect to the organization of large groups of community members but also the governance, structure, and management of the seedbank	(Shrestha et al., 2013a,b; Subedi et al., 2013a; Vernooy et al., 2014)
Knowledge Sharing	The perceived ease and frequency and common happening of knowledge exchange amongst community members	(Shrestha et al., 2013a,b; Subedi et al., 2013a; Vernooy et al., 2014)
Community Empowerment	Autonomy in decision making	(Shrestha et al., 2013a,b; Subedi et al., 2013a; Vernooy et al., 2014)
Sovereign Food Systems	Described in translation as the 'control' over their choices of what and how to cultivate food	(Vernooy et al., 2014)
Collective action	The level of collaboration and action taken together within the community	(Shrestha et al., 2013a,b; Subedi et al., 2013a; Vernooy et al., 2014)

2.4 Data processing and analysis

As there were a total of four different data collection methods using both qualitative and quantitative data, data processing and analysis was specific to each method. All data was tabulated into Excel spreadsheets so to organise responses per question and participant, details of the data's further analysis can be found below under each collection method.

2.4.1 Focus group discussions and key informant interviews

Responses from focus group discussions and key informant interviews were tabulated into Excel (Newing, 2001).. Responses were combined per community, generating one spreadsheet for Kachorwa and a separate spreadsheet for Ghanteswor. Each response given (FGD counted as one response) was organised under the different aspects of farm management, private livelihoods, and social cohesion. From this a narrative was built based on the frequency of responses in respect to specific changes (Newing, 2001).Those which were spoken of more often, are given a central focus throughout the narrative which serves to complement and explain some of what is seen in the radar charts. Of course responses mentioned only once or a few times are also included, as they too highlight important key issues and future points of attention.

2.4.3 Semi-structured questionnaires

Responses were transferred into an Excel spreadsheet, organised by respondent and question. The response per participant was then subdivided into more specific themes of farm management and private livelihoods. Responses were then coded, so to organise in tables based on the frequency of responses (Newing, 2001). Under farm management this included: rice varietal diversity (as a measure of richness and evenness), as well as the frequency in varietal rotation, and changes to pest, soil fertility management practices. Under private-livelihoods responses were divided by seed producers and those member who produce for home consumption, in order to asses each group's change in farm revenue, cost of inputs, and change in labour. Lastly, for all farmers change in production was also tabulated. All responses were self-explanatory without needing any further interpretation, with the exception of changes in farm revenues. Due to the variety of forms of responses these were re-categorised into five distinctions:

Large increase, this included verbal responses that state their revenue had increased by a large amount as well as the percentages given covering the range 50 to 100 percent

Medium increase, encompasses again verbal responses stating a medium increase as well as the percentage range of 25 to 49 percent

Small increase, covers both a verbal response stating a small increase and a percentage range of 0 to 24

Non-quantifiable increase, covers the responses of all those farmers whom stated they have experienced an increase in their farm revenue but were uncomfortable with verbal of percentage precision and

Increase in home consumption was specific to those farmers who do not sell anything produced on their farms, but have seen a change in the availability of produce for their families' consumption.

2.4.5 Radar diagrams

All of the radar diagrams filled in by participants were tabulated into Excel (assigned values from one to six from centre to exterior). These were subsequently aggregated per surveyed community. Following, for each of the criteria in the radar diagram, the standard deviation was taken. This was done for each community. From these, it was inferred that the average was an adequate representation of community level response per criteria, as the data points did not diverge by more than 1.6[4] standard deviations of the mean. The averages of each criteria were used to create the final radar chart per community.

2.5 Limitations

There are four main limitations in the methodology of this study, which are a result of its explorative nature, nuance both as a framework and study of community seedbanks as well as time constraints while conducting fieldwork.

[4] There is an exception for three data points: for the criteria of seed and food sovereignty in Kachorwa, for the criteria of soil fertility management and diversity in Ghanteswor, and for pest management and diversity in Aygauli, these discrepancies will be expanded upon in results and discussion.

Firstly, although it aims to follow a participatory action research methodology, it did not include farmers in the design of data collecting methods, for this only Bioversity International and LI-BIRD partners were consulted, along with published literature. As an example, for the purpose of this study all aspects of, farm management private-livelihoods, and social cohesion are weighed equally; while farmers' might find changes dealing with social cohesion to be of greater importance. However, it is important to note that the chosen variables of studies did not come from a theoretical understanding of the situation but are the result of published case studies with in-field experiences of projects pertaining to community seed banks and on-farm conservation strategies. The formation of this framework is also only a first-step, a trial-run, which will need reflection, further refinement, and adjustment. Its results will be shared with farmers inquiring on their opinions of the process and the importance they place on the different variables, allowing the framework to evolve in an iterative manner, and hopefully lead to action on common challenges found throughout the communities.

Secondly, there is no published or otherwise ex-ante data on the past state of each community. This means that there is no opportunity to compare the results below. Yet, this is why and how trying to understand changes through farmer's perspectives becomes crucial. It allows for community members to recall and assign a level of change or even no change to each of the variables which are inquired, according to their experience from before and after the establishment of the CSB.

Thirdly, due to the differences amongst seedbanks and farming communities, the age and experience of each seedbank, the agro-ecological zones within which farmers operate, and socio-economic conditions, the content of the data collected is not congruent across all three sites as some provided more relevant context for studying a particular impact. Yet, it should be noted that this is an aspect inherent to the individuality of seedbanks, and that one of the objectives of this study is to also evaluate different data collection methods for future assessment of seedbanks. To clarify, it was important to study the details of changes taking place at farm-level, the semi-structured questionnaires were too time consuming to carry out across all sites and even within Agyauli the questionnaires only address changes to farm management and private livelihoods, this means that there is no data on the social cohesion of Agyauli. However, as stated earlier, this allows for the comparison of the effectiveness of different data gathering methods.

Lastly, this study does not take into account social variables such as sex, age, ethnicity, or class differences when analysing the impacts of CSB. As stated earlier for this study it was more important to develop a framework under which to assess CSBs and generate a structure under which to collect data of perceived changes, time was limited to include such a wide range of variables yet, future studies should incorporate such distinctions.

3. Results

Below are the results of the focus groups discussions, key informant interviews, and questionnaires, all responses are integrated, presenting a narrative for the different impacts felt within each community. The following is organized fist by presenting the results of the focus group discussions and key informant interviews from Kachorwa and Ghanteswor. This is then followed by the results of the semi-structured questionnaires which were carried out in Agyauli. Each section includes its respective radar diagram.

3.1 Kachorwa, Bara

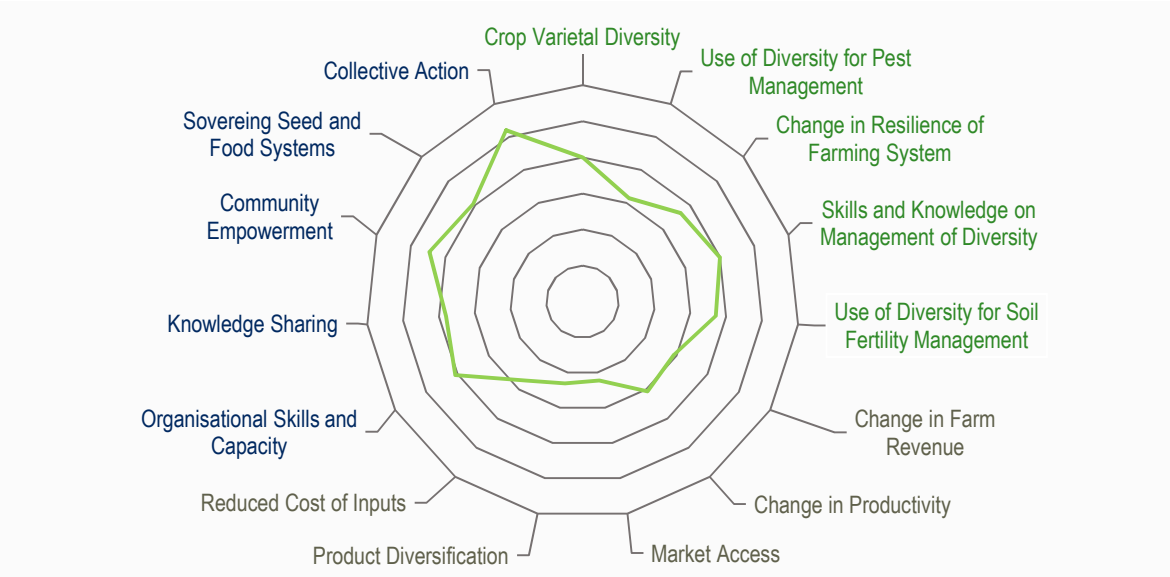

Figure 3. Kachorwa farmers' perception of change
The different criteria shown in green represent farm management, those in grey encompass changes in private-livelihoods, while the criteria shown in blue show the changes felt in social cohesion

3.1.1 Farm management

"Save the seeds, save the future": it was thought that with potential changes in rainfall and drought persistence in harder years, the existence and availability of local, drought-resistant and diverse varieties would be both crucial and effective, explained one of the ACDS founding members. Farmers said that it was important to continue sowing these varieties to ensure that they change with the climate and increase in strength and resilience over time. Thus, whereas in the past many farmers would restrict the vast majority of their production to Hardinath or Sawa Mansouli, which require relatively favourable growth conditions (higher water demand), now with the sowing of different rice varieties (up to 4 or 7 in a season) and the introduction of crop rotations, production stability was maintained. In this respect, the CSB was understood as playing an important role, by maintaining and facilitating the use of local rice varietal diversity in turn, giving farmers greater resiliency to their paddy cultivation, reference *Figure 3*. But the value placed on diversity was not only pragmatic. An ACDS member also explained that "conserving local varieties [is about] conserve[ing] heritage for future generations", further listing rice varieties of cultural importance which are now under conservation: *Krandi* used for the worshiping of ancestors, *Laldan* needed for marriage ceremonies and *Saathi dan* which is used during the *chhath puja*[5]. It was thought that the establishment of the CSB has created amongst farmers a sense of pride, and instilled a greater understanding of and interest in the unique characteristics of the different cultivars and varieties available to them. In turn, this had fomented a conceptual distinction between local and improved varieties. Likewise, fertiliser and pesticide requirements were thought to be greater for improved than for local varieties, which grew too tall with excess application, and had fewer pests to begin with. However, a farmer also stated that he hopes to be provided with the knowledge and skills to minimize the use of pesticides and chemical fertilisers.

[5]Chaath puja is a festival observed by followers of Hinduism in which the Sun is thanked and revered for the life-force it gives to this Earth

The perceptions on the use of fertilisers after the CSB changed due to training and information programs. As part of these, soil fertility was sampled to ensure more targeted management and prevent fertiliser over-application, which is now perceived by farmers as increasing soil acidity and reducing its quality. To the extent possible, its use was substituted by *dhaincha*[6] and compost manure, as well as ground *pina*[7] amendments, but this was by a few farmers. Some farmers with large khets would rotate the application of compost manure to maintain field fertility. However, many found that the labour requirements of additional cattle rearing were prohibitive to the production and application of compost manure, meaning that for these other farmers, especially those households subject to urban out-migration, the use of compost manure declined without any reduction in that of inorganic fertiliser. Although farmers, scored use of diversity for soil fertility management relatively high, reference *Figure 3*, there were not any specific discussion points brought up which provided insight or examples as to how farmers now use diversity to manage soil fertility, outside of stating that local varieties use fewer inputs.

Likewise, whereas the use of pesticides prior to the initiation of the CSB involved 3 treatments for each of the crop germination, planting, and growth stages, now some farmers sprayed only at the planting, and growth stages, a drop of a third. However, there were exceptions to this drop. If a neighbouring field was sprayed, then farmers felt obliged to do the same to prevent pest migration from the adjacent plot. Also, while they tried in particular to minimize pesticide use for local varieties (maintaining their resilience and 'strength' was seen as critical), if pests appeared on those same varieties in the diversity block they would be forced to spray, as there would be no replacing of those seeds if lost. Here again, although the use of diversity for pest and disease management was ranked high, there were no examples given of pest management strategies outside the use of inorganic pesticides, diversity here was equated with the higher resistance of local varieties.

3.1.2 Private-livelihoods

It was an observed consensus across all respondents that farm productivity had increased. For those who were sustenance farmers, having access to varieties which resist drastic fluctuations in water was linked to an increase in yield and as such greater food availability. For seed producers yield increase, attributed to quality seed, translated into an increase in farm revenue. The increase in farm revenue was a result of the CSB being a market outlet for those farmers now involved in seed production. Seed producers explained that before surplus rice would be sold at half of what they earn now selling their grain as seed.

To expand an ACDS member explained that although those involved in seed production, the larger land owners, have more resources to invest and therefore more to gain; all farmers received training on proper seed production and storage. The ACDS member estimated that around 20 percent of those farmers who cultivate seed from the CSB, now source seed from their self-saved stock. It was the availability of quality foundation seed (from the CSB) coupled with training on proper seed storage and production enables farmers, who might be more limited on resources, to maintain a quality seed stock, meaning a reduction of costs for seeds. Farmers recounted having to travel to either India or to Birgunj, the nearest city which is 50km from Kachorwa in order to access seeds prior to the CSB. A reduction in the cost of inputs was most felt with the now easy access, lower cost, and better quality seed available from the CSB, reference *Figure 3*.

3.1.3 Social cohesion

The custom of loaning and exchanging seed was decreasing, overall there was a not a strong sense of cooperation within the community. Farmers explained that they had never collected anything together, and now since the establishment of the CSB, both seeds and money are collectively saved. One farmer explained, that its "the seedbank's policy not to bring differences into [this] space, before there was a strong division between cast, men, women, religion, [and] political affiliation, but today we all ate together". This discussion lead to farmers unanimously deciding to mark high change for collective action and

[6] Dhaincha*, Sesbania bispinosa, speciose, rostrata* is a leguminous shrub native to Southeast Asia, commonly used as a green manure and source of fodder

[7] Pina, describes the by-product obtained during the process of oil extraction from pressing mustard seed for oil

organisational skills and capacity, see *Figure 3*. The CSB served as a platform through which different groups were formed, mixing together people of different wards.

From this came the Women's Sustainable Agriculture and Savings Credit Cooperative, other savings groups but also the establishment of a CBM fund. Farmers explained that by developing the habit of saving in groups, especially amongst women a sense of financial independence and empowerment was felt. As they no longer had to rely on men, they could take loans and make their own financial decisions. One of the committee members explained, that "women would cover their face and rarely come outside, ever since the savings group they have been more independent, now women speak in front of men." Members continued the discussion explaining that, women are treated more equally as they are not only included but asked for their views in meetings. Womens' groups alone increase from 2 to 9 with 380 members (Yadav, 2012). And that as a whole the CSB was trying to reach the 50 percent mark of female inclusion rate. It was also noted that the CBM fund allowed all members to access loans at lower interest rates, explaining that larger land owners would charge more than 30 percent interest rate. Explaining that now the loans provided are also given with seed, for the reproduction and conservation of rare varieties as a condition. It was a strong highlight of this discussion that community empowerment was reflected and understood in as an increased access to financial resources, which in turn enabled the community and especially women to feel more autonomous in their decision-making ability, see *Figure 3*.

Similarly, the reorganisation of the community into different savings and farmers groups has allowed for different meetings throughout the season in which farmers inevitably share knowledge. Farmers gave the example, although this is group dependant, women's savings group meet every month for administrative purposes, but farming is also spoken of. Adding that while savings are being collected from all wards, which take 10 to 11 days, information is shared regarding seed varieties and farming problems. Members of the ACDS recalled that prior to the CSB there was no knowledge or information on seed production, quality or storage, and much less was there any discussion on local varieties. Explaining that now farmers often come asking for varieties with specific qualities suitable to the heterogeneity of their khet. It is not just the CSB that is now recognised as a source of knowledge, it was also established that all who attend meetings have different knowledge and management practice to share. As a reflection, an ACDS member stated that it is important to be more active within the national seedbank network of Nepal and to conduct frequent trainings to share practices and knowledge already within the community. He explained that training workshops can be funded by the CSB and the Village Development Committee (VDC). Explaining that is from the VDC, or District Agriculture Development Office (DADO) is available, farmers themselves can provide the training. The availability of and the confidence in sourcing knowledge and information was a clear change amongst the farmers who formed part of the CSB, see *Figure 3*.

There was, however, a general concern from ACDS members about the future of their efforts. In individual interviews, different members explained concerns over human capital, seed, and food sovereignty. Some of the ACDS members felt that there were not enough human resources, which to them meant, people skilled and educated in English and proposal writing to move past some of the limitations. This was specifically in reference to needing more storage space and facilities. One member explained that although they in the past managed to get the VDC to donate land for the biodiversity block, so it would be under the ownership of the CSB and not be a yearly expense of renting land. Now they hope to do the same in order to receive the necessary funding for the construction of a storage space, it has up until this point only been a discussion and no action has been taken although it would contribute to reducing costs (as storage space is rented) and helping the organisation run more smoothly. While when reflecting on the notion of sovereignty it was explained that in regard to the freedom to choose seeds they felt no restrictions. A combination of the availability of diversity, along with its associated knowledge, and the opportunity to sell rice as seed rather than grain evoked a sentiment of control over seed production and use. However, the same was not said in respect to their control and choice over how to cultivate, the same independence was not felt as many farmers did not feel there was a management choice outside the use of inorganic fertilisers or pesticides that would yield harvest, reference *Figure 3*.

3.2 Ghanterswor, Doti

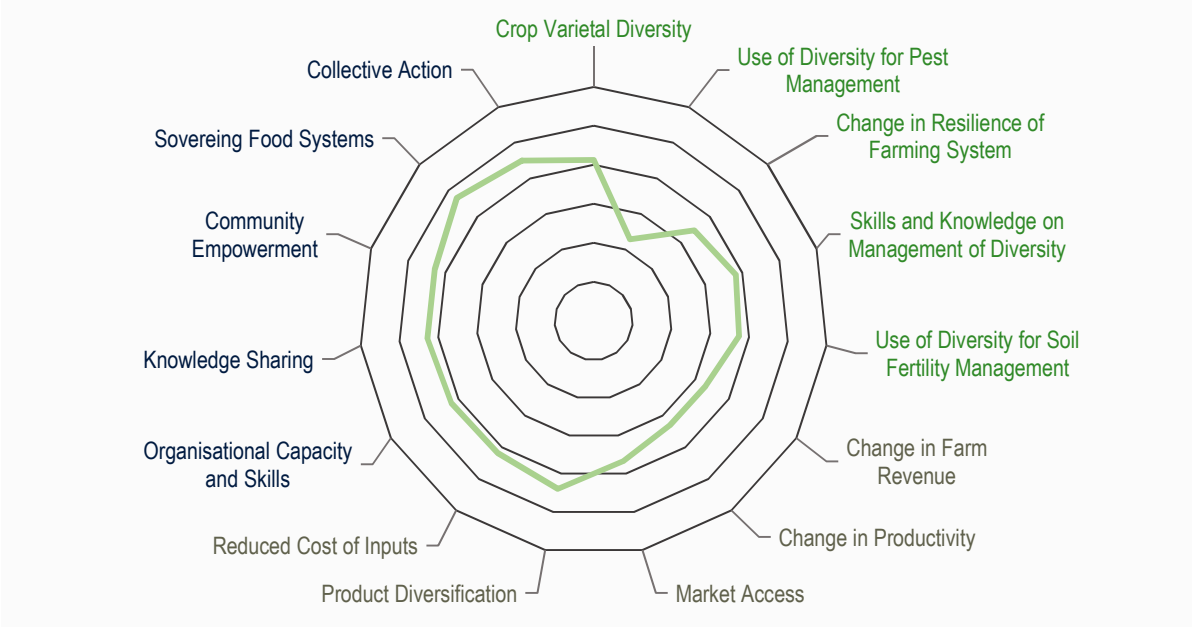

Figure 4. *Ghanteswor farmers' perception of change*
The different criteria shown in green represent farm management, those in grey encompass changes in private-livelihoods, while the criteria shown in blue show the changes felt in social cohesion

3.2.1 Farm management

The majority of farmer cultivated a few number of cereal crops for the purposes of home consumption, most commonly citing wheat, maize, millet, and barley. All farmers explained that the establishment of the CSB instigated the cultivation of other crops such as: potato, cauliflower, broccoli, radish, tomatoes, beans, peas, cucumber, pumpkin, coriander, garlic, and onion. Leaders of SPGs explained that previously there was no care for local varieties. Hybrids and improved varieties were a preference amongst farmers due to the promise of high yield. One leader of SPG highlighted the example of his group; stating that with the CSB, farmers have the opportunity to participate in the conservation of *choto* radish, earning from seed reproduction but also becoming familiar with the cultivation of new vegetables.

In turn, the availability of new cultivars and varieties created the opportunity for farmers to explore new management practices. Farmers stated that prior to the CSB they accustomed broadcasting seeds, whereas "now [they] are more concerned with spacing, line-sowing, manure, and irrigation." Additionally, all farmers, SPG leaders, and committee members interviewed stated that due to trainings on cattle-shed management and composting they have stopped using inorganic fertiliser. Some farmers additionally stated that they have chosen to stop using Urea and DAP out of concern for their family's health, and the perception that inorganic fertiliser damages long-term soil fertility. The use of inorganic fertiliser was replaced by different management practices. Farmers now use a mixture of farm yard manure and compost with other organic matter including, old livestock bedding, forest, and crop residue. Other farmers, explained that now they were practicing vermicomposting and the incorporation of legumes into their rotation "to return what the maize and radish take away." However farmers, did explain that outside the use of legumes, they were not sure what the role diversity played in soil fertility management, the lack of confidence in their relation was seen in the variation of responses was reflected in the 1.93 SD from the mean, see *Figure 4.*

Correspondingly, pest management practices ceased to be centred on the use of chemical pesticides. Respondents explained that after receiving training for the making of bio-pesticides, from the CSB, they felt the access to information and options for pest management. Farmers explained that now they first focus on identifying the pest to then decide how to treat it, i.e. picking off if caterpillar or increasing the application of bio-pesticides. Some farmers also explained that at times they felt at odds with

how to manage pests, as bio-pesticides serve to control but not eliminate pests and crops such as radish, cabbage, and cauliflower are prone to aphid infestations. However, these same farmers have observed the negative effects on their honey bees after the application of chemical pesticides. In general farmers had mixed opinions on the effect of diversity on pest management. Few farmers specifically stated that diversity lowers pest incidence but still felt that pest infestation was dependant on climate. While some farmers were not sure what effects diversity has pest infestations, they did acknowledge that certain crops such as garlic and coriander deter pests. This was reflected in farmers' low scoring of the criteria *use of diversity for pest management*, see *Figure 4*.

Despite the changes in management and the higher use of diversity, one farmer explained that "water is a big problem, there is a lack of irrigation facilities. As compared to before things are good but we should continue, [granted] not all problems can be solved at the same time but we should not become satisfied, we must always grow." Many other farmers shared this thought, stating that although they have more options with new diversity and a secure source of seeds, crops are destroyed by hail, droughts, and variability in rainfall. Although most farmers mentioned the need for irrigation, there was no mention of acquiring drought resistant varieties, the use of mulch, cover crops, or general integration of diversity for better moisture-retention, and water management, reference *Figure 19* and *Figure 18* in Appendix 6.8. The lack of full confidence in a newly found resiliency of their farming systems was also reflected, in the average score marked in *Figure 4.*

3.2.2 Private-livelihoods

Equally, farmers expressed a major difference in the access and flow of financial resources. Experienced changes in income were most often attributed to an involvement in seed production, as it was seen as being more profitable. For farmers not involved in seed production, it was explained that that cultivating a diversity of crops has yielded more income from the same amount of land. She explained that before production was mostly for home consumption "but now we plant radish and get clothes and rice for it." This was in reference to now having more options for income-generation, as only a large part of their vegetable production was now sold. Farmers explain that the CSB has not only become a market for the sale of seed but that it has encouraged farmers to organise marketing facilities and collection centres for their surplus vegetables. Yet, they also highlighted that they felt prices for their products were still too low and that due to the remoteness of their village it was not easy to access markets, see *Figure 4.*

Additionally, an increase in yield was also factor recognised by farmers as playing a role in an improvement of not only farm revenue but their general livelihoods. Farmers cited a general increase in the productivity and yield of vegetables. One farmer, in particular, stated that because of this his family is "food self-secure for 8 months, [whereas before it was] 3 months." Higher production was attributed not only to the diversity but also to an increasing interest, knowledge, and overall better management of the farm.

The highest scores were given, in reference to experienced change, were to the categories of product diversification and reduced cost of inputs, see *Figure 4.* These are a direct result of the increase in diversity, above all the inclusion of a large variety of vegetables and other non-cereal crops, to what used to be a cereal-dominated cropping system. But also to the changes in farm management which have replaced the use of inorganic and chemical inputs, with self-made and thus monetarily cost-free bio-pesticides, compost, and farm-yard manure.

3.2.3 Social cohesion

It was not a common practice to discuss problems within the community, "people were more reserved" a SPG leader recalled. It was explained that although groups within wards were always there, the interaction amongst farmers was much more informal. The SPG leader explained that farmers are more active and interested in farming and sort out problems together, "slowly a positive attitude is coming. " One farmer cited as an example, the fact that after a hail storm, people came to CSB to see what could be done. Other farmers provided the example that attending meetings and trainings had created an interest in learning, instigating farmers to discuss problems and visit one another's plots. The CSB is accredited with establishing a goal

and structure to the tasks needed to achieve it. It was stated that the CSB provides facilities, a space to come and work together. Farmers marked response for collective action can be seen in *Figure 4.*

Naturally, changes in organisational capacity and skills were felt, though more so for leaders of SPG and CSB committee members who seemed to have a more overarching perspective on the changes taking place. Committee member cited now having the skills for writing in small request funds to DADO and VDC, for acquiring material for tomato production. Yet, a BCAC committee member expressed interest in being able to find funding for purchasing the land use for the fodder and citrus tree nursery which is currently being rented. While SPG leader stated now feeling comfortable interacting and organising large numbers of farmers. Another SPG leader made the point that it is also the members of SPG that know how to better organise themselves; explaining that if the group is unsure how to go about solving an issue, they know to reach out to the CSB or other farmers, before they would not really know what the first step in problem-solving would be. Overall, all participants, that is SPG leaders, committee members, and farmers gave organisational skills and capacity a high score, reference *Figure 4.*

Similarly, it was a consensus that the CSB has become a source of information as all participants explained that before the CSB they did not have access to information or knowledge. One farmer gave the example that he was not aware of the possibility to grow other crops outside maize and wheat. To add to this another farmer, explained that now he helps others when it comes to the cultivation and seed production of potatoes, training, and knowledge given by the CSB has allowed him to become skilled and experienced in working with different crops. Farmers listed new learned practices ranging from compost and farm yard manure management, to vermicomposting, seed and vegetable production, seed storage, sowing densities, honey bee keeping, management of fodder and citrus nursery, irrigation and water harvesting. Another farmer explained that although it had been a slow learning process, she hopes it continues, she has seen that the more the farmers learn the more trainings they want. A SPG leader stated that now farmers are all interested in information, they come early to meetings and never hesitate to request more information. One committee member made the point that farmers act as teachers and spread knowledge, explaining that they now often visit each other's fields. He continued clarifying that "the committee only manages the process of storing and loaning paperwork but the farmers are involved in producing seeds, so they are the ones truly in charge, they carry the knowledge." The respondents' mark for *knowledge sharing* is reflective of the above-listed changes in access to knowledge, and the general sharing of information that now takes place, reference *Figure 4*.

There was a greater sense of confidence within the community which was attributed to the knowledge gained. As one farmer put it: "we have options to choose from we can now choose to produce seed, or choose to make compost and manage FYM, or choose to take a loan, or sell vegetables." Additionally, farmers explained that having access to the CBM fund as well as different options for income-generation makes them feel more in control of their decision-making. One SPG leader, reiterated this by stating that "people feel more in charge of decisions" providing the example that "we [the farmers from SPG group], are in the process of requesting from DADO irrigation channels and funding to set up drip irrigation." Empowerment was a result of gained knowledge and access to information, availability of varieties and the knowledge on how to manage them, along with greater information on different farm management practices which gave farmers room to choose and experiment with alternatives. The community's marked response to *community empowerment* can be seen in *Figure 4.*

Farmers understood seed and food sovereignty in relation to now having sufficient information and a choice of which crops to plant and how to cultivate them. Further explaining that "there is a major difference in the way we used to plant and the access to crops and crop varieties." The experimentation with new crops, varieties, and management practices that followed the establishment of the CSB, made farmers feel that now they can "plant according to interest," though water for some farmers is still a limiting factor for production. In general, the access to seed and knowledge on different management practices left farmers feeling like they had options and because of this were sovereign in their choices, reference *Figure 4*.

As a final note, though this was not a part of the aspects addressed by the research questions, the following relates to a gender concern which was raised by one of the female farmer who was individually interviewed. She observed female

membership, interest, and engagement to be relatively low. For her, this was potentially alarming, as she hoped to be able to motivate female participants. Her concerns were reflected in the fact that all SPG leaders that were interviewed were male, as there were no SPG leaders who were females. Within the CSB committee, only two of the members who participated in the focus group discussion were female.

3.3 Agyauli, Nawalparasi

3.3.1 Farm management

Unanimously farmers stated that the access and availability to a diversity of seeds has been a motivating factor in experimentation with different crops and specifically rice varieties. Amongst the 29 interviewed farmers, there was a total of 17 different rice varieties under cultivation (i.e. species richness) composed of both local and improved varieties. By contrast, the measure of species evenness was equal to 0.618, mainly due to the fact that out of the 17.721 ha of aggregated cultivated land, 10.655 ha were planted with a single variety, *Sabitri*. This variety is popular within the *terai* region as it is a high-yielding, regardless of it also being drought-susceptible (Yadaw et al., 2013). No other rice varieties came close to taking up so many hectares as can be seen in *Figure 5*, where all other varieties take up areas less than 1.5 ha. Even so, the majority of varieties are cultivated by at least two farmers, with local varieties such as *Anadi* and *Jhinuwa* by 17 and 6 different farmers, respectively. Farmers specifically pointed out that prior to the seedbank it was difficult to access local and diverse seeds, as outlets for seeds were either self-saved seed, neighbours, or the nearest agrovet in urban centres. Yet, now the seedbank's proximity allows for the easy access to a diversity of quality seed and knowledge on how to manage such varieties, encouraging the cultivation an average of 3 varieties within a season.

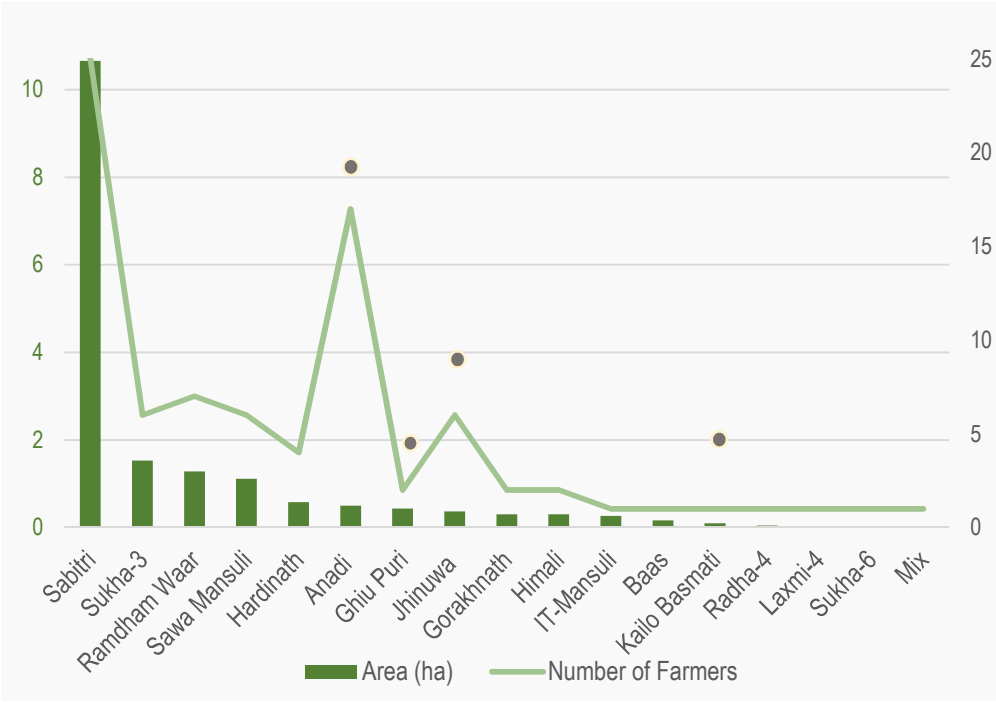

Figure 5. Rice varieties under cultivation

The left axis corresponds to the hectares which each variety occupies, marked by the green bars, while the right axis corresponds to the number of farmers which cultivate each variety, it is denoted in the graph by the grey line. Local varieties are signaled by the dots placed within the chart

Furthermore, the availability and accessibility of diverse seeds allowed farmers to change the varieties they cultivate across time. As seen below in table 4, 52 percent of farmers, change the rice varieties they cultivate every 2 to 3 years, as the seedbank allows access to and maintenance of seed diversity, farmers are not constrained to re-sowing varieties solely form their self-saved seed stock, neighbours or agrovet. Even so, 35 percent of farmers, do cultivate the same rice varieties every year without rotating their location within the field. Although most stated that they were discouraged by the size of their landholding it is important to note that there was no difference in the average or median size of the landholding, between farmers who do alternate the rice varieties they cultivate and those who do not. Inclusively, farmers with the smallest

landholdings out of all the participants of 0.2 and 0.25 ha, cultivated only 1 or 2 varieties each season but would change varieties yearly. Uniformly, farmers stated that what keeps them from cultivating more than their current number of varieties within a season, is the probability of mixing during threshing and storage, some additionally mentioned they would lack storage space and containers. Furthermore, some farmers found it too time-consuming as different varieties would require different plot preparations and management, one of the last reasons cited was the lack of hectares.

Table 4. Farmers' rotation of rice varieties in Agyauli

Farmers	Change of Rice Varieties	Reasoning
15	Change in rice varietal selection ranged from every 1 to 4 years; the most common response being every 2 to 3 years	Value consumption qualities, cultural significance, and commercial opportunities in local market Value managing risk and experimenting with different varieties
10	No change in rice varieties or rotation within field	Value consumption qualities and above all the high yield of Sabitri Limited and discouraged by labour availability and size of landholding
3	No change in rice varieties but yearly rotates location	Value consumption qualities, cultural significance, have a preference for varietal traits
1	Rice varieties cultivated dependant on demand of seedbank	

The CSB seems to have little to no impact on farm management with respect to farm design for utilising and integrating diversity in the optimisation of land utility, pest, disease, and soil fertility. For example, only 38 percent of farmers practice intercropping of mustard with lentils, wheat with peas, radish with peas, or pumpkin and gourd with maize. Only one farmer practiced relay cropping, planting lentils and mustard shortly before the rice was to be harvested. All of these farmers stated that this is elder's advice, a traditional practice which in their experience allows for better productivity and use of the land. In contrast, farmers who did not practice intercropping, stated it would be too troublesome to harvest and manage a field with mixed crops.

In respect to the management of pest and disease the CSB, or LI-BIRD, was cited as a source of information amongst 45 percent of farmers, who either attended a training for bio-pesticide production and usage or received knowledge from a neighbour who personally attended. A total of 52 percent of farmers currently uses chemical pesticides, stating that they do not have another option if they wish to avoid infestation and yield-loss. This includes 17 percent farmers whom use both bio-pesticide for vegetables and chemical pesticides for rice. Out of the farmers who use chemical pesticides, 20 percent stated that they felt a need to use chemical pesticides, when neighbouring fields were sprayed in order to prevent the transferring of pests into their field. A separate 20 percent stated that they started using chemical pesticides 7 to 10 years ago as they either began seeing an increase in pests or switched from cultivating a local variety to an improved variety. Furthermore, when inquiring about diversity and its role in managing pests and diseases, only 10 percent of farmers gave the example of local rice varieties being more resistant, while 35 percent could not cite any other practices outside the use of pesticides. Some farmers specifically stated that they have not observed diversity to play a role in controlling pests, rather they find climatic factors, specifically warmer monsoon seasons coupled with drought, to play a role in the level of infestations. Farmers' range knowledge and practices, on the subject, is also reflected within the within the variance in responses for the criteria of *diversity for pest management* (*Figure 6)* as it had the highest variability, with 1.12 SD from the mean.

Interestingly enough, those who cited having pest problems and found chemical pesticides a crucial component to their farm tended to cultivate only 1 or 2 varieties, or plant 2 seasons of rice. A diagram depicts the use of chemical pesticides, in relation to number of rice seasons farmers grew in a year and the frequency of change in rice varieties, found in Appendix 6.9, *Figure 20*. The number of seasons of rice planted appears to be a strong determinant for pest infestation and pesticide use.

It's important to note that although 48 percent, of the farmers interviewed (14), did not use pesticides it was only 14 percent (4 farmers) who made the conscious decision to stop after a long history of usage. All of these farmers were women, who took

part in a three month-long integrated pest management training and after receiving information decided to stop out of concern for their families' and soil health. The remaining 35 percent of farmers (10) claimed to have little to no problem with pests or to have used pesticides only once some years back. In general, it's not surprising that over half of the farmers cited having problems with pest and diseases; at a landscape-level, there is no species diversity, see *Figure 21*, *Figure 22*, *Figure 24*, *Figure 23* in Appendix 6.10.

By contrast, no farmer claimed to receive information from CSB for soil fertility management. Although some farmers reported attending a compost and farm yard manure management training given through the seed bank it was repeatedly stated that they either had no access to information or consulted with the Junior Technical Assistant (JTA) or agrovet. The use of inorganic fertiliser was universal amongst farmers and regarded as one of the only ways to maintain soil fertility. The quantity and frequency of application varied greatly amongst farmers; with the range of 9 to 210 kg/ ha of 2:1 mixture of Urea and DAP (reference Appendix 6.11) and with some farmers doing 2 to 3 consecutive applications prior to rice transplantation. Most farmers stated that they did not believe their field would yield a harvest without the use of inorganic fertiliser, further explaining that they had no other option or choice. Amongst most farmers, few could cite different soil fertility management options. Only 13 percent, a total of 4 farmers, stated that they knew inorganic fertilisers negatively affect long-term soil fertility, but due to a lack of compost and farm yard manure, felt they had no other choice. These same farmers incorporated additional practices to maintain soil fertility, which included: buying chicken manure, collecting and incorporating leaf litter, leaving crop residues on field, incorporating *pina,* and growing *dhaincha* prior to rice planting. One farmer, being a committee member, felt it is her duty to take risks and provide examples for other farmers, she has been experimenting by reducing her use of inorganic fertiliser, from original 50kg to now 20 kg by replacing it with the use of *dhaincha* and monitoring rice yield.

Although most farmers cited that they felt they had gained more knowledge on how to use and manage different varieties, only few could claim they thought diversity played a role in pest or soil fertility management. Knowledge on different types of varieties was apparent and can be seen in the average score given be farmers in the radar diagram, shown in *Figure 6* below. Farmers unanimously stated that the, as the CSB provides easy access to a diversity of seed and knowledge on its cultivation, they feel more confident and skilful in the management of diversity. Providing the example that through the seedbank they have access to vegetables seed and training on cultivation. However, farmers often made the point that they felt there was still much more to learn, which might explain why integrating crop diversity for pest and soil fertility management, is not a common strategy and both received a low average score.

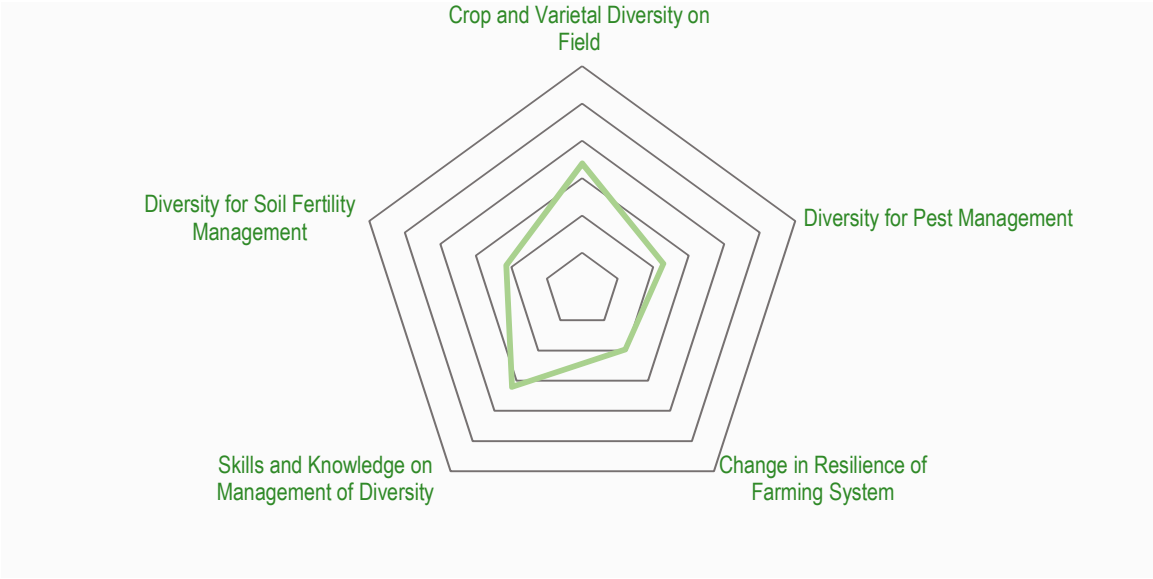

Figure 6. *Aygauli Farmers Perception on Changes in Farm Management*
Radar diagram depicting farmers' perceive effect of the community seed bank on their farming systems

Lastly on perceived resilience, farmers noted that productivity of their farms is completely dependent on climate and rainfall, and as such did not feel that the presence of the seedbank did much to contribute. Farmers, however, do acknowledge that having guaranteed access to quality seed of rice varieties which withstand fluctuations in rainfall contributes to resiliency. Yet rightfully so, stated that this was not enough to guarantee good production in years of unfavourable or erratic climate. The CSB has not influenced overall farm structure, it has led to a greater use of rice varietal diversity but not to an inclusion of diversity for the better management, function, and resilience of the farming systems.

3.3.2 Private-Livelihoods

In terms of farmers being able to secure basic necessities either from a financial gain from or simply a production of food, the CSB has facilitated private economic growth. Farmers who participate in seed production, 62 percent of those interviewed, reported an increase in farm revenue. Even those farmers who produce solely for home consumption, 38 percent of those interviewed, stated either an increase in their food availability and/or the opportunity to now sell the surplus on the market. The responses for each can be seen in *Figure 7*. For farmers involved in seed production, the increase in farm revenue came from the opportunity to sell rice as seed rather than grain, at a higher price but also more generally due to an increase in productivity. For those farmers whose production is for home consumption, the experienced increases in food availability and the new opportunity to sell on the market come from an increase in production.

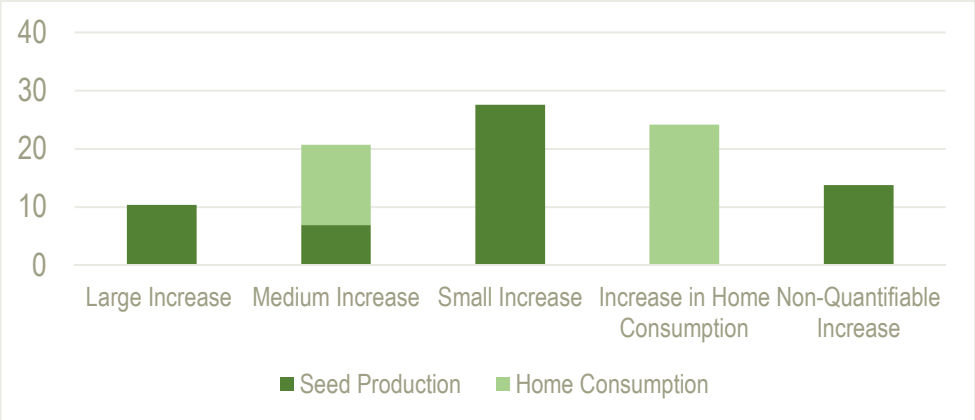

Figure 7. *Perceived change in farm revenue*
Responses are shown in percentage

The great majority of farmers, 90 percent, experienced an increase in productivity. Farmers attributed this to better quality seed and better management, but also noted that harvest was climate-dependant. In fact those farmers, 10 percent, who found productivity to be similar or decrease explained that it was due to unfavourable climate and pest. The more detailed breakdown of these results can be found in table 5, note not all farmers provided a reasoning for their response. It's important to highlight that of those farmers who experienced an increase in productivity 73 percent attributed it to better quality seed. Of these farmers, 24 percent also attribute the increase in productivity to better management.

Table 5 Farmers' percieved changes in productivity and respective reasoning

Change in Production	Number of Farmers [Percent]	Reasoning	Number of Farmers [Percent]
Increase in Production	22 [75.86]	Seed Quality, Better Management, Irrigation	6 [20.69]
		Seed Quality	10 [34.48]
Increase in Production and Stability	4 [13.79]	Seed Quality, Better Management, Climate	1 [3.45]
		Seed Quality	2 [6.90]
		Harvest is dependent on climate, but stability is greater due to use of diversity	1 [3.45]
Similar Productivity	2 [6.90]	Dependent on climate and pest	2 [6.90]
Decrease in Production	1 [3.45]	Climate; variety did not perform well	1 [3.45]

A change in some farm management practices is also reflected in farmers' expressed change in labour. While 55 percent of farmers stated the experienced no change, 41 percent of farmers stated that there was a small difference in the labour invested into the farm. The small difference was attributed to a slight change management which differed amongst seed producing farmers, and farmers producing for home consumption, as can be seen in *Figure 8*. Farmers involved in seed production explained that in order to maintain good seed quality they had to integrate irrigation, practice weeding, line sowing with proper spacing, along with an overall more attentive management. While farmers cultivating for home consumption experienced a change in labour as they were adjusting management to new varieties, mostly in regards to the cultivation of new and different vegetables. Only one farmer stated a reduction in labour, due to the use and access to machinery, in reference to threshing.

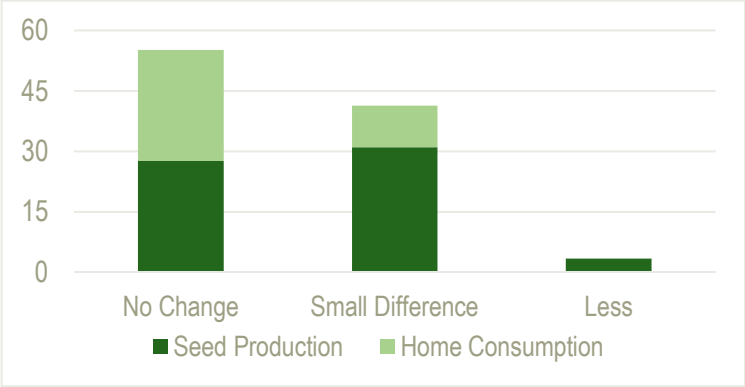

Figure 8. *Perceived changes in labor invested*
Responses are shown in percentage

In respect to the CSB effect on cost of inputs, farmers most often mentioned *lower seed cost* as a change to their investments in production, as seen in *Figure 9*. The lower cost of seed made up 59 percent of the responses and was attributed to about a 5 NPR difference per kilogram of seed between the price paid at the agrovet and the price paid at the CSB. Farmers also explained that the proximity of the CSB saved them from the hassle and cost of traveling to acquire seed. A total of 10 percent of farmers, who produce seed, stated that in general, they have had to invest more in the farm, only one farmer (an extra 3 percent) stated investing more on inorganic fertiliser. And although there were also a total of 14 percent of farmers who claimed to have lower costs of inorganic fertilisers and pesticides, these were some of the earlier talked about respondent who had made efforts to cut down on the fertilisers and/or discontinue their use of pesticides. Still, there was a total of 23 percent of farmers who felt they had seen no change in the cost of their investments for farm inputs, which is also reflected in the low average score marked by farmers on the radar diagram, see *Figure 10*. In general farmers explained that the CSB only made a significant difference in the direct cost of seed.

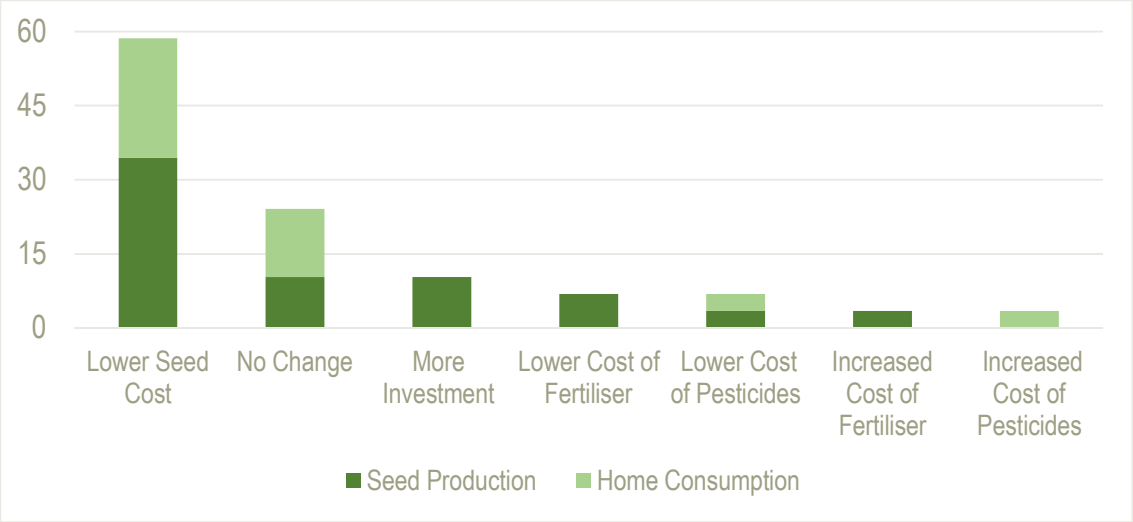

Figure 9. Perceived changes in costs of inputs
Responses are shown in percentage

The radar diagram below addresses, *Figure 10,* three of the above-presented criteria in addition to *market access* and *product diversification.* This chart helps to highlight the different changes experienced by those farmers who produce seed and those who produce for home consumption. Seed producers, experienced a greater livelihood impact in relation to an increase in

farm revenue, an increase in productivity a better access to the market, a diversification of products sold, and to some smaller degree a reduction in the costs of inputs. While sustenance farmers experienced some change in farm revenue, a greater impact of overall productivity, a small change in their market accessibility, product diversification, and overall cost of inputs. For seed producers, the CSB has now become a guaranteed market facilitating the sale of rice as seed. This same group of farmers also marked higher in product diversification explaining that they now grow different or more rice varieties than they had prior to the CSB. It should be highlighted that both seed producers and sustenance farmers marked a relatively equal a high positive score for change in productivity. Naturally so, farmers who produce for home consumption would not have racked access to market very highly, there is a slight changed which was marked by those, who now had a surplus to sell on the market. And although sustenance farmers stated, that they have begun cultivating a greater variety of vegetables since the CSB, it did not encourage them to mark a high average score for the diversity of products now available for home consumption. Of these farmers, 72 percent cultivate the same rice varieties every year, so in this respect, there has not been a large change in the diversification of their staple food crop.

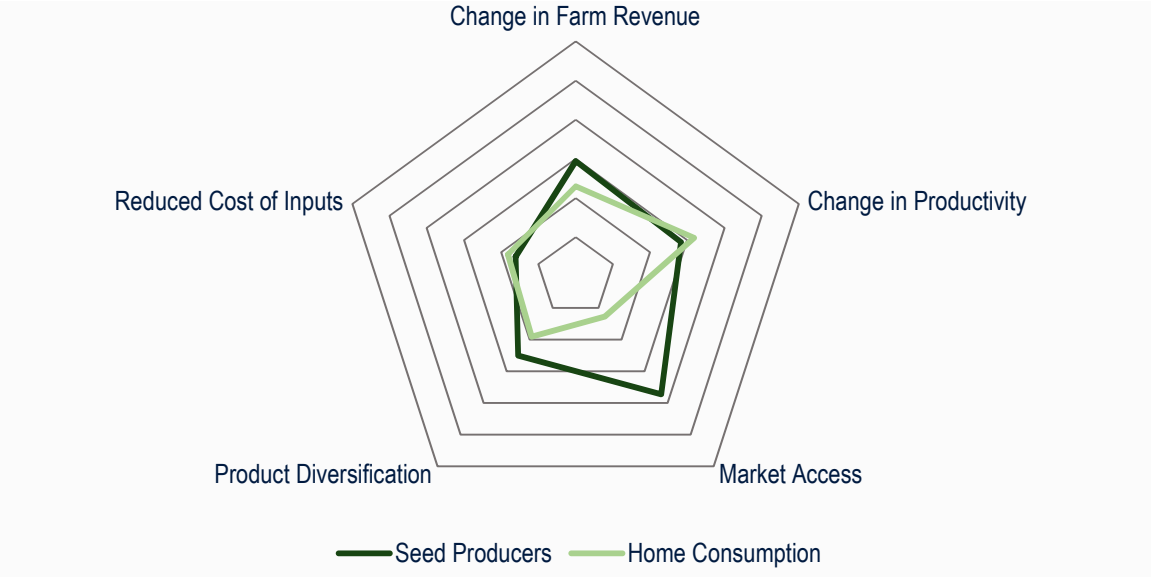

Figure 10. *Aygauli farmers perception of changes in private-livelihoods*
Radar diagram showing farmers' collective opinion on the personal livelihood changes which have taken place since the establishment of the CSB.

4. Discussion: suggestions and conclusion

4.1 Discussion

The discussion is organised as follows: First, the results for each study sites are compared to explore differences, according to the criteria of farm management, private-livelihoods, and social cohesion in relation to the CSB's history, the socio-economic context of each community. The discussed changes are related to broader literature, in relation to the potential of community seed banks as local institutions which catalyse natural resource management, and socio economic change. This is followed by a series of suggestions to address participants involved, with one section of suggestions addressing the challenges found relevant to farming communities and the other addressing LI-BIRD and Bioversity International partners to cover future approaches to establishing, researching and evaluating CSB. This section is ended with an overarching conclusion of the study.

4.1.1 The meaning and synergies of the agroecological lens

It should be stressed that the results and formulation of the following discussion are a reflection of the framework assessment used. As the CBM methodology, and CSBs inherently, are concerned with conserving plant genetic resources (Subedi et al., 2013a; Shrestha, et al., 2013b; Vernooy et al., 2014), it is reasonable to expect that projects undertaken with its perspective would increase intra-specific diversity within target communities, as shown by farmers' perception of change in *Figure 3, Figure 4,* and *Figure 6*. However, as is also discussed, there is little focus in CBM and CSBs on integrating diversity for the better functioning of farming systems in their self-regulation of pest and soil fertility. Nor is there a focus on landscape-level diversity or the integration of permanent natural elements around fields. It is in this respect that integrating agroecology as an additional, nested component of the assessment framework has proven useful, since it is this perspective highlighted gaps in the integration of diversity beyond the intra-specific, towards the inter-specific (Altieri et al., 2015; Wezel et al., 2016).

Conversely, CBM provides an extremely effective practical foundation upon which agroecological theory can be realised. By prioritising private livelihood benefits and community-based organisations, the resulting empowerment and self-determination achieved paves the way for the conservation of plant genetic resources, albeit as a secondary consequence (Subedi et al., 2013a; Shrestha, et al., 2013b). The focus of CSB is after all on conserving genetic variation of local crop varieties through livelihood integration and the building of social capital (Shrestha et al., 2013b; Sthapith et al., 2015), both of which were achieved to a significant degree since CSB establishment, in the results found here. While these are aspects of agrarian life which agroecology accounts for within its theoretical framework, these remain as such, with little if any practical means of achieving them in the field or community.

It is through this lens that this discussion is framed.

4.1.2 Farm management

Although it is clear that there has been an increase in the availability, access and in turn use of varietal and crop diversity, this does not translate into aggregate changes in cropping system and plant diversity from field to farming system level. In this regard, for example, whereas in all 3 sites farmers unanimously reported an increase in crop varietal diversity, none reported an increase in within-field diversity –that is to say, that for a given field, a single crop was maintained (i.e. monoculture), even if across 5 fields, different crops were sown. Furthermore, while an increase in varieties sown was reported, this again didn't necessarily translate into variety when aggregated to acreage. Thus in Agyauli, while 17 rice varieties were sown, the vast majority of the land area remained devoted to a single variety – Sabitri (see Fig. 5). On the other hand, the access to multiple varieties allows for the long-term alternation of planted rice varieties (temporal diversity). Similar dynamics are presently evident amongst those surveyed in both Ghanteswor and Kachorwa. In this way, it appears that having greater access to, and knowledge of, nominal crop diversity (total number of planted varieties) does not guarantee the integration of different crop types and species at the field scale, for the self-regulating functioning of the farming system.

However, the nature and direction-of-change of practices resulting from these interventions is highly oscillatory. On the one hand, at all sites, the potential for the CSB to effect changes in management at the farming system scale was clearly realised in the transition from broadcasting seed to adequate-density and in-line sowing, following its influence. In Ghanteswor in particular farmers halted the use of inorganic pesticides and fertilisers as a result of CSB initiative (and potentially distance from input markets). The introduction of these practices was seen to be important contributing factors to increases in farm productivity. On the other hand, there appeared to have been a disconnect between seed-related management practices and those practices that would address community-specific management issues or agrobiodiversity. Thus, for example, in Ghanteswor in-line seed sowing was introduced without the complementary introduction of water-saving techniques (e.g. mulching) in a drought-prone region, reference *Figure 19* and *Figure 18*. Similarly, while all respondents gave relatively high scores for their increases in *skills and knowledge on management of diversity*, in reality, this was limited to varietal traits and the introduction of new vegetable crops. Perhaps this could be expected, given that this information allowed farmers to introduce new crop varieties to their fields. However, little knowledge seemed to have been transmitted which would allow them to adequately maximise between-crop synergies and subsequent land-use ratios. For the survey categories *use of diversity for pest management* and *use of diversity for soil fertility management*, respondents' knowledge of the linkages between these concepts and that of plant diversity was limited to examples of specific varieties with high pest resistance and/or low fertiliser requirements, and the intercropping of few pest-deterrent plants, without a more general training in the broader concepts and benefits of in-field functional diversity.

Thus the potential benefits of on-farm diversity could be improved, as is perhaps reflected in relatively mute farmers' perception of changes in resilience owing to greater crop diversity. Indeed, the resilience criterion may have been somewhat inflated, given that respondents' reasoning for perceived increases in resilience referred specifically to access to rice varieties that were less sensitive to hydrological extremes, whereas they expressed little confidence in the resilience of the farming system as a whole. For this reason, farmers often responded that they were conflicted in terms of how to actually respond, given the divergence between these two forms of resilience.

Nonetheless the introduction of the CSB kickstarts the transition towards sustainable agri-food systems by simultaneously targeting both the system and the socio-economic relations that are otherwise often considered external to them. Doing so gives rise to what has been dubbed 'agroecological territories', that is, zones in which processes of full-spectrum transition are underway, specifically through the following dynamics (Wezel et al., 2016):

(i) The adaptation of existing farming practices, an openness to change farming systems for the range of present and foreseeable future pressures (Wezel et al., 2016).
(ii) Promotion of agrobiodiversity, and conservation of local crop varieties on-farm (Wezel et al., 2016). In addition the surrounding natural habitat is included within the "territory", with the objective of establishing ecological corridors and habitat for species within agricultural landscapes (management of green and blue networks, i.e. hedge rows, creeks) (Wezel et al., 2016).
(iii) The building of socio-technical networks which connect people within the territory to their surrounding natural resources, creating opportunities to restructure social and economic values and relations around food (Wezel et al., 2016).

On the basis of the preceding, it seems clear that community seed banks, at least as pertains to those examples looked into here (and more broadly, those that fall under the CBM), fulfill in nascent form all of these criteria, and as such are part of "agroecological territories".

4.1.3 Private livelihoods

In general, the CSB was seen as having provided benefits to private livelihoods, as indicated by the surveyed categories. While this is true of all indicators, responses varied most between sites according to biogeography (terai vs. hillslopes), in the input cost, market access, and product diversification categories. Although all communities

reported a decrease in input costs resulting from decreased cost of seed inputs, in Ghanteswor, in particular,, the reported cost reduction was markedly higher, owing to the fact that the community at large had fully foregone consumption of all purchased fertilisers and pesticides, replacing them instead with home-production of organic substitutes. By contrast, at the other two sites purchased input use had not declined appreciably.

Although all three sites are cereal-based cropping communities, in Ghanteswor the vast majority of production was previously limited to maize, wheat, and barley. Thus, the introduction of and significant land area newly devoted to vegetable crops substantially increased the sense of product diversification there as compared to the other two sites. Farmers in Kachorwa and Agyauli felt that while they were producing more varieties of rice, this was limited to rice, without noticeable changes in the number of other crop types. Changes in perceived market access largely mirrored that of product diversification: Ghanteswor farmers now had a wider diversity of products to sell on the market, particularly with their surplus of vegetables, those in the other two sites generally only perceived greater market access and increase in farm revenue if they had begun participation in seed sales to the CSB.

In this respect, the seedbanks studied here are shown to create private incentives for farmers for the continued maintenance of crop diversity which, according to Bellon et al (2015), can be considered a successful strategy for on-farm conservation. Likewise, the three CSBs adhere to CBM's livelihood-based agrobiodiversity management (Subedi et al., 2013a) as well as the CSB functions, services and 'benefits' referred to in Vernooy et al., 2014. Further, these CSBs have the potential go above and beyond the practical outcomes originally envisioned within the CBM and CSB frameworks, to challenge existing capital –dominated production and allocation dynamics.
CSBs allow for small-scale joint production and surplus creation, devolving decision-making power away from the centre to the local level, and to some extent buffering their members from the unfavourable exchange relations of global markets (van der Ploeg, 2013). CSBs arguably establish what Gibson-Graham and Roelvink (2011) refer to as 'community economies', a form of exchange in which a commons are produced and sustained through social interdependence. Likewise, CSBs allow for an alternative framing of what constitutes an 'economy', by establishing an enterprise that is largely independent from global commodity markets, and whose ultimate goals go beyond the private accumulation of surplus (Gibson-Graham and Roelvink, 2011). CSBs thus take rural societies a step closer to heterogeneous economic landscapes, expanding the relative diversity and autonomy of the exchanges that occur within them.

4.1.4 Social cohesion

Community level perceptions of changes of sovereignty in terms of seed and food production systems arising from CSB intervention were positive in both Ghanteswor and Kachorwa, but higher in the former, owing to the independent production of all farm inputs there. For perceived changes in community level collective action, Kahorwa respondents scored higher, stating that the CSB had helped to bridge divides of religion, social status, political affiliation, and gender, generating a greater overall sense of cohesiveness and inclusion in the community. While in Ghateswor it was felt that collective action increased within seed-producing groups, little mention was made of similar forms of inclusiveness arising. Indeed, one female respondent raised concerns regarding the future inclusion of women to CSB activities there. While *organisational skills and capacity* were gained, both communities expressed the desire to gain skills in proposal writing for access to grant funding in the future, a concern also reported by Chaudhary et al (2016). Given that this at present is done in English, there may be a role for government to play in providing this capability.

The existence of different farmer groups and the use of the CSB as their nucleus and social focal point allowed for the sharing of knowledge and skills between farmers both within and between wards in a village. Indeed, prior to the CSB, the practice of knowledge sharing and discussion of practices between farmers at ward or community level was highly uncommon or non-existent, highlighting the importance of the seedbank in generating a space for knowledge dissemination and learning. The sense of community empowerment between the two sites differed because loan access in Kachorwa and the existence of savings groups gave them a sense of decision-making capacity, while in Ganteswor this came from the perceived array of options which opened up due to increased access to knowledge and information.

Clearly, the different 'functions' of the CSB have led to closer-knit communities, which as was the case in Karchorwa, may even serve to challenge reigning socio-cultural power relations (i.e. gender, cast, political differences). This should be seen in the context of the country's recent political history. Nepal's peasant-based revolution (the Maoist Peoples' movement), coupled with the present-day deadlock of governance at the federal level have placed budgets for community development under the management of district and village-level Development Committees (DDCs, VDCs) (Rankin et al., 2016). According to Rankin (2016), Nepal's governmental fragmentation has resulted in political decentralisation via the increased involvement of actors in local governance. These new political and socio-cultural arrangements create spaces at the local-level for new modes of public-sphere politics, with the potential to unseat existing hegemonies (Rankin et al., 2016). Likewise, and particularly in Kachorwa (perhaps because of its age relative to other CSBs studied here), CSBs provide the practical and institutional space to take up the reins of local political decision-making as well as bridging culturally-entrenched divides within the community.

4.2 Suggestions

The suggestions that follow are grouped firstly for communities in aggregate, so as to address problems and concerns expressed at each one, and secondly at the institutional level, particularly aimed at reviewing the methods used, thereby providing possible evaluation benchmarks for future CSBs.

4.2.1 Kachorwa, Ghanteswor, and Agyauli

- Active communication within national CSB network, could be key in solving challenges and continuing an exchange of knowledge and experience
  - ACDS in Kachorwa has experience on funding application (for biodiversity block), which could help BCAC of Ghanteswor in also becoming owners of the land currently rented for the tree nursery as well as for the BCAC of Agyauli for the biodiversity block
  - While the experiences of farmers in Ghanteswor can provide useful insight and testaments to cultivating without the use of external inputs
  - Ghanteswor and Agyauli can both exchange knowledge and experience with the use of bio-pesticides with Kachorwa
- To address farmers expressed desire to continuing their learning process a form of collective experimentation (cf. Misiko, 2009), self-made farmer field schools (cf. Davis et al., 2012; Sanglestsawai et al., 2015), could facilitate interactive knowledge generation, experimental learning and agroecosystem analysis for improvement of farm practices. As noted in Kachorwa, training can be carried out using farmers' own knowledge evenmore so, given it was found in Agyauli that farmers are experimenting it is important for the CSB to support these efforts to continue the sharing of practices. It is a suggestion/extension of something already taking place.
  Experiments to consider:
  - Alternative management for soil fertility incorporating the use of dhaincha and/or other green manures. Although there is not much recent literature on the use on Sesbania previous trials showed a positive results (c.f Weerakoon et al., 1992; Sharma et al., 1995), more recent literature uses different plants as green manures, but likewise shows successful incorporation of different nitrogen sources (cf. Lee et al. 2010; Xie et al., 2016) and even increase in beneficial soil fauna (cf. Zhang et al., 2017)
  - Greater water use efficiency (specific to Ghanteswor), continue exploring methods for water harvesting and irrigation accompanied by in-field strategies for soil moisture retention such as soil mulching (cf. Qin et al, 2015 ridge-furrow mulching (cf. Zhao et al., 2014), and the use of cover crops (cf. Kaye & Quemada, 2017).
  - Collective experimentation can include several farmers, enabling experimentation with several 'trials' and a 'control' by pooling together their land resources. However, the question arises as to which members should partake in these experiments.
    Should seed producers, who have more resources and receive greater private-benefits from their involvement in seed production be responsible for trying out different management practices for the improvement of seeds? Indeed, the genotypic and phenotypic strength of seeds is in the hands of the farmers who sow them –should they determine whether future generations depend on fertiliser for crop

production, or should all generations have access to all plausible options in their agricultural strategies, as the Agyauli ADCFC committee member previously discussed is attempting to do?
Or can this be an opportunity for sharing risk across the community and allow for farmers without the necessary capital for seed production to increase their involvement in the CSB? The intensive management of small landholdings facilitates small-scale experimentation, thus most benefitting those of least means with the synergy of low-input farming systems (Altieri, 2002; Altieri et al., 2015)

4.2.2 Bioversity International and LI-BIRD

- Although the framework used in this study appears to be effective both practically and conceptually it requires further testing and application.
  - In order to move forward the framework, data collection methods, and results must be discussed with farming communities; only in reflecting on this research process with the communities will it be possible to arrive at a better fitting set of questions, scope (i.e. more in-depth questions, subjects which were not so relevant), and methods.
  - This entails carrying further trials of the framework both within Nepal but also other CSBs. So to allow for the testing of the framework's practically and applicability in different contexts
  - Both conceptually and practically, the framework does account for a manner in which to share results with each community and facilitate self-reflecting and critical thinking within each community. This framework and studies carried out in its manner, should facilitate community dialogue around the establishment of each seedbank, its present functioning, and future aspirations for what each community envisions. This is an aspect of the framework which needs further development and must be done with community participation.
- Although semi-structures questionnaires (SSQ) were the most time-consuming and one-way/least interactive/extractive method, they're useful in providing detailed information for changes in say income or temporal diversity as shown in the results for Agyauli.
  - The larger sample size of the SSQ could also yield more representative results as seen in Agyauli scoring some of the lowest markings (radar chart) it could be precisely because it is in fact more representative.
- The openness of the questions used in FGD and key informants interviews were more engaging, and allowed participants to engage in a more thoughtful/reflective manner.
  - Filling radar charts collectively during FGD on the one hand allowed that participants to discuss what each criteria meant in relation to the changes they have seen, giving room for reflexion, Yet, a better approach might be to do the same process but provide each participant with his/her own sheet, so that their individual opinion is not influence by other members seeing what is marked
- Even though participants' completion of the radar diagrams was carried out consistently, and their opinions were reflected in their responses to SSQ, FGD, and key informant interviews, it is impossible to very if and whether these rankings reflected the level of change stated in the same way –indeed, this is not likely. An approach that could prove useful to try out in following studies is to have the participants collectively define the scale of the radar charts. This would ensure that in there is a communal understanding on what each level of change represents. This could also facilitate a 'future vision' dialogue as to what the most idyllic state and functioning of each seedbank would entail, while providing a standardisation of each radar diagram.
- For future evaluations of CSB both approaches to data collection seem applicable and were complementary as they allow for an understanding of dynamics at the broader community level but also the specifics changes at the farm/household-level.
- Although integrating diversity at farm and landscape level is outside the scope of CBM methodology and CSB functions it should be consider in future and current efforts
- Likewise, the importance of farm management within these efforts should not be side-lined. Seeds, and plant genetic resources in general, are the result of both environmental factors and human management of the land and its biology. Farm management dictates the future capacity for subsequent generations to react to and withstand biotic and abiotic pressures, and as such, is a critical aspect of diversity-based resilience (cf. Lammerts van Beuren & Myers, 2011).
- Additionally, integrating methods for self-evaluation and/or yearly reflection within future CSB establishments, could prove to be helpful in continuing the development and progress of communities with seedbanks.

4.3 Conclusion

Although they have existed on the rural development stage for the last 30 years, to our knowledge no studies have been conducted to assess the impact of community seed banks with respect to either their own goals, or the wider human and biological community. This study represents a first, tentative step at addressing this gap, by both gathering primary data regarding the changes experienced by farmers due to the CSB in Nepal, and by creating a framework for the future evaluation of CSBs, which would allow for a more responsive, and coherent, reciprocity between CSB, community, and the broader theoretical aims of the CSB methodology.

Thus, the framework developed here collected, processed and interpreted data from three sites regarding the perceived changes (due to the lack of baseline data) in the areas of farm management, private-livelihoods gain/loss, and social cohesion from farmers affected by the CSB. In doing so some of the disconnects between the practice of on-farm conservation and the theoretical base of 'agroecology' are highlighted, discussed and suggestions made for their greater integration with respect to CSBs.

Overall, this study found that CSBs catalyse changes in farm management practices, in particular those affecting the use of inputs, aggregate varietal diversity and plot-scale plant temporal diversity over seasons and years. By facilitating greater organisational capacity centred on the establishment of local institutions and the collective action necessary for their formation and management, the CSBs served as an incubator for greater community cooperation, knowledge sharing and capacity building, which in turn could drive personal empowerment via sovereignty over their seed plant and its inputs. By strategizing and achieving livelihood gains through the maintenance of diversity, and community based forms of market engagement centred on local control over local natural resources, the CSB facilitated to some extent and in some cases, a movement towards 'food sovereignty' in general.

The interpretation of these results is not 'objective' per se, in the sense that this interpretation is intricately interwoven with the perspectives of agroecological theory. On the other hand, doing so enables a critique of that theory in the CSB context, in terms of its own aims, as well as those of its interaction with the CSB. The CSB focuses mostly on the conservation of intra-specific (rice) diversity, while generally ignoring the broader (inter-specific) plant diversity at field and landscape level. By putting such a focus on single-species diversity, a disconnect is found between PGR conservation and intra-specific diversity within the seedbank. Here, it is proposed that agroecology might bridge this gap, allowing farmers to account for and take into their own hands the landscape and farm management dynamics that generate the genetic characteristics of seed. Regardless, the CSBs and the underlying CBM methodology is to be applauded. Farmer testimony leaves no doubt that such an approach provides functional alternatives for farm functioning, social interaction, market relations and biodiversity conservation, and in doing so lays the ground for a parallel, more communitarian path of rural development. On the other hand, while agroecology has similar, if indirectly achieved, goals as the CSB, it is generally deployed at the academic level to increase biological diversity and synergy in the plot, farm and landscape. However, the landscape scale is practically rarely achieved by agroecology, due to the apparent presumption that the surrounding community is a static, rather than dynamic, body on which to impose agroecological prescriptions. As a result of their respective strengths and shortcomings, it appears appropriate that these practical and theoretical aspects are brought together to optimise both planning and outcomes in roll-out and management of CSBs. This is a first attempt at developing a framework for the evaluation of CSBs, which will be iteratively developed over time with the participation of CSB communities. A systematic data collection effort was also conducted, aimed at informing both the communities themselves as well as potential governmental and non-governmental stakeholders. This evaluation framework holds clear advantages to both sets of practitioners for potentially optimising agroecology and on-farm conservation goals through future information sharing, project planning and the creation of shared strategic concepts.

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6. Appendix

6.1 Diversity block of Kachorwa and Agyuali

Figure 12. Rice diversity block in Kachorwa
Different rice varieties within the diversity block can be seen, observe difference in color and height
Photo: Rice diversity block in Kachorwa
Credit: Monserrat Gómez César

Figure 13. *Rice diversity block in Aygauli*
Sign showing the in-field loation of the 20 different rice varieties planted
Photo: Rice diversity block in Aygauli
Credit: Monserrat Gómez César

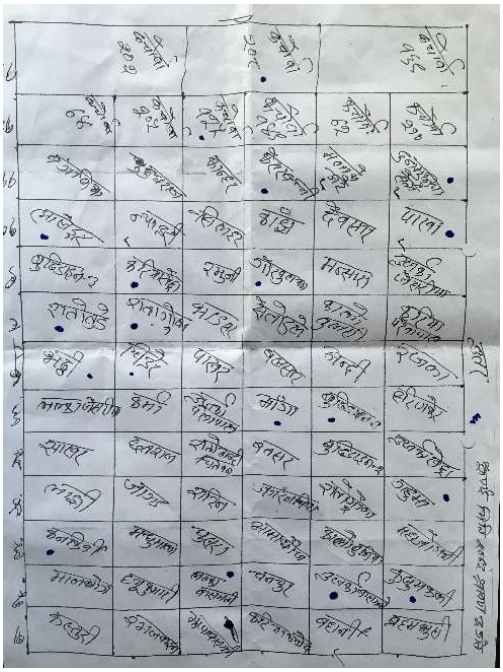

Figure 11. *Map of rice diversity block in Kachorwa*
Showing the location of the 75 planted rice varieties
Photo: *Map of rice diversity block in Kachorwa*
Credit: Monserrat Gómez César

6.2 Example of Community Biodiversity Register

बाली	धान
वैज्ञानिक नाम	*Oryza sativa*
जात	काठे गुर्दी
खेतीका लागि उपयुक्त क्षेत्र	९०० देखि १४०० मिटरसम्मको उचाइ भएको, टारी तथा पानी कम लाग्ने खेत ।
जात पाइने स्थान	बेगनास र नजिकका गाउँहरु, कास्की ।
उत्पादकत्व	प्रतिरोपनी १०० देखि १५० के.जी.सम्म ।
बाली-अवधि	जेठदेखि कातिकको दोस्रो हप्तासम्म ।
हुलिया	बोटको उचाइ १३० देखि १५४ से.मी. सम्म, बालाको लम्बाइ १९ देखि २६ से.मी. सम्म, दानाको आकार ठल्लो मसिनो, दानाको टुप्पामा कालो रङ, पराल मसिनो र नढल्ने ।
विशेष गुणहरु	भात खान मीठो, मल कम भएको ठाउँमा राम्रो फल्ने, पानी रोप्ने बेलामा मात्र भए पनि आकासे पानीको भरमा उत्पादन दिने, रोगकीरा कम लाग्ने र नढल्ने ।
प्रयोग	चामल भात खान र पराल बस्तुलाई खुवाउन प्रयोग गरिने ।
हालको अवस्था	धेरै कृषकले थोरै जग्गामा खेती गरेको ।

Figure 14. Example format of Community Biodiversity Register
Source: Paudel et al., 2015

6.3 Shared principles between participatory action-research in relation to community biodiversity management methodology, community seed bank and agroecology

The table below compares the approaches of CBM and agroecology with PAR principles in efforts to show their overlapping approaches. PAR and agroecology principles used in this table were adapted from Mendez et al (2013), while the rural development approach within CBM was adapted from de Boef et al., (2013).

Table 6. Common principles of participatory action research, agroecology, and community biodiversity management methodology

Participatory Action Research Principles	Agroecology Principles	New Professionalism for enabling CBM
Focus on community empowerment, community partners play key roles in defining research agenda	Agroecologist work alongside farmers, food consumers, communities, agricultural ministries, for the empowerment of all actors within the food system	Rural development approach is seen as a learning process which results in enhanced autonomy and empowerment
Creates long-term relationship through multiple iteration learning and doing cycles	Focuses on developing strategies for long-term benefits	Evaluation is internal and continuous, where errors are seen as opportunities for learning and re-arrangement for sustained and improved performance
Context-dependant process, responsive to stakeholder needs, involving interdisciplinary teams	Strives to establish farming and food systems that adjust to local environments	Local resources are given precedence with and a mutual learning and sharing experience
Research informs action for positive social change at multiple scales	Seeks to manage and understand whole systems	Analytical preposition that is systemic and holistic
Includes a diversity of voices and knowledge systems so to democratise research process and social change	Necessitates processes which diversify biota, landscapes and social institutions	Awareness and action are the first steps in an evolving and involving field-based learning process

6.4 Semi-structured questionnaire

On-Farm Conservation Questionnaire

The information collected is for research purposes and strictly confidential.

Does the household consent to provide information Yes ( ), No ( )

Date dd.mm.yyyy	
Starting time of interview	
End time of interview	
Language used in interview:	Gender of household head: M F

General household information

Country	Nepal
Region	Western Development Region
Zone	Lumbini Zone
District	Nawalparasi
Town	Agryouli / Agyauli
Village	
Household ID	
Name of household head	
Name of respondent	
Gender of respondent	
Relationship with head	
Mobile number of respondent	

Form 1a: General information about CSB membership
Notes:

1. What year did you start using the seedbank?

2. Why did you begin to use the seedbank, how did you become aware of it?

3. What are the most significant changes you've experiences, to your livelihood, since you've started using the seedbank?

4. What is the purpose of the seedbank?

Form 1b: Farm structure
Notes:

	amount	unit
How much land are is available for crop cultivation?		
How much of this land is irrigated?		
How much is rain fed?		

Notes:
Detail of soil

1. Can you describe your soil to me, how do you find its fertility?

Form 1c: Richness of crop varieties
Notes:
Richness of rice varieties
Note in customary units under cultivated area

Total number of rice variety	Name of rice varieties	Area under cultivation of each	Always cultivated Y / N	Source of seed Before	Now

Notes:
Yearly rice cultivation practice

Notes:
Semi-structured questionnaire on the inclusion of diversity on field

1. What prompted you to start cultivating different varieties?

2. What benefits do see to cultivating more varieties?

3. What makes this a difficult task?

4. How has the community seed bank influenced the integration of diversity into your fields?

From 2a: Farm management: pest and diseases
Notes:
This section deals with changes in pest management
Ask question 1: if yes, go to table 1 if no, go to question 2

1. Do you currently use pesticides? Y / N

Table 1 currently does use pesticides

Year of first application	

1. Why do you use pesticides?

2. Descriptors of pests and diseases; observed increase, decrease, neighbouring fields:

3. Why don't you, why have you stopped using pesticides?

4. What practices do you carry out to manage pests and diseases? (not including pesticides)

5. Where do you get information about pest management?

6. How does diversity (in varieties and crops) help with pest management?

LIST crop rotation:

Intercropping:

Resistant varieties:

From 2b: Farm management: soil fertility
Notes:
This section deals with changes in soil fertility management
Ask question 1: if yes, go to table 1 if no, go to question 2

1. Do you currently use chemical fertiliser? Y / N

Table 1 currently does use chemical fertiliser

Year of first application				
Type of Fertiliser				
Quantity of application amount / unit	/	/	/	/

Notes:
Ask question 2: if yes, fill out Table 2 if no, proceed to question 3 before continuing to the semi-structured questionnaire

2. Have you ever used chemical fertiliser? Y / N

Table 2 currently does NOT use chemical fertiliser

Years of usage		i.e yyyy-yyyy		
Type of Fertiliser				
Quantity of application amount / unit	/	/	/	/

Notes:
This is to be asked to all respondents regardless of their use of chemical fertiliser

3. Do you use farm yard manure or compost on your fields?

Specify: FYM, Compost, or Chicken Manure			
Quantity of application amount / unit	/	/	/

Notes:
If the respondent answer NO to both question 1 and 2 fill from question 2 onwards
Question 1 and 1.1 is a further inquiry for respondents who fill Table 1
Question 2 is a further inquiry for respondents who fill Table 2

1. Why do you use chemical fertiliser?

1.1 Why does the amount of chemical fertiliser you apply vary?

2. Why don't you, why have you stopped using chemical fertiliser?

3. What other practices do apply to manage the fertility of your soil? (not including chemical fertiliser)

4. Where do you get information about soil fertility management?

5. How does diversity (in varieties and crops) help in maintaining soil fertility and recycling nutrients?

Organic matter / Soil cover:

Use of legumes:

Mixing crops with different rooting patterns:

Form 2c: Conclusion to farm management section

Notes:
Concluding question before filling out diagram

1. How have you gained more knowledge on how to manage diversity on farm? Where did this knowledge come from? How have you incorporated it into your farm management?

Visual diagram of perceived change in Farm Management
Notes:
Respondent is to indicate the perceived change the CSB has had in the five different aspects with the innermost pentagon signifying no change

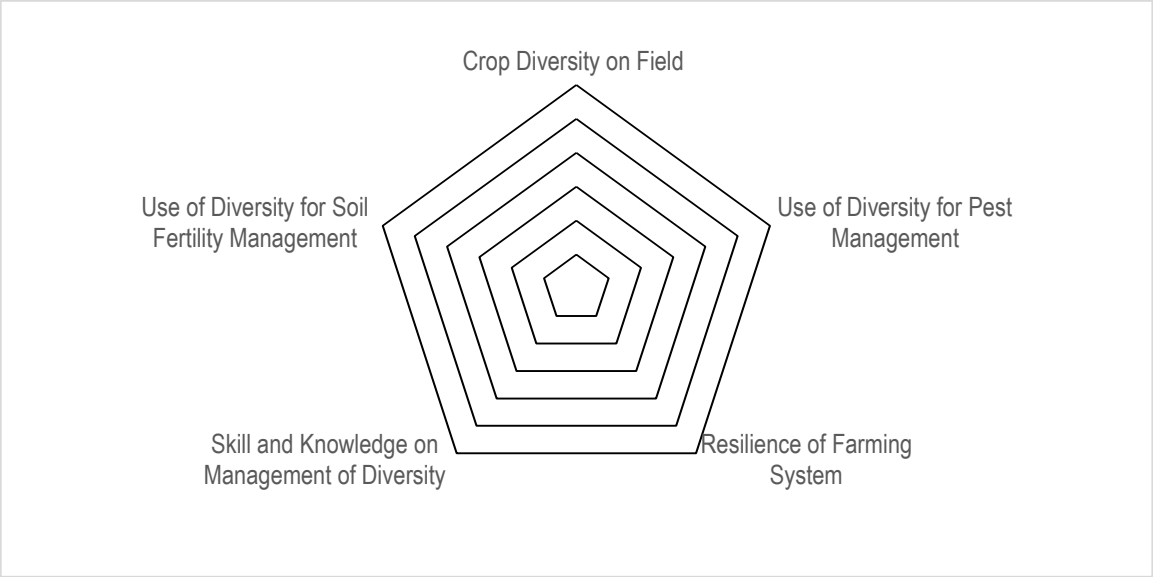

Figure 15. Radar diagram for farm management

Form 3a: Labour management and farm productivity

Notes:

This section deals inquiries about labour and farm productivity

1. How has your labour changed since you've become involved in the seedbank? List of different / new tasks, responsibilities

2. Have you seen a change in the productivity, total yield, of different crops? Specify *Muri* before and after

Form 3b: Private livelihood benefits

Notes:

Please make clear that all questions refer to changes and benefits since they have begun loaning seed from seedbank

1. What are some of the personal benefits your household has received?
2. What is your current farm revenue[8], has your farm revenue income increased? If so, state quantity now / before and year it begun to increase : if no sale of farm goods inquire about household food consumption

3. Do you participate in seed reproduction and sales? What is percentage of your total revenue comes from seed sales?

4. Do you now sell a specific crop you didn't use to cultivate on the market? How has the seedbank change your access / ability to sell your good in the market?

[8] Farm revenue refers specifically to any income made from selling crops

Form 3c: Visual diagram of perceived change in Private Livelihoods

Notes:
Respondent is to indicate the perceived change the CSB has had in the five different aspects with the innermost pentagon signifying no change

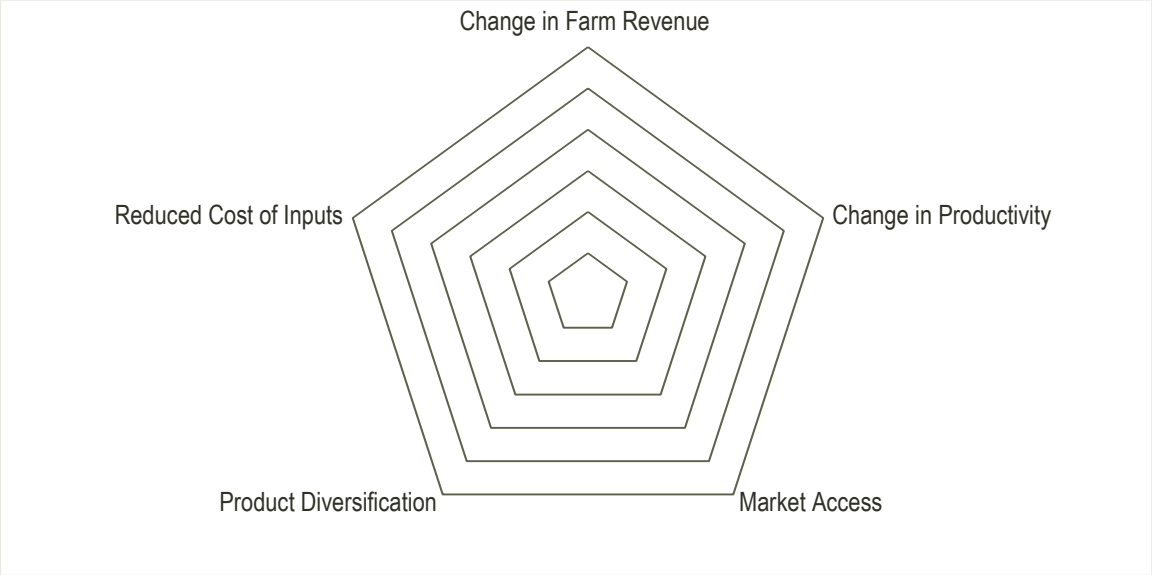

Figure 16. Radar diagram for changes in private-livelihoods

6.5 List of participants for semi-structure questionnaires

Table 7. List of participant for semi-structured questionnaires in Agyauli

No.	Gender	Date Interviewed	Ward, Village, District
1	M	19.10.2016	Ward 5, Agyauli, Nawalparasi
2	F	19.10.2016	Ward 5,Agyauli, Nawalparasi
3	F	19.10.2016	Ward 5, Agyauli, Nawalparasi
4	F	19.10.2016	Ward 5, Agyauli, Nawalparasi
5	F	19.10.2016	Ward 5, Agyauli, Nawalparasi
6	M	20.10.2016	Ward 4, Agyauli, Nawalparasi
7	F	20.10.2016	Ward 4, Agyauli, Nawalparasi
8	M	20.10.2016	Ward 4, Agyauli, Nawalparasi
9	F	20.10.2016	Ward 4, Agyauli, Nawalparasi
10	F	20.10.2016	Ward 4, Agyauli, Nawalparasi
11	M	20.10.2016	Ward 4, Agyauli, Nawalparasi
12	M	20.10.2016	Ward 4, Agyauli, Nawalparasi
13	F	21.10.2016	Ward 8, Agyauli, Nawalparasi
14	F	21.10.2016	Ward 8, Agyauli, Nawalparasi
15	M	21.10.2016	Ward 8, Agyauli, Nawalparasi
16	F	21.10.2016	Ward 8, Agyauli, Nawalparasi
17	M	21.10.2016	Ward 8, Agyauli, Nawalparasi
18	M	22.10.2016	Ward 3, Agyauli, Nawalparasi
19	M	22.10.2016	Ward 3, Agyauli, Nawalparasi
20	M	22.10.2016	Ward 3, Agyauli, Nawalparasi
21	F	22.10.2016	Ward 7, Agyauli, Nawalparasi
22	M	22.10.2016	Ward 7, Agyauli, Nawalparasi
23	M	22.10.2016	Ward 7, Agyauli, Nawalparasi
24	F	22.10.2016	Ward 7, Agyauli, Nawalparasi
25	F	23.10.2016	Ward 2, Agyauli, Nawalparasi
26	F	23.10.2016	Ward 2, Agyauli, Nawalparasi
27	M	23.10.2016	Ward 2, Agyauli, Nawalparasi
28	F	23.10.2016	Ward 2, Agyauli, Nawalparasi
29	M	23.10.2016	Ward 2, Agyauli, Nawalparasi

6.6 Guiding questions for focus group discussion and key informants

Group i: community seed bank users and members

- How has your farm management changed since being a member of the seedbank? i.e use of diversity
- Do you now produce different crops than before? Do you sell different products on the market or consume more or different foods at home?
- Do you feel you've gained more knowledge and skills on how to manage diversity on your farm?
- What role does diversity play in pest and soil fertility management?
- Has your use of chemical fertiliser and pesticides changed since using local varieties/
- What are some of the most important changes you have experienced since being a part of the seed bank? .i.e private benefits: income, access, productivity
- Do you feel your farming system is more resilient to climatic changes due to the use of different varieties?

Group ii: community seed bank committee

- How have you seen the seed bank affect the way in which the community works together to solve and discuss problems? .i.e collective action
- What organisational and management skills have you learned that make you confident in the community's capacity to conserve biodiversity?
- How have you seen the seed bank enable farmers to share knowledge and practices?
- How have you seen the community have more "independence" in the production of food and seed?
- What aspects of the community seed bank has changed the community's motivation to conserve agrobiodiversity?
- How will the knowledge and skills you now have be shared with the younger generations?

I. Visual diagram of perceived change in Social Cohesion

Notes:

Respondent is to indicate the perceived change the CSB has had in the five different aspects with the innermost pentagon signifying no change Social Cohesion

Figure 17. Radar diagram for changes in social cohesion

6.7 List of participants for focus group discussion and key informants

6.7.1 Kachorwa

Table 8. List of participants in focus group discussion and key informant in Kachorwa

No.	Gender	Date	Village, District
	FGD: Committee Members		
30	M	25.10.2016	Kachorwa, Bara
31	M	25.10.2016	Kachorwa, Bara
32	M	25.10.2016	Kachorwa, Bara
33	M	25.10.2016	Kachorwa, Bara
34	F	25.10.2016	Kachorwa, Bara
35	F	25.10.2016	Kachorwa, Bara
36	F	25.10.2016	Kachorwa, Bara
37	F	25.10.2016	Kachorwa, Bara
38	F	25.10.2016	Kachorwa, Bara
39	M	25.10.2016	Kachorwa, Bara
	Key Informants		
40	M	26.10.2016	Kachorwa, Bara
41	M	26.10.2016	Kachorwa, Bara
42	M	26.10.2016	Kachorwa, Bara
43	M	26.10.2016	Kachorwa, Bara
45	F	26.10.2016	Kachorwa, Bara
46	F	26.10.2016	Kachorwa, Bara
47	F	26.10.2016	Kachorwa, Bara
	FGD: CSB member		
48	F	26.10.2016	Kachorwa, Bara
49	M	26.10.2016	Kachorwa, Bara
50	M	26.10.2016	Kachorwa, Bara
51	M	26.10.2016	Kachorwa, Bara
52	M	26.10.2016	Kachorwa, Bara
53	M	26.10.2016	Kachorwa, Bara
63	M	26.10.2016	Kachorwa, Bara
64	M	26.10.2016	Kachorwa, Bara
65	M	26.10.2016	Kachorwa, Bara
67	F	26.10.2016	Kachorwa, Bara
68	F	26.10.2016	Kachorwa, Bara
69	M	26.10.2016	Kachorwa, Bara
70	M	26.10.2016	Kachorwa, Bara

6.7.2 Ghanteswor

Table 9. List of participants in focus group discussion and key informant in Ghanteswor

No.	Gender	Date Interviewed	Village, District
Key Informant			
71	M	21.11.2016	Ghanteswor, Doti
FGD: CSB members			
72	F	22.11.2016	Ghanteswor, Doti
73	M	22.11.2016	Ghanteswor, Doti
74	M	22.11.2016	Ghanteswor, Doti
75	M	22.11.2016	Ghanteswor, Doti
76	F	22.11.2016	Ghanteswor, Doti
77	F	22.11.2016	Ghanteswor, Doti
78	F	22.11.2016	Ghanteswor, Doti
79	F	22.11.2016	Ghanteswor, Doti
80	F	22.11.2016	Ghanteswor, Doti
81	F	22.11.2016	Ghanteswor, Doti
82	F	22.11.2016	Ghanteswor, Doti
83	F	22.11.2016	Ghanteswor, Doti
84	F	22.11.2016	Ghanteswor, Doti
85	F	22.11.2016	Ghanteswor, Doti
Key Informant			
86	M	22.11.2016	Ghanteswor, Doti
87	M	22.11.2016	Ghanteswor, Doti
88	M	22.11.2016	Ghanteswor, Doti
FGD: CSB committee			
89	M	22.11.2016	Ghanteswor, Doti
90	M	22.11.2016	Ghanteswor, Doti
91	F	22.11.2016	Ghanteswor, Doti
92	M	22.11.2016	Ghanteswor, Doti
93	M	22.11.2016	Ghanteswor, Doti
94	M	22.11.2016	Ghanteswor, Doti
95	M	22.11.2016	Ghanteswor, Doti
96	M	22.11.2016	Ghanteswor, Doti
Key Informant			
97	F	23.11.2016	Ghanteswor, Doti
98	M	23.11.2016	Ghanteswor, Doti
99	M	23.11.2016	Ghanteswor, Doti
100	M	23.11.2016	Ghanteswor, Doti
101	M	23.11.2016	Ghanteswor, Doti

6.8 Soil water evaporation

This, reference figure 12 and 13, was a common site throughout fields of newly planted radish, peas, cauliflower, other vegetables, and cereals. As farmers mentioned, they now practice line-sowing and 'proper' density. These pictures were taken during the field visit in the month of November, the rainy season had ended, and although water availability was a concern for farmers, there was no observations or mention of a practice of mulching soil or growing cover crops for soil water retention.

Figure 18. Cauliflower field with barren soil, near potato storage facilities

Photo: Potato storage facilities in Ghantewor
Credit: Monserrat Gómez César

Figure 19. Line-sown radish field with exposed soil

Photo: Radish field, practice of line-sowing in Ghanteswor
Credit: Monserrat Gómez César

6.9 Pest and disease management amongst Agyauli's farmers

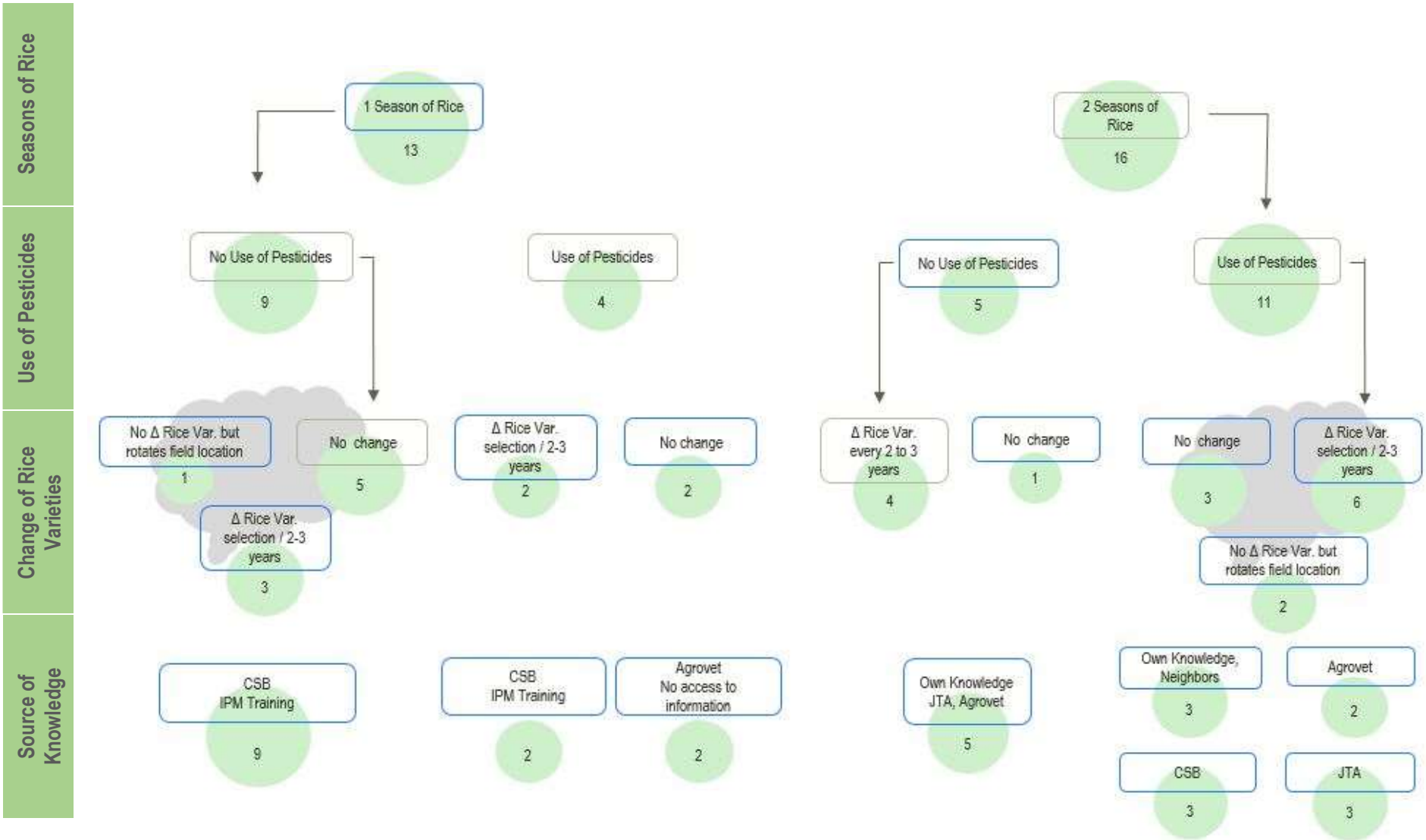

Figure 20. Pest and desease management amongts farmers

Graphical summary of respondent (numbers) farmer practices according to the number of rice planting seasons. Farmer practices are sub- grouped in visual order into whether they use pesticides, their variation of rice cultivar and sources of knowledge in implementing the preceding practices, with specific information regarding these subgroupings and the number of farmers adhing to them contained in the squares and circles, respectively. The grey clouds highlight that the change in rice varieties seems to have little effect to no effect on the application of pesticides. For example, of those frrmers who plant only one season of rice and do not use pesticide the majority do not change rice varieties. While of those which plant two seasons and use pesticides the majority roate the rice varieties cultivated.

6.10 Landscape diversity in Agyauli

Figure 21. Landscape of Agyauli
Rice variety observable in variation of color, height and harvest time, but no observable permanent natural elements

Photo: Paddy-rice landscape in Agyauli
Credit: Monserrat Gómez César

Figure 22. Landscape of Agyauli
Rice varietal diversity clearly evident, in different harvest times along with different plant height

Photo: Paddy-rice fields in Agyauli
Credit: Monserrat Gómez César

Figure 24. *Landscape of Agyauli*
Paddy rice field with scare to no permanent natural elements, notice that there ae no permanent vegetation even along the dikes at the edges of the field

Photo: Paddy-rice landscape in Agyauli
Credit: Monserrat Gómez César

Figure 23. Landscape of Agyauli
Rice varietal diversity can be observed; difference in height of with left and right field and some color difference; no observed permanent elements

Photo: Paddy-rice fields in Agyauli
Credit: Monserrat Gómez César

6.11 Fertiliser application in Agyauli

Table 10. Fertiliser application in Agyauli

Use of Inorganic Fertiliser kg/ha
9.00090009
27.06359946
34.83646216
45.6
46.15384615
48.00480048
50
54.5464463
55.81135761
60.00461574
61.60784314
66.92050306
81.17169578
89.100089
89.99550022
90
90
90
90.00562535
115.3668666
115.3972964
125
150
152.6899678
155.1831161
157.5042569
200
210.7350936

Table shows the total reported application of fertiliser ranging from 9 kg/ha to 210.7 kg/ha. The participants involved in a study applied on average of 91.50 kg of Urea:DAP (2:1), with the median application being 89.55. Note the data set has a large variation with 51.30 standard deviations from the mean.