SYNTHESIS REPORT

Agroecology as a Pathway towards Sustainable Food Systems

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Aachen, October 2018

Layout and Design:
VISUELL Büro für visuelle Kommunikation

Photos:
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Agroforestry in the smallholder settlement Nova Esperança in northern Brazil.

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Key messages

- **Food systems are at a critical juncture and a dramatic transition to agroecology is urgently needed.** Alarming rates of food insecurity and malnutrition persist, manifested as undernutrition, micronutrient deficiencies ("hidden hunger") and "overnutrition" (overweight and obesity), alongside the growing crises of biodiversity loss and climate change.

- **Agroecology's profile in the national and international arena, and amongst researchers, farmers, and movements, is growing.** To fully realize its potential, it is thus all the more important for concerned actors, practitioners, and civil society to maintain pressure and support for agroecology's full gender-sensitive, political, ecological, pro-small-scale food producer and pro-poor orientation, alongside food sovereignty and food justice.

- **MISEREOR works with community-based organizations and researchers who share a vision for action and fundamental shifts to support a sustainable and just food future. This work enables us to learn from and support development interventions aligned with a transformative approach to agroecology.** Practically, this has already been demonstrated in previous research with MISEREOR-supported partners in Uganda and the Philippines (see pp.22-25), where agroecological processes have helped farmers increase incomes, resilience, diversity, autonomy, gender empowerment and food sovereignty. Continuing and amplifying this line of work based on partnerships with local NGOs and networks to build capacity and provide a voice for small-scale farmers, this report compiles studies of work on transformative agroecology and rural development in India, Brazil, and Senegal.

- These studies provide further evidence that **agroecology can help increase farmers' economic viability and income, farm productivity and diversity, food and nutritional security, and promote social change and women's empowerment.**

- **To continue to realize agroecology's potential, it will be important to promote and scale-up ongoing deliberative, inclusive, cross-sector policy dialogues;** promote and secure sociopolitical equality across gender and marginalized groups; enable local institutions for horizontal learning and sharing; recognize and encourage diversified economies; increase participatory approaches for generating and maintaining crop and animal diversity; recognize women's connections to improved nutrition, diversity, and diets; increase support for agroforestry in particular; and improve rural access to water, water quality, and other elements of basic infrastructure. To make these interventions more effective, governments and development agencies should substantially increase support for agroecological interventions and shift funds away from "conventional" approaches that are disempowering, synthetic input-intensive, and harmful to the environment.

Foreword

In a time in which humankind is seriously challenged by climate change, loss of (agro-) biodiversity, soil degradation and malnutrition, comprehensive solutions are sorely needed. While much research focuses on technological fixes, small-scale farmers worldwide have adapted their livelihood and farming systems continuously and proactively in order to improve their living, protect their environment and become climate resilient. Particularly in regions where climate change poses a threat to agriculture and food security, agroecological approaches offer future-oriented solutions. This study provides evidence of the potential agroecology offers in three different country and continental contexts – Brazil, India and Senegal – in the world's dry zones. This evidence demonstrates a viable way forward for achieving the main objectives of the Sustainable Development Goals (SDGs) agreed by the global community for the Global South and for the Global North.

But what does agroecology stand for? Agroecology is more than making agriculture more ecological. It entails a holistic approach, seeking social and political change as well as people-led development. It challenges the prevalent perception of agriculture as production of commodities and the commodification of nature, and aims at reconciling agriculture with nature. This paradigm shift is already underway in the Northeast of Brazil, where smallholders are starting to "live with the semiarid" rather than "fighting the drought". The cases in Senegal and India offer similar experiences.

As a systemic approach, agroecology engages with small-scale farmers in longer-term, bottom-up processes, which can bring about viable positive impacts in various dimensions. Environmental impacts can be achieved in terms of soil fertility, reforestation and increased (agro-) biodiversity. Socioeconomic impacts are visible as improved and secured access for smallholders to natural resources and land, healthy and balanced diets as well as increased monetary income, together with strengthened networks, empowerment and social equity.

Based on almost 1200 interviews with smallholders, this study aims to understand the complex realities, the challenges smallholders face and the potential agroecology has to establish more sustainable agriculture and food systems. Agroecology as it presents itself in the Global South is often strongest in its form as a people-led movement and practice, with comparatively less institutional support for science and policy. However, the contributions of the latter two areas are valued in a dialogue and cooperation among all partners involved that are based on equal footing.

Coherent and political conditions that are actually enforced are equally key factors for putting into practice convincing agroecological solutions such as those presented in the study and for enabling them to be scaled up and scaled out. However, the decision to implement the needed shift remains highly political. Whether or not agroecology can realize its full potential is dependent on political will.

Dr Martin Bröckelmann-Simon

Managing Director MISEREOR
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Executive summary

This report summarizes the results of impact studies about agroecological interventions in semiarid regions in three countries, namely, Pernambuco state in Brazil, Fatick district in Senegal, and Osmanabad district in India. The work was carried out by partner organizations funded and supported by MISEREOR. The results provide strong evidence of the impact and potential of agroecology as a pathway towards more sustainable agriculture and food systems. In line with other contemporary studies, academic literature, and international demands for agroecology, it supports calls for substantially increased support for diversified, agroecological farming and food systems. Agroecology enhances the livelihoods of local communities, including improved economic viability and income, food and nutrition security, and sociopolitical empowerment, while generating more stable and sufficient yields.

The radical shifts required will entail changing attitudes around conventional rural development approaches in order to promote diversified practices and apply a framework of participation, inclusion, and social, economic and environmental justice. The results in this report present the main strengths of the various initiatives carried out by partners with smallholder family farmers in each region. It concludes with recommendations around the continued and future support needed to secure and expand successful agroecological interventions, grounded in a transformative vision of agroecology that will allow a scaling-out of farming and food systems that put people and nature before profit.

This report takes place in the context of the recognition that food systems are at a critical juncture and a dramatic transition to agroecology is urgently needed. The motivation for this study and publication originates from many conversations and a growing realization of the need for agroecology among academics, civil society, NGOs and international organisations who advocate for a different, more sustainable and just food future. Alarming rates of food insecurity and malnutrition persist, manifested as undernutrition, micronutrient deficiencies ("hidden hunger") and "overnutrition" (overweight and obesity), alongside the growing crises of biodiversity loss and climate change, and concomitant increased risks of disasters, ecosystem collapse, and extreme weather events. These challenges reflect biophysical processes that have emerged from short-term decision-making, power imbalances, and excessive corporate control over seed, fertilizer and food systems, generating lock-in effects and exacerbating problems of democratic accountability and participation in policy, research and development.[1]

Although the possibilities for changes to democratic processes and policymaking are often hard to envision, particularly as abuse of corporate power and lack of responsive governance continue, social movements around the world continue to organize to demand a different path. Along with researchers, funders, and other allies, they are providing evidence that alternatives are possible and much needed. Civil society participation in intergovernmental processes opens additional doors, raising hope for effective lobbying towards agroecology in the future.

In the work examined in this study, cases of agroecological interventions are presented from three countries, based on work supported by MISEREOR and led by local partner NGOs and farmers. The challenges faced in the cases in India, Brazil and Senegal are brought together by parallel histories of support disproportionately flowing towards cash-crop, export-focused agriculture, while local production, diversity and traditional foodways were passed over or neglected. Current national policies and development funding are largely unfavourable to food systems based on small-scale farming and are much less forthcoming with the kind of additional support needed in difficult environments, such as the semiarid regions in which each of the cases are located. In India, the public procurement systems (PDS) makes little use of locally produced foods, favoring instead wheat and rice from surplus-producing areas in India and processed ingredients. In Senegal, significant subsidies for chemical and industrial inputs corresponded with large-scale rollbacks of state support, leaving small-scale farmers highly vulnerable. And in Brazil, a history of deep inequalities in land and wealth and little support for small-scale producers or rural workers has begun to be addressed over the decades since the end of the Brazilian dictatorship in 1985. However, there is still a long way to go for a predominately agroecological system to be realized, that generates sustainable livelihoods for the majority of small-scale farmers. Recent political events in Brazil

[1] "Lock-in effect" is a term used in academic literature about agroecology refer to "the focal points around which industrial food systems now revolve, and the vicious cycles keeping them in place… regardless of [the] outcomes; it is these cycles that will need to be broken if a transition towards diversified, agroecological systems is to be achieved," (IPES-Food 2016, p. 45).

Drylands face numerous challenges. Agroecology adapts to soil, climate and to the site-specific resources available to the farmers.

have only moved developments further from this ideal, despite previous advancements.

The Food and Agriculture Organization of the United Nations (FAO) has held a series of recent international symposiums and workshops on agroecology. This and the number of reports by entities like International Panel of Experts on Sustainable Food Systems, the current and former Special Rapporteurs for the Right to Food, and the second Nyéléni Forum, to mention a few, are making it feel as though agroecology is everywhere. Of course, this poses opportunities for "scaling-up" and "scaling-out" agroecology, and gives rise to threats in terms of co-optation and dilution of the term. It is therefore all the more important for concerned actors, practitioners, and civil society to maintain pressure and support for agroecology's full gender-sensitive, political, ecological, pro-small-scale food producer and pro-poor orientation, alongside food sovereignty and food justice, so that its full potential can be realized.

MISEREOR's principles which guide its research and development interventions are therefore aligned with a transformative approach to agroecology. MISEREOR works closely with community-based organizations and researchers who share a vision for action and fundamental shifts to support a sustainable and just food future. MISEREOR and its partner organizations throughout the world strive towards agriculture and food systems that promote agricultural biodiversity and ecological production methods; protect farmers' rights over seed, land and other resources; and recognise the values of local knowledge, solidarity and diversity, from the levels of production, to markets, and consumption. MISEREOR has contributed to amplifying the voices of peasants, women farmers, indigenous communities and other marginalized groups, through partnering with movements demanding changes from top-down approaches towards those that include all voices in democratized and food-sovereign systems.

In practical terms, this can be seen in MISEREOR's previous work with partners around the world. But it has been made especially apparent in Uganda and the Philippines through extensive research in those cases, in which agroecological processes have helped farmers increase incomes, resilience, diversity, autonomy, gender empowerment and food sovereignty. Continuing and amplifying this line of work based on partnerships and support for local NGOs and networks to build capacity and provide a voice for small-scale farmers, this report compiles three studies of work on transformative agroecology and rural development in India, Brazil, and Senegal.

The three studies provide further evidence that **agroecology can help increase farmers' economic viability and income, farm productivity and diversity, food and nutritional security, and promote social change and women's empowerment**.

Farmers in all three case studies showed significant gains in income, specifically greater income from

agricultural sales, value of home consumption, and net income. Median income from agricultural sales for agroecological farmers was 79 % higher compared to a "reference group" of farmers in India, 177-284 % higher in Brazil, and 36 % higher in Senegal. In terms of cash equivalents for consumption based on self-supply, agroecological farmers showed an advantage of 67 % in India, 61-74 % in Brazil, and 14 % in Senegal. Importantly, the **agroecological interventions were shown to be particularly pro-poor**: while cash income from the sale of agricultural products was higher for all agroecological farmers, it in fact rose most sharply amongst the poorest farmers, with the poorest 10% of farmers in Brazil and Senegal increasing their income by US$65-650, compared to zero annual sales for reference group farmers. In India, income for agroecological farmers was nearly 500 % higher than the reference group, at ~US$430 per year.

Similarly, increases in livestock and crop productivity and diversity were reported for agroecological farmers in all three countries. Reports of increased productivity for agroecological farmers' primary crops ranged from 17 % higher than in the reference peer group in Senegal, 32 % higher in India, and 26 % and 49 % higher in the two studied areas within Brazil's Pernambuco state. Agroecological farmers in India produced nearly twice as much food from less-commonly cultivated crops (21,866 kg compared to 11,614 kg) over an area only 20 % larger than reference group farmers (who also grew fewer types of crops). In Senegal, 75 % of agroecological farmers were found to have taken up one additional variety, 17 % took up two new varieties, and 8 % took up three new varieties of the vitally important crops of cowpea and millet. And in Brazil, agroecological households produced 119 to 133 distinct types of goods, while reference farms produced 105 to 119 distinct types. Livestock-keeping and production also (mostly) increased amongst agroecological farmers in Brazil and India. In Senegal, however, ownership of most kinds of livestock has declined across all types of farms, likely due to high mortality levels owing to insufficient prophylaxis, the reduction of pasture, and insufficient access to appropriate water sources; the decline appears to have been slightly lower on reference farms.

With regards to food security, besides the higher levels of income and self-supply amongst agroecological farmers, qualitative and quantitative data indicate improvements in both the amount and diversity of food consumed in most cases. Focus groups in Brazil generated unanimous feedback that **beginning to work with agroecology was a major factor in improving their diets, particularly in terms of increasing variety and consumption of fruits and vegetables, and decreasing health problems.** Indian agroecological farmers similarly reported notable increases in the diversity of food groups grown, and improvements in dietary sufficiency for cereals and millets, pulses and non-vegetable foods, and vegetables compared to reference farms. In Senegal, differences between households in these types of measures were minor; the proportion of agroecological households reporting self-sufficiency in millet, rice, and groundnuts was less than 5 % higher than the reference group in each case.

There was also evidence across the cases of **greater participation and capacity-building, particularly for women farmers in agroecological households**. In India, women in the agroecological households had higher levels of membership in various pertinent organizations, and amongst women who were trained in group leadership, 25 % went on to take up roles as leaders, and 22 % as agroecological trainers. In Brazil, women on agroecological farms participated more in structured organizations (municipal council, cooperatives, fairs, and nonprofits and political parties in particular) and showed higher utilization of public support policies to which they were entitled, such as government purchase programs and income transfer programs. In Senegal, potentially promising trends included the fact that over half of agroecological households received training and information on gender inequality and marginalization, and about the adoption of a national law for gender equality – important work, given that even basic awareness of women's formal legal rights can be lacking in Senegal's rural areas. Additionally, women-headed households in the Senegalese agroecological group saw a median 28 % improvement in income (compared a median 12.6 % improvement for men).

Thus, while limitations and on-going challenges must be acknowledged, the cases of work by MISEREOR's partners and agroecological farmers present compelling evidence that agroecology can compose a solid backbone for transformative and just rural development. From these studies, much can be learned in order to build on current successes and expand the scope of agroecology's ability to help family farmers in precarious regions, such as in the world's semiarid regions. Agroecology's transformative nature and potential to build sustainable, dignified and resilient farmer livelihoods should be embraced. With deliberation and on-going participation from communities in each of the three regions and beyond, the possibilities for continued improvement of the lives and livelihoods of the farmers in India, Brazil and Senegal, and the 1.5 billion other smallholder farmers in the Global South, are immense.

Thematic context

A critical juncture: Challenges of the current food system

It is widely recognized that dramatic changes in our current agricultural and food systems are needed to address the present and persistent food crisis. Echoing 2009's *International Assessment of Agricultural Knowledge, Science and Technology for Development* (IAASTD), the Food and Agriculture Organization of the United Nations recently stated that "business-as-usual is not an option" (FAO 2017). In fact, the estimated number of malnourished people in the world increased from 777 million in 2015 to 815 million in 2016, according to the conservative assumptions of the FAO (FAO et al. 2017). This increase occurred alongside the adoption of the Sustainable Development Goals in 2015 (SDG2 is Zero Hunger), and despite continued growth in per capita food production: the world currently produces approximately 2,900 calories of food per person per day, after losses, waste, and conversion to livestock (FAO 2016) – enough food for over 9 billion people. Yet estimates of both the proportion and absolute number of people suffering from severe food insecurity increased in the period 2014-2016. Some experts judge that more accurate estimates of the food insecure and hungry would be over 2 billion (Hickel 2016; Lappé and Collins 2015).[2] Where progress has occurred, increasing gender equality has been shown empirically to have been one of the most important drivers (Smith and Haddad 2015). Nevertheless, studies show that where there is deprivation, it is often worse yet for women, who may eat least, and last (Brown et al. 2018; Narayan 2018).

The dire state of the status quo becomes even clearer when taking account of all three forms of malnutrition. The first form, as mentioned above, is undernutrition, meaning a lack of access to sufficient calories. The second form of malnutrition includes overweight, obesity and diet-related non-communicable diseases (e.g., heart disease, stroke, diabetes and some cancers) (WHO 2017). With the third form of malnutrition, people may suffer from micronutrient-related deficiencies, or "hidden hunger", which is defined by insufficient intake of important vitamins and minerals, such as folate, iron, or Vitamin A. An estimated 1 to 2 billion people suffer from micronutrient deficiencies (Bailey et al. 2015), while approximately 650 million people are estimated to suffer from obesity (WHO 2017).

Thus, going beyond the outrage and tragedy of undernutrition in a world of surplus, we must focus our attention on the avoidable illnesses and deaths caused by the second form of malnutrition: obesity, overweight, and their associated non-communicable diseases. Taken together, this second form of malnutrition is thought to cause 3.4 million deaths per year, or about 6 % of all deaths (WHO 2014). Although the relative importance of different factors and measurements used to assess obesity and overweight are still being understood (Guthman 2011), there is strong consensus that they are leading to unnecessary illness and death from associated non-communicable diseases like heart disease and diabetes (WHO 2017). Diet, lack of physical activity, and environmental pollutants have all been pointed to as potential causes. The three factors are all connected with larger "environmental and societal changes associated with development and lack of supportive policies in sectors such as health, agriculture, transport, urban planning, environment, food processing, distribution, marketing, and education" (WHO 2017), as well as the under-researched and uncertain scale of the impacts of pollutants known as obesogens, a chemical class that includes some pesticides (Lind et al. 2016). And, as has been noted for almost two decades, a "nutrition transition" is underway that has increasingly led to higher obesity and overweight rates in developing countries as cheap, imported processed foods enter their markets; advertising overexposes junk food and a pretended connection to "modernity"; and food distribution and retailer consolidation changes the availability, relative prices, and perceived attractiveness of junk foods (Patel 2008; Popkin et al. 2012). Some researchers have found obesity is still a greater problem for wealthier and urban residents, in Sub-Saharan Africa for example (Steyn and

[2] Anthropologist Jason Hickel argues that estimates like the FAO's "ignores the fact that most poor people… are usually engaged in demanding physical labor, so in reality they need much more than the FAO's minimum caloric threshold… If we measure hunger at the more accurate (and still conservative) level of calories required for normal activity, we see that 1.5 billion people are hungry… If we measure hunger at the level of calories required for intense activity, the number of hungry is 2.5 billion" (2016, p. 759). From another perspective, Lappé and Collins (2015) argue that those who suffered from significant hunger during childhood are negatively affected throughout their life and should additionally be included in counts of "those [currently] suffering the consequences of nutritional deprivation," (p. 15).

Agroforestry in Brazil results in multiple benefits for biodiversity, soil fertility, climate resilience and farmers' livelihoods.

Mchiza 2014), but others have found that "while… obesity prevalence appears to be rising across all low- and middle-income countries, it is not clear what urban-rural difference may exist" (Popkin et al. 2012).

The third global malnutritional burden, micronutrient deficiencies, affect a similar number of people as each of the other two forms; an estimated 1 to 2 billion worldwide. This nominally "hidden" form of hunger contributes to clearly negative afflictions from anaemia, diabetes, and cardiovascular disease to stunting, mental retardation, and maternal and child mortality (Bailey et al., 2015; Caulfield et al., 2006). Although there are multiple avenues to address hidden hunger, it is generally linked to a lack of dietary diversity, insufficient accessible food choices, and the marginalization of women (vegetables are often considered "women's crops" and marginalized or replaced by cash crops); all of which may be connected to the displacement of healthier traditional foods and increased consumption of nutrient-poor processed foods (Herforth 2010).

It is very significant to note that all three forms of malnutrition are increasingly co-occurring: in the same nations, regions, and even within a single household, or individual:

> Children in low- and middle-income countries are more vulnerable to inadequate prenatal, infant, and young child nutrition. At the same time, these children are exposed to high-fat, high-sugar, high-salt, energy-dense, and micronutrient-poor foods, which tend to be lower in cost but also lower in nutrient quality. These dietary patterns, in conjunction with lower levels of physical activity, result in sharp increases in childhood obesity while undernutrition issues remain unsolved. (WHO 2017)

These findings clearly and compellingly point to the need to address our current food crisis at multiple levels, including at the levels of production and consumption, as well as local and global, rural and urban settings, and in many different socio-cultural contexts.

Rural structural change and lack of adequate policy support for small-scale farmers

The industrial agro-food regime has altered how we produce food and who produces it. Besides the above-mentioned dynamics, farmers are continuing to leave, or be pushed off, their land; governmental support and intervention for agriculture has decreased or even been withdrawn completely, including agricultural banks, extension, research, and infrastructure; and agricultural technologies and packages reward large-scale, chemically- and energy-intensive agricultural operations able to operate with low margins and, frequently, poorly paid labor (Chappell et al. 2013; HLPE 2013; Weis 2007). And despite the ample research pointing out the shortcomings of the Green Revolution and synthetic input-intensive, "conventional" approaches (e.g. Freebairn 1995; Negin

et al. 2009; Patel 2013), proposals that would essentially repeat or perpetuate these problematic approaches and further marginalize small-scale farmers continue (e.g., the Alliance for a Green Revolution in Africa [AGRA], the broader work of the Gates Foundation, etc.) (McKeon 2015). Off-farm employment, which has practically always been one feature of rural life, has become increasingly vital to farmers' survival, pulling rural residents between the poles of differing livelihood strategies and uncertain fortunes (Bryceson 2002; Vandermeer 2011; van der Ploeg 2009). Still, across nine countries in Sub-Saharan Africa, "non-agricultural activities are ubiquitous (70 percent participation), [but] they still account on average for only about one third of total earnings," (Davis et al. 2017) and "agriculture remains the mainstay of rural livelihoods in SSA" (Christiaensen 2017). Across regions, the lack of pro-poor, redistributive land reform; uncertain land rights; shifting population patterns; and aging rural populations have also contributed to the declining farm size seen in most lower-income countries, while patterns of consolidation have seen land inequality and average farm size grow in most rich countries (Lowder et al. 2016; see also Figure 1, below). Notably, despite higher wealth and, in principle, access to significant amounts of resources, many small- and medium-scale farmers in richer countries face persistent challenges in sustaining viable livelihoods in the face of land-grabbing, corporate concentration and on-going industrialization of food systems (van der Ploeg 2009; Weingarten 2017).

There are over 570 million farms in the world, but approximately 85 % of farms are 2-5 ha in size, or smaller (Lowder et al. 2016, Samberg et al. 2016). In their 83-country sample, Samberg et al. further found that this 85 % of all farms operated on 30 % of agricultural land in the sampled countries but produced more than 70 % of the countries' total food calories and over 50 % of global food calories. Small and "medium"-sized farms (under 50 ha) devote more of their production to crops that directly nourish people, as opposed to the 45 % of crop-based calories that go to biofuels or feed (Cassidy et al. 2013). Small- and medium-scale farmers also produce over half of the world's micronutrients (Herrero et al. 2017; Ricciardi et al. 2018). Alongside the fact that most of the world's hungry lives in rural landscapes (IFAD 2010), there can be no doubt that supporting smallholders to achieve stable, diversified, low-input,

Figure 1: **Average farm size, 1960–2000.**

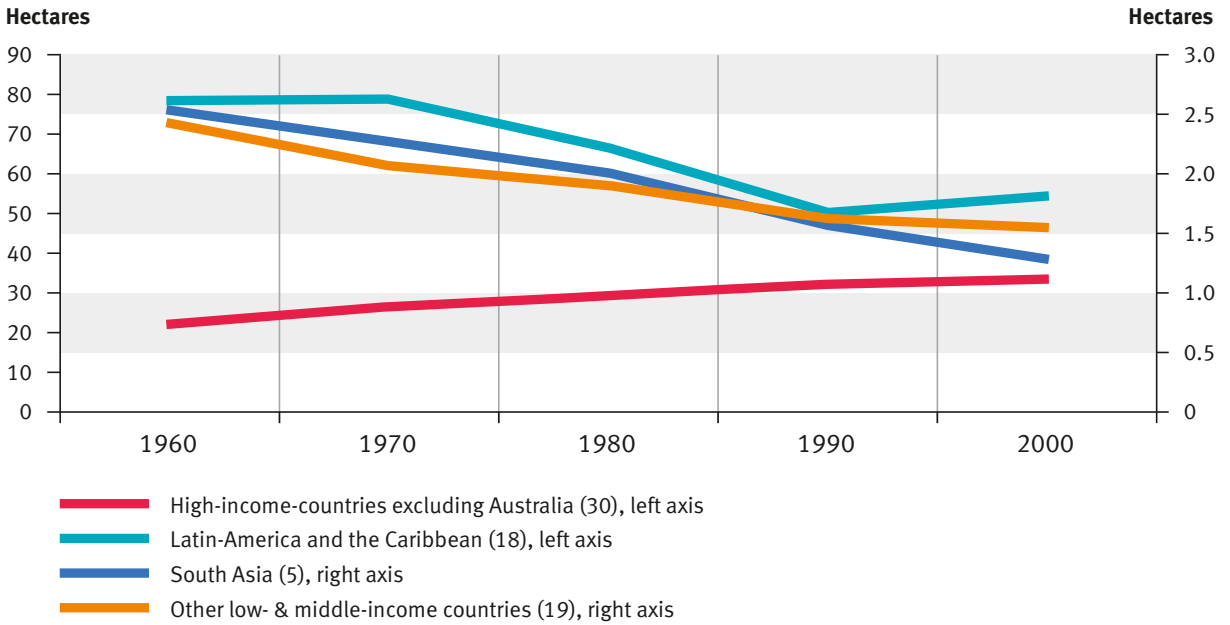


Figure from Lowder et al. (2016), p. 22, based on their calculations using FAO (2013) for average farm size, together with further data collected by Lowder et al. on the number of farms. The total number of countries included is indicated in parentheses. Reprinted here under Creative Commons License BY-NC-ND 4.0 (https://creativecommons.org/licenses/by-nc-nd/4.0/). Trendlines indicate the average farm size in each region in hectares. High-income-countries and Latin America and the Caribbean should be read against the left-hand axis; South Asia and Other low- & middle-income countries should be read against the right-hand axis.

remunerative, stimulating, sustainable and culturally-appropriate farm livelihoods is vital to future food security and the end to all three forms of malnutrition (Shetty 2006). Yet appropriate, locally-tailored policies and support for small-scale farmers are very much the exception, not the norm, throughout the world (Graeub et al. 2016; HLPE 2013).

Biodiversity loss, small-scale farming and climate change

The nexus between biodiversity and agriculture is being increasingly recognized, as they each pose risks and offer benefits to the other. The estimated rate of biodiversity loss is 100 to 1,000 times greater than the "background" rate, threatening to cause dramatic changes to our ecosystems, irreversible losses of unique organisms, and numerous other challenges to agriculture as the ecosystem functions that depend on these organisms and their complex interactions are lost.[3] In 2015, the FAO estimated that the uninternalized price of these services and their loss were equal to between 134 and 170 % of the production value of the studied agricultural goods. In other words, when looking at the environment, the true cost of many agricultural commodities could be nearly twice as high as current prices: a huge amount of food is *artificially cheap*. Professional auditing giant KPMG (*Klynveld Peat Marwick Goerdele*) further found, in their examination of multiple production areas, that "some sectors, such as food producers, would have no profits left if they had to pay the full cost of their negative environmental externalities and took no mitigating actions" (KPMG 2012, 2014). From carbon storage, water filtration, flood and storm mitigation, pollination, pest control, to aesthetics, resilience and stability, nonhuman organisms provide huge direct and indirect values for agriculture.

Moreover, most farmers wish to be good stewards of our environmental systems, particularly the world's hundreds of millions of small-scale farmers whose livelihoods depend all the more immediately on healthy ecosystems (Chappell et al. 2013). Chouinard et al. (2008) even showed that some farmers will sacrifice a degree of profits for the sake of stewardship. Nevertheless, how farmers interpret such stewardship, and their capabilities with regards to carrying it out, vary from context to context and farmer to farmer.[4] Furthermore, while climate change poses challenges across society, this is particularly the case for farmers, who not only may contribute to it through conversion of land to agriculture, use of petroleum-intensive inputs, and other practices, but also directly suffer from the effects of climate variability and increased temperatures. More frequent floods and droughts are only two of the most visible threats to agriculture from climate change. At the same time, farmers hold an immense number of tools to help mitigate climate change. But it is certainly possible to generate profitable livelihoods using fewer resources while protecting natural habitats on farm borders and adjacent land, enhancing genetic diversity in their production systems at genetic and landscape levels, particularly through the use of techniques like agroforestry, rotations, appropriate grazing practices, and cover cropping; and controversially, through pro-poor, redistributive land reform, which would likely increase productivity (Lipton 2009).[5]

Significant amounts of the world's remaining biodiversity are still present in small-scale farming systems, which are also habitats of rich culture and traditions (Barthel et al. 2013). Small-scale farmers grow a higher diversity of crops (Jarvis et al. 2008; Ricciardi et al. 2018) and agroecological farmers present unique opportunities to support biodiversity on-farm and (indirectly) off-farm (Chappell and Lavalle 2011; Perfecto et al. 2009). The link between cultural and biological diversity is perhaps most visible amongst indigenous peoples whose habitats coincide with several of the world's biodiversity hotspots, especially tropical forest landscapes (Barthel et al. 2013; Toledo 2001). However, conservation policies at various scales largely fail to support the resilience or viability of the biocultural mechanisms that bind humans and nature in agroecosystems; rather, increasingly commodified systems militate to separate and undermine these links (Chappell et al. 2013; Goodman and Redclift 2002; Scott 1976). While small-scale farming communities continue to evolve, innovate and in many cases even still thrive using traditional and locally-

[3] The "background rate" refers to the approximate average rate of extinction in earth's geological and biological history before humans became a primary contributor to extinctions.

[4] It is sometimes observed that some farmers, particularly poorer ones, may practice some form of "soil mining" or engage in other "vicious cycle" behaviors where their socioeconomic circumstances force them into degrading the environment their livelihoods depend on. While this certainly occurs in some cases, it is important to note that "even where poor people degrade the environment, this is often due to the poor being denied their rights to natural resources by wealthier elites and, in many cases, being pushed onto marginal lands more prone to degradation" (DFID et al. 2002; see also Chappell et al. 2013).

[5] Lipton and colleagues (1998) note that land reform is "classical but recently undervalued," by "otherwise well-informed people… There is almost no area of anti-poverty policy where popular, even professional opinion is so far removed from expert analysis and guidance on land reform," (Lipton et al. 1998, p. 112).
Vandermeer and Dietsch (2003) observed that "if increasing production is your goal, breaking up large farms and giving the land to small producers would be the best short-term solution."

adapted practices to provide for socioeconomic and environmental resilience and food sovereignty, the spaces for this have become more and more marginalized and difficult to maintain in contexts that have emphasized trade and corporate profit over food security, food sovereignty, and human rights (Chappell 2013; McKeon 2015; MISEREOR 2008).

Changes along the rural-urban continuum

The important challenges around the connected issues of malnutrition, rural development, biodiversity loss, and climate change bring us to the need to analyze our food systems beyond just agriculture and rural landscapes. The world's urban population is growing rapidly, in part as a result of the lack of policy support for sustainable livelihoods for smallholder farmers. Alongside this, diets are changing as animal products and processed foods with artificially-cheap prices are increasingly available and incomes (for some) continue rising. Calorie-dense but nutrition-light foods are composing larger and larger parts of people's diets, and are often nominally more affordable, and thus more accessible, to people with lower incomes. This "nutrition transition" is thought to be a significant part of the reason for increasing overweight and obesity, and while it is happening more rapidly in cities, the transition is taking place in many rural areas as well (Hawkes et al. 2017). Meanwhile, food processing and supermarket corporations are consolidating at a rapid pace, parallel to the consolidation seen in agricultural input markets (Howard 2016). This means that companies at many points in the "food chain" are able to exert pressure on farmers to pay more for inputs and accept lower prices for their products, while at the same time taking advantage of corporate market dominance and scale to sell highly-processed foods that appear cheap to consumers only because their real costs are not easily apparent (FAO 2015; Smith et al. 2011). The challenge for healthy food cultures and traditions, based in a diverse diet and adequate prices for farmers, is immense.

The potential of the alternative: Agroecology and food sovereignty

Smallholder farmers face numerous socioeconomic and environmental challenges and are not well-supported by current policies; but they also have immense potential and play a unique role in the possibilities for constructing more sustainable, just, vibrant and livable food systems. Small-scale agroecological farming has positive impacts on environmental quality, the social fabric of farming communities, and fair economic systems that allow for more inclusive participation (Chappell and LaValle 2011; Perfecto et al. 2009). Agroecological farmers and scholars increasingly dare to envision reinvigorated local, regional and national economies based on mutually reinforcing values of solidarity, economic justice and self-determination (Heuser et al. 2017; International Forum for Agroecology 2015a; Lyson 2012).

These values, along with those honoring stewardship, climate change mitigation, sociocultural diversity, biodiversity, and sustainable and dignified livelihoods are increasingly coming together under the heading of "agroecology" (see Box 1, and Figure 2). As outlined recently by Vaarst et al. (2018),

> agroecology's core principles include (1) resource recycling and minimizing losses in agrifood systems; (2) minimizing the use of external inputs; (3) basing practices and systems on local context, traditions, knowledge, and values; (4) building and maintaining socioecological resilience; (5) multifunctionality; (6) complexity and integration; (7) equitability; and (8) co-creation of processes that nourish the soil, the environment, plants, animals, humans, and landscapes as a whole. Agroecology is also increasingly defined as being composed of science, practice, and movement (Wezel et al. 2009).

Agroecology's scientific roots go back over 85 years, having developed alongside the modern versions of the fields of ecology, agronomy, and horticulture. Agroecology is particularly linked to ecology, which has advanced significantly over the past 150 years. Ecology's advancements have brought us ever-more sophisticated insights into how ecosystems and organisms interact, provide functions useful to humankind, and undergo continuous change as complex systems. However, practices mimicking these ecological functions preceded their formal scientific recognition, having been developed by farmers over thousands of years. Today's farmers continue to develop new practices as well, amongst themselves and in cooperation with researchers who respect the knowledge and autonomy of traditional farming communities, and who are committed

Box 1

MISEREOR's approach to agroecology and sustainable rural development

Agroecology is based on people-led-processes of transition towards self-reliant, resilient and sustainable farming and food systems. The approaches to achieving this transition spring from local contexts and are bottom-up and holistic, and contribute to empowerment, food sovereignty and the right to food. Agroecology promotes principles aimed at improving integration with the natural world, and justice and dignity for humans and the environment, rather than rules, recipes or one-size-fits-all solutions. The principles can be applied progressively but should result in joint application in order to bring about the needed improvements in the ecological, economic, social and political dimensions of agriculture and food systems.

In order to guarantee that agroecology effectively ensures good food for all and combats poverty, climate change and the loss of biodiversity, it is essential to initiate not just technical but also social and political changes. The conditions required to overcome social injustice and precarious economic situations in rural communities include access to local resources such as land; natural resources including seeds and water; preservation of natural diversity; deepening capacity and capabilities for self-help; appropriate organizations to represent communities' interests; small-scale farmer-friendly agrarian policies; and the enforcement of human rights.

Agroecology is therefore part of an inclusive transformation that offers livelihood security to large numbers of people in rural areas and enhances resource-poor farmers' and communities' ability to better cope with stress and risks. Relying mainly on subsistence and local marketing, smallholder farmers rarely need cost-intensive standards and certification systems. However, MISEREOR also supports alternative farmer-based quality systems that enable small-scale farmers to access new markets.

The term "agroecology" can go hand in hand with the terms "sustainable agriculture" as well as "ecological" and "organic" farming where they build on the principles elaborated here.

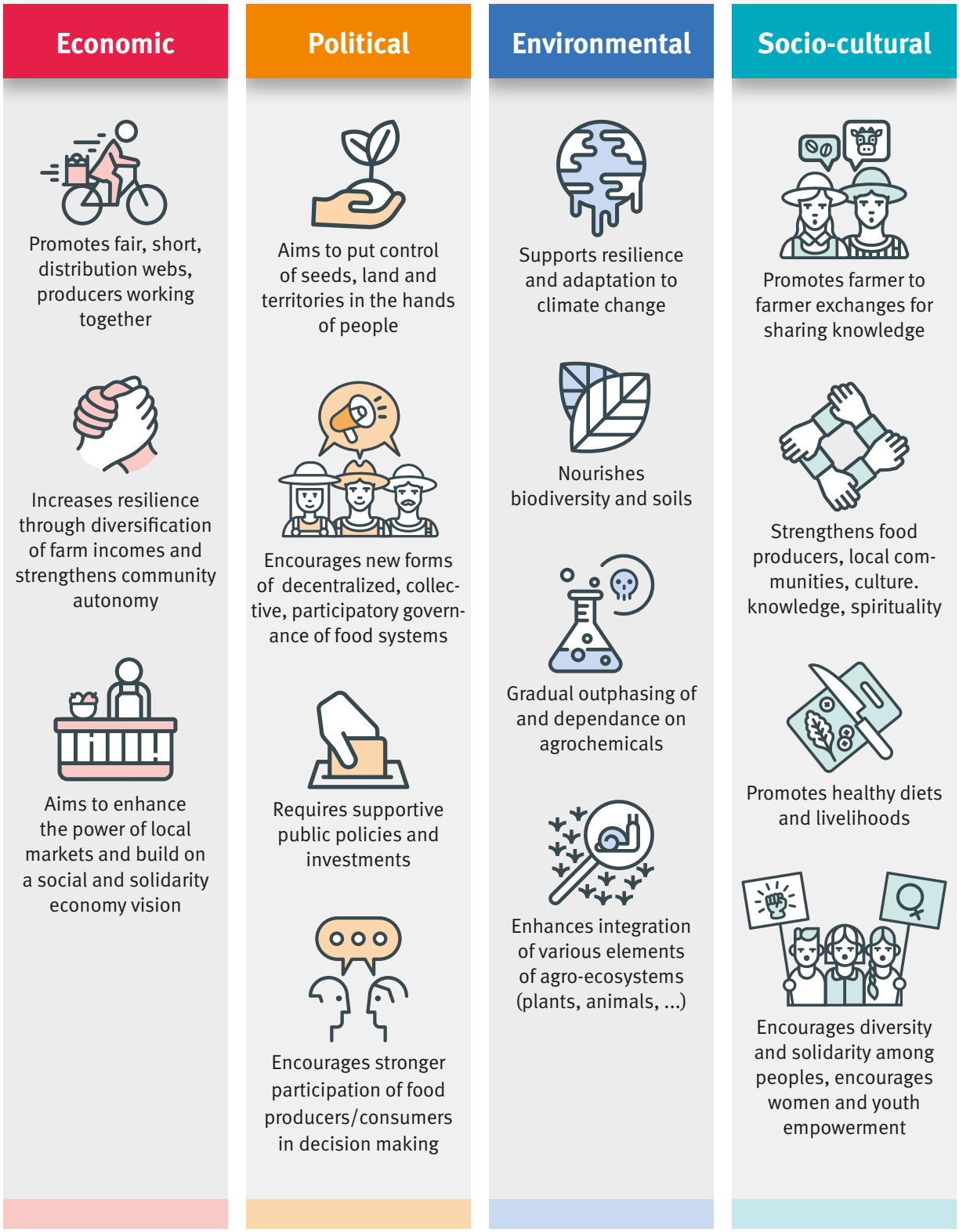
Indian farmers examining their field plants. Farmer-to-farmer exchange is an important element of learning in agroecology.

to empowering new and old forms of food sovereignty in such communities. Such approaches enable farmers and researchers to combine the best of new agroecological scientific knowledge with the continuously evolving traditional practices, innovations and wisdom of peasants.[6] Crop rotations, agroforestry, pest predators, cover crops/green manure, "push-pull" systems, intercropping, appropriate fallow periods, and integration of crop and livestock diversity are just some of the many agroecological techniques that draw on both old and new knowledge. Working together, farmers, researchers, and other groups (from urban residents, gardeners, and responsible consumers, to fisherfolk and pastoralists) make up the *movement* of agroecology that pushes for the social changes necessary to realize its potential.

Indeed, contributions from agronomists and agroecologists in Europe and Latin America have broadened agroecology to also emphasize farmer livelihoods, cul-

[6] It is important to note here that "peasant" is used in the sense of its root meaning as "person of the land," and not in the sense of the negative connotations it may bring up in English. *La Vía Campesina*, the International Peasants' Movement, among others, have staked claims to positive and dynamic definitions of the word.

Figure 2: **The principles of agroecology**



These principles are a set of broad "guidelines" that constitute the building blocks of agroecology, its practice and implementation.

Source: CIDSE 2018

ture, and social context, including the important barriers and challenges posed by repeated patterns of exploitation and expropriation from small-scale farmers around the world (Araghi 2008; Chappell et al. 2013; Pimbert, 2018). Given these patterns and the clear and rising environmental costs of input-intensive agriculture, agroecology has thus also rooted itself strongly in social critique and social movements for change.

With respects to its practical effects and advantages, the alternative practices used in agroecology and its related approaches lower the need for external inputs (particularly seeds, fertilizers and pesticides) and can thus contribute to both increased income and lower energy use (Clark and Tilman 2017; Crowder and Reganold 2015; LaCanne and Lundgren 2018). On the other hand, there is a contentious debate about whether yield differs between agroecological systems and conventional systems, especially given the context-dependence and variation within agroecological systems. Comparing organic and conventional systems, Ponisio et al. (2015) found that organic systems had 20% lower yields, but when crop rotations and polyculture were used, this difference was cut in half. Further, when looking specifically at African agriculture, Pretty et al. (2011) found that shifts towards more agroecological approaches amongst 40 projects with 10.4 million farmers on 12.75 million ha achieved, on average, more than a doubling of crop yields compared to the previous (varied) practices.[7] Previous work with MASIPAG, a MISEREOR partner in the Philippines, also found that organic rice yields compared favorably to yields of conventional farmers in the same regions (discussed below, in the section *MISEREOR's vision for agroecology*). With regards to the 40 projects examined by Pretty et al., they went on to cite "seven lessons" learned in terms of what made them effective:

i. Participatory, linked-up methods connecting scientists and farmers to develop practices that combined crops and livestock;
ii. New infrastructures that built trust and information sharing among farmers, farmer organizations, research actors, spaces of governance, and local actors such as banks and NGOs;
iii. Improvement of farmer knowledge and capacity through Farmer Field Schools, farmer trainers, videos, and "modern" information technology;
iv. Appropriate engagement with the private sector and developing farmers' capacity and knowledge of markets and business;
v. Particular focus on women's representation, education, financial, technological, and social needs;
vi. Insuring the availability of appropriate financial resources for farmers (credit and finance);
vii. Ensuring public sector support to insure provision of necessary public goods (secure land tenures, supportive physical, social, and research infrastructures).

Within these lessons learned, one also sees the importance of dealing with local, cultural and very humanistic factors, such as supporting farmers' confidence in themselves; experimenters and experts with important prior knowledge and wisdom, and further ability to improve; and understanding the constraints and trajectory behind existing barriers and problems in local production systems.

Agroecology as a pathway to sustainable food systems

Agroecology is sometimes argued to conceptually encompass the entire food system, but classically has focused on the agricultural side. But of course, the issues of shifting diets and the influence of the food industry affect the dynamics of agricultural landscapes. Analyses from this broader point of view make up the "ecological political economy" tradition of agroecology (Buttel 2007; Méndez et al. 2013). Observers in this tradition have noted that "farmers, workers and consumers often face constrained choices in how they participate in the agrifood systems because of… asymmetric power relationships… there has been an increase in concentration in almost all sectors of the agrifood industry in the USA," with similar trends globally (Hendrickson 2015). In the markets from seeds, to agrochemicals, meat processing, and food retailing, the top four companies in each area control over 50 % of US and global markets (Hendrickson et al. 2017). Meanwhile, in 2012 the fast-food industry spent over US$4.5 billion in advertising in the United States alone for "mostly unhealthy products" (Harris et al. 2013), and spending on junk food advertising is 30 times higher than spending promoting healthy food in the United Kingdom (O'Dowd 2017). This has led even some "mainstream" economic analyses to contend that

[7] This means that in some cases the improvements would have been measured versus a low-intensity, low-input prior system, and in other cases, improvements were seen versus higher-input conventional systems, though in few or no cases was it likely to have been a "high-input" conventional system in terms of the intensity of fertilizer and pesticide use seen in many parts of Europe or the United States.

market mechanisms around food and eating are suffering from a "breakdown" (Smith et al. 2011).

Despite the systems-wide challenges facing us, from agricultural production to food marketing and consumption – and agroecology's history of critique – analyses of entire food systems through the lens of agroecology are scarce (Vaarst et al. 2018). Some, like the international peasants' rights movement La Vía Campesina, have effectively argued that agroecology is incomplete without *food sovereignty* – the right of all communities to self-determine what they eat, what they grow, how they grow it, and how it is valued and exchanged. Proponents for food sovereignty acknowledge that it requires the reconsideration of the systems governing food and agriculture, in order to create spaces and opportunities for democratic participation, deliberation and control.

The global agroecological movement and food sovereignty

In 2016 more than 500 representatives from more than 80 countries came together in Mali to issue the Nyéléni Declaration on Agroecology (International Forum on Agroecology 2015a). This document lays out the principles, challenges, and needed changes as seen by representatives from social movement organizations of small-scale farmers, the landless, rural workers, indigenous peoples, hunter-gatherers, artisanal fisherfolk, pastoralists and nomadic peoples, urban communities, consumers, and others.

The excerpt below is a good example of how the scientific and practical proceed necessarily to the social and movement aspects. It is only reasonable to point

Box 2

"Our common pillars and principles of agroecology"

Agroecology is a way of life and the language of Nature that we learn as her children. It is not a mere set of technologies or production practices. It cannot be implemented the same way in all territories. Rather it is based on principles that, while they may be similar across the diversity of our territories, can [be] and are practiced in many different ways, with each sector contributing their own colors of their local reality and culture, while always respecting Mother Earth and our common, shared values.

The production practices of agroecology (such as intercropping, traditional fishing and mobile pastoralism, integrating crops, trees, livestock and fish, manuring, compost, local seeds and animal breeds, etc.) are based on ecological principles like building life in the soil, recycling nutrients, the dynamic management of biodiversity and energy conservation at all scales. Agroecology drastically reduces our use of externally-purchased inputs that must be bought from industry. There is no use of agrotoxins, artificial hormones, GMOs or other dangerous new technologies in Agroecology.

Territories are a fundamental pillar of agroecology. Peoples and communities have the right to maintain their own spiritual and material relationships to their lands. They are entitled to secure, develop, control, and reconstruct their customary social structures and to administer their lands and territories, including fishing grounds, both politically and socially. This implies the full recognition of their laws, traditions, customs, tenure systems, and institutions, and constitutes the recognition of the self-determination and autonomy of peoples.

The autonomy of agroecology displaces the control of global markets and generates self-governance by communities. It means we minimize the use of purchased inputs that come from outside. It requires the reshaping of markets so that they are based on the principles of solidarity economy and the ethics of responsible production and consumption.

Agroecology is political; it requires us to challenge and transform structures of power in society. We need to put the control of seeds, biodiversity, land and territories, waters, knowledge, culture and the commons in the hands of the peoples who feed the world.

Women and their knowledge, values, vision and leadership are critical for moving forward... For agroecology to achieve its full potential, there must be equal distribution of power, tasks, decision-making and remuneration.

Excerpt from The Nyéléni Declaration on Agroecology
(International Forum on Agroecology 2015a)

Local communities and grassroots organizations are key actors in developing proposals and making public demands for an agroecological transition.

out that if "business as usual is not an option," then there must be social movements to push for and achieve the alternative. Private and public institutions do not change from "business as usual," or leave behind discriminatory and unequal social structures and consider the well-being of both people and nature without agitation by and pressure from the affected and their allies.

From the point of view of practice, agroecology can support enhanced livelihoods and incomes for farmers, as increased use of low- and no-input ecological processes decreases the need to buy inputs – with the possible exception of labor; agroecology can require greater labor, which can be a positive in terms of boosting local employment (Finley et al. 2018; Wittman et al. 2017), but must be approached based on local context (Pretty et al. 2011). Premiums for sustainable and organic foods, when available, can also contribute to agroecological farmers' economic security. Agroecology similarly advocates for short-chain, local markets, although context and detailed arrangements matter here as well. Equally important is agroecology's emphasis on creating shared values between producer and consumer (Little et al. 2010), and where possible link local production to public procurement schemes for circular economies (FAO, 2018).

Agroecology and food sovereignty also place high importance on addressing issues of gender inequality, although the inclusion of gender empowerment cannot be taken for granted and work remains to ensure its centrality in agroecology. Recent studies, however, have shown the power of agroecology that properly incorporates gender empowerment: participation in the Malawi Farmer to Farmer Agroecology project was correlated with large reductions in food insecurity, and "strong evidence of change in gender relations between men and women," (Bezner-Kerr et al. 2016; Kangmennaang et al. 2017). There is also ample evidence that the diversity and practices associated with agroecology increase farmers' resilience to economic and environmental tumult, allowing them to recover much more quickly from, for example, the effects of a hurricane and providing the necessary security through self-provisioning in the face of market fluctuations (Chappell et al. 2013; Holt-Giménez 2002). Given the particular challenges faced by small-scale farmers in terms of limited capital, increased vulnerability to low prices and price volatility, and high dependence on local environmental conditions, the socioecological and economic resilience of agroecological systems is of especial importance for the survival and flourishing of these billions of farmers.

Agroecology in the international arena

Research and experience from cases around the world have shown the value agroecology provides to small-scale farmers, as well as the environment. Agroecology particularly has much to offer to the estimated 80 % of South Asian farmers and 90 % of Sub-Saharan African farmers who are smallholders (<5 ha); over 60 % of farms in both of these regions are in fact less than 1 ha (Lowder et al. 2016). For this reason, agroecology has been taking a growing position in international and national debates about the future of agriculture and support for the majority of the world's farmers. This includes recent reports and events by the International Panel of Experts on Sustainable Food Systems (e.g., IPES-Food 2016), both the current and former Special Rapporteurs on the Right to Food (De Schutter 2011; Elver 2015), Oxfam (Parmentier 2014), the Alliance for Food Sovereignty in Africa (AFSA 2016), the Institute for Agriculture and Trade Policy (Varghese and Hansen-Kuhn 2013) and MISEREOR itself (Bachmann et al. 2009; Bachmann et al. 2017; Heuser et al. 2017). These works build on the long efforts of grassroots organizations, movements, and numerous academic agroecologists, alongside an on-going series of international and regional symposia on agroecology hosted by the Food and Agriculture Organization of the United Nations (FAO 2018). (See the Annex for a partial list of recent reports on agroecology.) Agroecology, it is beginning to feel, is everywhere; making it all the more important for concerned actors, practitioners, and civil society to maintain pressure and support for agroecology's full gender-sensitive, political, ecological, pro-small-scale food producer and pro-poor orientation, alongside food sovereignty and food justice, so that its full potential can be realized.

MISEREOR's vision for agroecology

MISEREOR's principles guiding its research and development interventions are aligned with a transformative approach to agroecology (Heuser et al. 2017; see also Box 1, p. 14). MISEREOR works closely with community-based organizations and researchers who share visions for action and fundamental shifts to support a sustainable and just food future. MISEREOR and its partner organizations throughout the world strive to achieve agricultural and food systems that promote agricultural biodiversity and organic production methods; protect farmers' rights over seed, land and other resources; and recognise the values of local knowledge, solidarity and diversity, from the levels of production, to markets, and consumption, as expressed in the recent collaborative report entitled *Better and Different! Transforming Food Systems through Agroecology* (Heuser et al. 2017). MISEREOR has contributed to amplifying the voices of peasants, women farmers, indigenous communities and other marginalized groups, through partnering with movements demanding changes from top-down approaches towards those that include all voices in democratized and food-sovereign food systems. As a result of decades-long trust-building based on common values and aims at local community levels, and working in solidarity with civil society and movement groups in international policy forums, MISEREOR has contributed to implementing the science, practice and movement of agroecology and the effective quest for a new paradigm in food and agriculture.

Previous studies

Some of MISEREOR's contributions have been articulated in previous studies covering on-the-ground partners' work conducted with collaboration and support from MISEREOR, collated and published by experienced researchers together with community-based organizations. These studies have affirmed the findings of IPES-Food, the Nyéléni Forum, and the other reports described in the previous section, particularly with regards to the risks and disadvantages of the dominant conventional/industrial food system; the advantages of agroecological farming systems, particularly for resource-poor farmers; and the wealth of further opportunities offered by agroecological approaches. The work of local actors in partnership with MISEREOR have con-

firmed the pro-poor, more sustainable, and more resilient characteristics of agroecology. At the same time, previous studies have also shown the continuing limitations and challenges for out-scaling agroecological practices under current dominant development frameworks. It is worth noting that such development frameworks have historically *and explicitly* accorded food security and agricultural livelihoods lower priority than favourable and increased trade and economic growth, whether or not these contributed to fighting hunger (McKeon 2015). As such, current challenges include continuing under-provision and underfunding of agroecological training and inputs for small-scale farmers, insufficient space for addressing gender and youth interests in agriculture, and continuing, unwarranted faith in market-based and unaccountable government approaches that do not include the voice and enhance the autonomy of all consumers and producers (Bachmann et al. 2009; Bachmann et al. 2017; Martens and Richter 2014; Weis 2007).

The potential of and challenges to agroecology are not new to the work of MISEREOR and its allies (see, e.g., CIDSE 2018; Engel et al. 2017; Johannsen et al. 2005; MISEREOR 2008). However, it is worth highlighting two of MISEREOR's previous studies in particular, which stand out for the strong evidence they found for the benefits of agroecological approaches; one in the Philippines, and one in Uganda.

The Philippines (Bachmann et al. 2009)
Between 2007 and 2008, MASIPAG – a farmer-led partnership between scientists and farmers in the Philippines – together with MISEREOR, undertook one of the largest studies ever on organic rice-based agricultural systems and sustainable agriculture. The study incorporated the experiences of 840 organic, partially organic (in transition) and conventional farmers. Remarkably, the poorest families in the study obtained especially large benefits from MASIPAG'S transformative work. The poorest quarter of full organic farmers had an average net annual agricultural income (including the value of consumption of their own production) of 12,610 pesos per hectare per year, while conventional farmers' income averaged only 8,590 pesos – an advantage of 31.1 % for organic farmers. Organic MASIPAG farmers reported 83-100 % lower expenditures for "inputs, seed, fertilizer, pesticides for all crops or livestock"[8], with a ~50 % reduction in average agricultural production costs overall. The study also found significant differences in debt amongst the study groups, with the fully organic farmers reporting a positive average annual balance of 4,749 pesos, while farmers in the reference group reported an annual average *debt* of 4,992 pesos. Even amongst the 25 % least successful farmers in each group, reference group farmers reported debt levels nearly three times higher than comparable organic farmers (-10,893 pesos average annual debt compared to -3,366 pesos for reference and organic farmers, respectively). The results therefore indicated the particularly strong contributions of MASIGPAG's approach towards poverty reduction.

A significant practical area of MASIPAG's work was rice diversity, as it continues to be a major food source in the Philippines. While much of rice's varietal diversity in the Philippines has been replaced by the supposedly-promising high-yielding varieties

of the Green Revolution, the MASIPAG collaboration demonstrated significant success in empowering farmers to become breeders and stewards of new and old varieties. The results of this farmer-led research and experimentation were increased yield stability alongside reduced dependency on external inputs such as commercial fertilisers, pesticides and hybrid commercial seeds. It was possibly one of the first institutionalized examples of farmer-led breeding efforts with a clear focus on breeding varieties for local conditions, including poor soils and organic practices: since 1985, a total of 1,000 new rice varieties by 65 farmer-breeders have been developed (77 % of the participating organic farmers had selected their own seeds while only 25 % of reference group farmers did so). And their efforts appear to have paid off: mean yields for organic farmers matched those of reference farmers while using no synthetic inputs, saving them an average of 7,000-10,000 pesos per year.

Organic farmers in the study also grew, on average, 50 % more crop species than conventional farmers. The study also provided evidence that farmer-led diversification led to increased food security and food sovereignty: 88 % of organic farmers rated their food security as better or much better compared to 2000, a clear advantage when compared to the 44 % of conventional farmers giving the same response. In terms of household consumption and nutrition, self-reports revealed that organic farmers ate 68 % more vegetables and 56 % more fruit, 55 % more protein-rich staples, and 40 % more meat than they had in 2000. These represent 2- to 3.7-fold larger increases in these items compared to the reference group of conventional farmers.

MASIPAG takes a strategy of promoting working together as a network, providing greater opportunities for participation and decision-making by women and youth.

[8] The 5% trimmed mean expenditures were 7,691 pesos for reference farmers and 0 pesos for full organic farmers in one study area, and 12,293 pesos compared to 2,065 pesos across two other study areas.

Diversification of food crops to enable rural farmers' families to ensure a balanced diet is a key element of agroecology, and of special interest for poorer populations in rural areas.

Although researchers have pointed out that the introduction of Green Revolution technologies often eroded women's agency and decision-making power (Negin et al. 2009), MASIPAG has made women's leadership and increased gender equality a clear priority. Joint decision-making was much higher (51-60 %) among in-conversion farmers compared to the reference group (39 %) and, surprisingly, fully organic farmers (41 %); while the frequency of women being sole decision-makers was 3 % for reference farmers, 5-6.3% among farmers in conversion, and 7 % for fully organic farms. Clearly, men still wield disproportionate power, but Wright (2014) has argued that the "many women leaders in MASIPAG" nonetheless represent important acts of resistance and change:

> Many women are drawn to MASIPAG because it advocates a different way of making decisions on the farm and in the family… The act of resistance here is not where unequal gender relations are reproduced, but where they are not. This is the disruption (p. 710).

Uganda (Bachmann et al. 2017)

A similar study was conducted in Uganda, where MISEREOR has worked with six partner organizations (Agency for Integrated Rural Development/AFIRD; Caritas Kabale, Caritas Kampala, Caritas Hoima, Samadi and Caritas Fort Portal) to empower smallholders by promoting agroecological farm management practices, including crop diversification, soil and water conservation, and livestock integration. The work of these organizations particularly seeks to address the needs of the most resource-poor farmers. Their approach was further aimed at providing an alternative to the government's focus on foreign capital provided by large-scale private enterprises, which disproportionately favors contract farming and the cultivation of a few, specialized crops – further marginalizing the country's smallholder sector.

In order to assess their progress, these organizations and MISEREOR carried out joint impact studies to validate their work in 2005 and in 2015. The 2015 study compared farmers involved in partners' programs supporting agroecology (termed Sustainable Agriculture/SA in the study) with a group of reference farmers who were not engaged with extension. A third group was also included in the comparative study, comprised of contract farmers assigned to tea outgrower schemes. The results of the study, which covered 714 households, indicated advantages for farmers in the SA/agroecology programs in terms of food security, natural pest and disease mitigation, and nutritional intake, although numerous challenges at the regional and community level made it difficult to conclusively connect all elements of uptake and effects of the various socio-ecological aspects of agroecological production systems.

Evidence from the study did indicate that diversification and increased livestock led to significant achievements for food security and nutrition. On average, SA farmers cultivated 23 crops compared to 15 in the reference group and 18 among tea outgrowers. In particular, the SA group produced crops indigenous to Uganda and used mainly for household consumption, such as leafy green vegetables, bitter berries and several varieties of yams. Fifty percent of SA farmers reported access to greater amounts of meat, milk and eggs than five to ten

years prior. Overall, the field survey results indicated that more than 80 % of SA farmers had access to ample amounts of food throughout the previous three years; just 60 % of outgrowers and 54 % of the reference sample reported the same. In fact, approximately one quarter of farmers in the latter two groups reported suffering from substantial food shortages for two to three months annually, compared to less than 9 % of SA farmers. At the extreme end, 5.6 % of farmers in the reference group, 2.6 % of outgrowers, and 2.4 % of SA farmers reported "hunger gaps" of four months or more. These figures are likely influenced by the positive impacts of SA farmers' increased consumption of their own production; this can directly positively impact income by reducing food expenditures and can help maintain dietary diversity and food access. The median value of all crops grown by SA farming families for self-sufficiency was found to be almost twice that of the reference group, with an even larger ratio amongst lower income percentiles.

In other areas, the picture is more complex, but still reflected likely positive and pro-poor effects of moving towards SA. In particular, due to a pervasive banana wilt, both SA farmers and the reference group faced alarming rates of decline in yields of this important crop: 13 % and 33 % respectively. It is worth specifically noting that the decline was less than half as steep for SA farmers. However, pesticide use did increase significantly among SA farmers, where the proportion who reported using pesticides quadrupled (5 % to 21 %), while the proportion dropped by almost 75 % for reference farmers (22.9 % to 6 %). Farmers' herbicide use was also higher amongst SA farmers than the reference group (29 % vs. 23 %). At the same time, it is notable that input usage in all groups was highly skewed: the median SA and reference farmer reported no expenditures on fertilizers, and approximately equal expenditures on pesticides. Meanwhile, at the 90th percentile, SA and reference farmers both spent 100,000 Ugandan shillings or more on fertilizers and pesticides. Thus, increased pesticide and fertilizer usage occurred among a minority of SA farmers, while the median farmer spent nothing on those inputs. Interestingly, if we assume that the lowest-income farmers in the study are the farmers with the lowest-yielding fields, the results indicate that the majority of SA farmers who refrained from increasing inputs may have seen the biggest benefits from adopting agroecological practices. While the crop yields among the 5th, 10th, and 25th least productive percentiles of SA and reference farmers were quite similar in 2005, by 2015 the SA farmers in those percentiles all saw approximately 50 % increases in yields, while reference farmers' yields in these brackets stayed approximately the same, or even dropped slightly (yields for farmers in the 75th and 90th percentiles dropped for both SA and reference farmers). Although the overall picture is therefore complicated, results from Uganda overall appear to reinforce the uniquely pro-poor characteristics of agroecological approaches and highlight the lack of resilience of high-synthetic-input systems, whether paired with other agroecological methods or not.

Country-specific backgrounds and introducton to current study

Background and methodology

The on-going work in India, Brazil and Senegal at the focus of the remainder of this report was supported by three local non-governmental organizations (NGOs) who partnered with MISEREOR: *Swayam Shikshan Prayog* ("self-learning by doing") in the Osmanabad district of India; *Centro Sabiá* (the Sabiá Centre) in Pernambuco state in Brazil; and *ENDA Pronat* (abbreviation of "natural protection of the soil") in the Fatick district of Senegal (see Figure 3; and Boxes 3, 4, and 5, next section). Each organization provided advice, training and support for agroecology to small-scale farmers, including not just practices, but also peer-to-peer learning, scientific principles, and social change for equity, rights, and sustainability.

The case studies in these three countries closely followed the methodology of previous studies in Uganda and the Philippines: one group of small-scale farmers working with a local partner organization supporting agroecological approaches was compared to an equal-sized reference group composed of local, small-scale

Table 1: **Methods and participants**

Method	Country	Quantitative data collection	
		Reference Group	Agroecology
Standardized questionnaire	India[9]	200	200
	Senegal[10]	185	185
	Brazil	201	218

Method	Country	Qualitative discussion group	
		Number of groups or in-depth interviews	Total participants
Group discussions	India	5	42
	Senegal	5	73
	Brazil	3	45
Singular interviews	India	10	10
	Senegal	3	3
	Brazil	3	3

farming families who were not engaged with agroecology. The studies were carried out in April/May 2016 (India); July/August 2016 (Brazil); and March/April 2017 (Senegal). Each study, conducted in coordination with the local partner organization, consisted of a preliminary training and refinement phase for survey questionnaires, followed by data collection conducted by locally-based interviewers using a detailed quantitative questionnaire to obtain household income and production analysis. In addition, qualitative group discussions and in-depth discussions with individual households were held along with consultations with research consultants and partner organizations (Table 1). Data analysis was subsequently conducted over several months and included discussions and validation of preliminary results at on-site workshops with the partner organizations and farmers.[11]

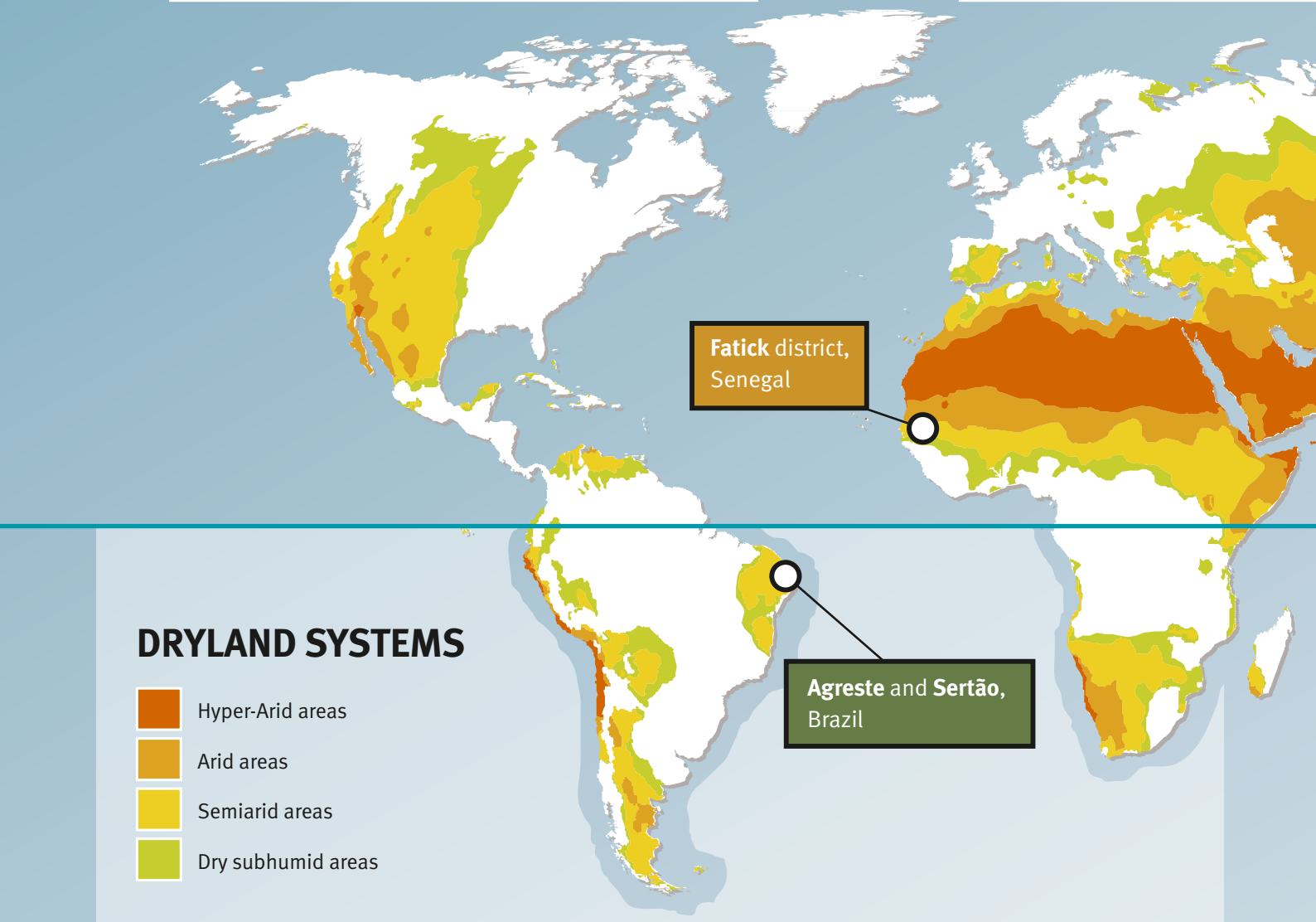
Cross-case biophysical context: The semiarid

The studied processes took place in semiarid regions in all three countries, which in many ways presented a more challenging and restrictive environment for agricultural production than the humid environments of the Philippines and Uganda. For instance, while many trees can grow to a considerable height and supply important ecological and microclimatic services after only four to six years in locations with an average precipitation of 1,000 mm or more per year, a similar level of tree development might take at least twice this amount of time in semiarid locations. In the regions of Brazil, India, and Senegal pertinent to this report, long-term precipitation averages between 550 and 800 mm per annum. Beyond the significantly lower amount of precipitation, an additional major problem for agriculture in semiarid areas is the fact that most annual precipitation is also concentrated in a small portion of the year and can be unpredictable. Unsurprisingly, semiarid regions also typically have a high risk of drought – though flooding has also become a common risk over the past two decades. Agriculture is thus inherently precarious in such regions, particularly for small-scale family farmers, who tend to possess lower amounts of capital and support to deal with the fragility of the environment and the restrictions it places on agriculture.

[9] In order to avoid distortions caused by variations in farm size, the investigation in India was limited to smallholder families with less than 1.2 ha of land.

[10] For the study in Senegal, a gender and civil status correction was performed to compensate for differences between the study groups.

[11] A methodology and assessment expert team was present in each case. In India and Senegal this team included a German consultant and a locally-based expert. The Indian team also included a Brazilian consultant, who subsequently led the study in Brazil with a second Brazilian expert. With regards to project partners, one to three partner NGO employees participated in each stage throughout the process. In order to conduct the household interviews, seven to ten local students were trained as researchers in each country.



DRYLAND SYSTEMS

- Hyper-Arid areas
- Arid areas
- Semiarid areas
- Dry subhumid areas

DRYLANDS FACE NUMEROUS CHALLENGES:

➜ Biodiversity loss

Water limitations and climatic extremes threaten vulnerable endemic species and slow down recovery.

➜ Desertification

Drylands are highly prone to soil degradation and desertification.

➜ Climate change

increases the frequency, magnitude and severity of extreme weather events, such as prolonged droughts, intense heat waves, heavy precipitation and strong winds.

➜ Water scarcity

aggravates the effects of desertification. In turn, land degradation negatively affects the availability, quality and quantity of water resources.

➜ Poverty and food insecurity

Drylands have some of the highest levels of poverty and hunger worldwide. Their socioeconomic conditions lag behind those of other regions (UNDP–UNCCD, 2011).

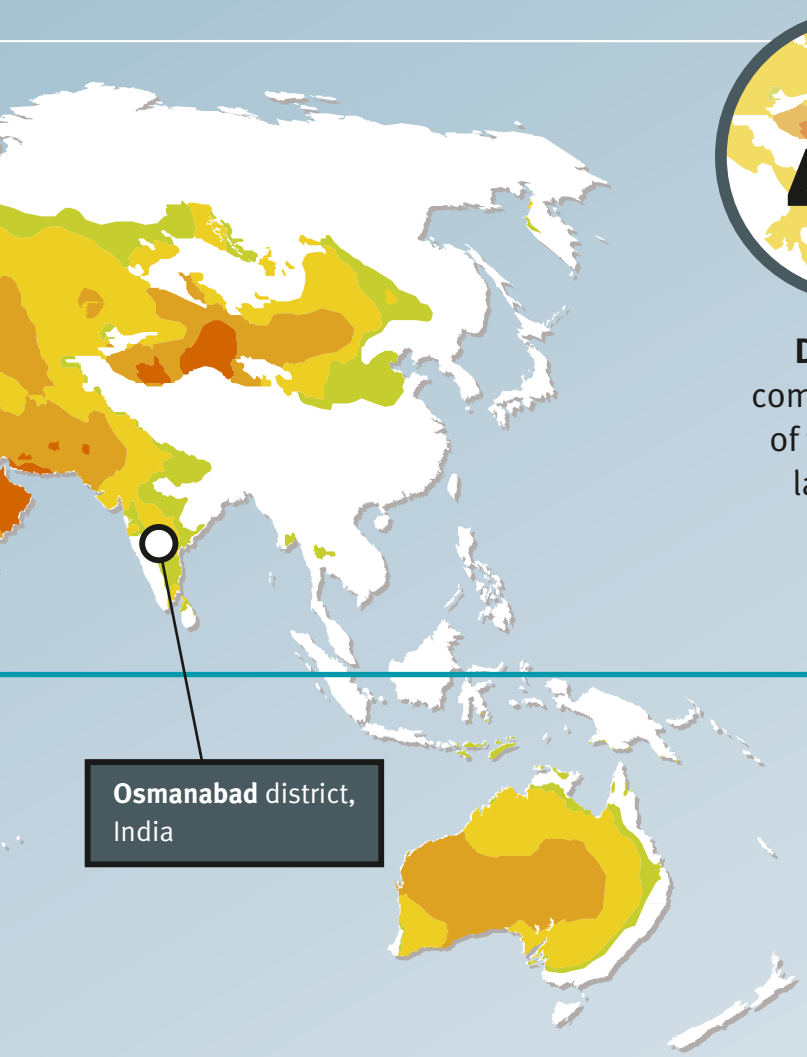
➜ Migration and conflict

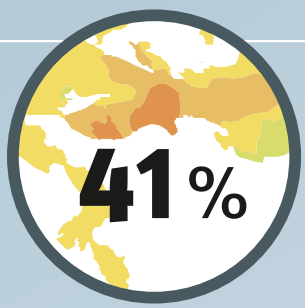
Up to 50 million people could be compelled to migrate between 2010 to 2020 as a result of desertification (UNCCD, 2011).

➜ Weak governance and inadequate policies

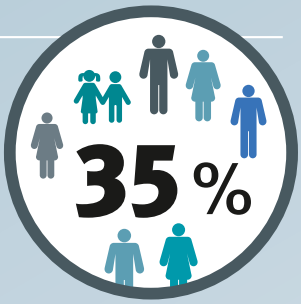
Lack of effective policies, investment, institutional support, coherent multi-sectoral approaches and planning processes to support dryland communities and the sustainable management of their resources.

Source: http://www.fao.org/dryland-forestry/background/challenges-today-and-ahead/en/





Drylands comprise 41 % of the global land area

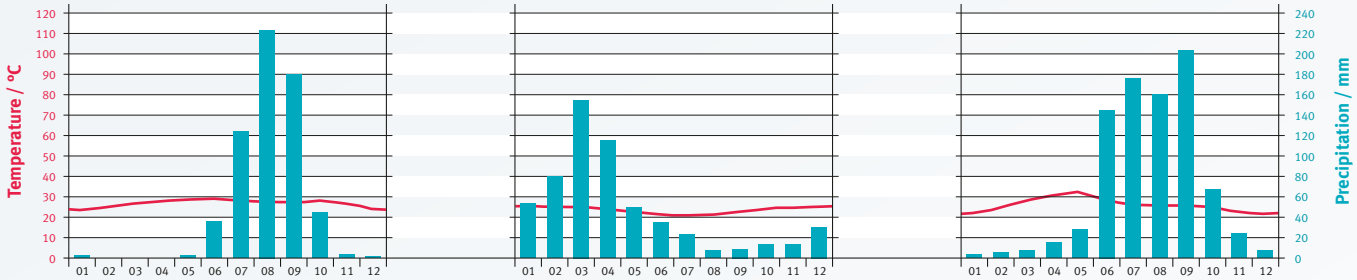


Drylands are home to 35 % of the global population (in 2000)

Source: Millenium Ecosystem Assessment

Hot semiarid climates – a challenging environment

Hot semiarid climates receive precipitation below potential evapotranspiration and tend to have hot, sometimes extremely hot, summers and warm to cool winters. Semiarid regions face long dry periods. **Rainfall is concentrated in a few months of the year, when excessive rains can fall in 24 hours or less.**



Senegal, Fatick district

Unpredictable alternation of dry years and wet years: Since 1960, average annual rainfall has been 568 mm, ranging from a minimum 260 mm(-54 %) to a maximum of 951 mm (+68 %). Rain concentrates on a few months per year.

Source: Bachmann et al. 2018

Brazil, Sertão region

Both the Agreste and Sertão region indicate a systematic decrease in precipitation and an increase in mean air temperature. In 2015, average rainfall was 515 mm (Sertão) and 1,160 mm (Agreste), a decrease of 20 % and 10 % respectively, compared with historic average rainfall.

Source: Gonçalves, et al. 2018

India, Osmanabad district

2014 and 2015 were severe droughts, with rainfall decreasing to 457 mm in 2014 and 359 mm in 2015, both years 33-48 % below the historic overall average of 666 mm rainfall.

Source: Bachmann, Gonçalves, Nandul 2017

Source: https://en.climate-data.org

Country context: India

The Indian policy environment for agriculture and food security

India has long protected its national markets and for many years had a limited orientation towards export. 87 % of India's approximately 90 million farms count as small-scale (Samberg et al. 2016, Supplementary Data). The Indian state was a promoter of the Green Revolution, with a particular focus (lasting through the present day) on some high potential areas (e.g., Haryana, Punjab), which in turn provide rice and wheat for India's Targeted Public Distribution System (PDS). These areas also suffer from the many environmental and health problems that have regularly accompanied the Green Revolution's industrial approaches. Other cash crops like soy, cotton and sugarcane have also been promoted, and agro-industry has a high level of influence, ushering in higher production costs and less resilient monocrop-focused systems alongside a loss of knowledge of traditional, diversity-based food systems. In short, current agricultural policies in India are dominated by socioeconomic development models focused on promoting rapid industrialization and export-oriented crops in agriculture. Such policy approaches almost exclusively benefit commercial enterprises with pre-existing and sufficient capital to match the high investment costs. Small-scale family farms, on the other hand, often find themselves under pressure to merge into larger farmer unions in order to respond and move towards an increasingly industrial model requiring costly inputs (hybrid seeds, synthetic fertilisers, heavy machinery) and competition in markets where prices may be near or below the cost of production. Such policy approaches driving towards larger scales and consolidation promote a development model that excludes the majority of rural people and raise the risk of losing out on the benefits of well-supported smaller-scale farms. Such benefits include increased local employment opportunities and stronger local economies (see e.g. Wittman et al. 2017), as well as productivity: "[the] productivity of small and marginal farmers is more than the large farmers, but they have received lower prices than large farmers due to lack of business knowledge, negotiating experience, holding capacity and collective organization" (Wangarwar 2016, 105).

Most of the farmers in India are smallholders.

India's PDS programs provide subsidized wheat and rice, and a few other goods, throughout the country, procuring most of the two grains from states with large surpluses. According to Bhattacharya et al.:

> As a result, farmers in surplus states are better off economically… the distribution of subsidized wheat and rice in poorer areas [may exert] downward pressure on the prices of local coarse grain, which hurts local and small-scale farmers of those grains…. [triggering] inequality between farmers in surplus states and those in arid and semiarid areas (2018, 55).

Additionally, two recent studies indicate that PDS's subsidization of wheat and rice may decrease consumption of "food items that are richer in micronutrients" such as coarse grains, and lower "micronutrient intake among a population that suffers from high levels of micronutrient deficiency" (Muchomba and Kaushal 2016; see also Kaushal and Muchomba 2015).

In response to such trends, some NGOs and women-led farmer networks in southern India have mobilized around the revival and recognition of small-scale grains and proposed replacing rice from the PDS with local millets, seeking to support local livelihoods at the same time as providing better nutrition (PTI 2018; Sakkhari 2009).

Figure 4: **Location of the Osmanabad district**

Gender and agriculture in India

Women in India, despite their significant contributions to realizing nutritious and diversified diets, experience exclusion at multiple levels (Agarwal 2015; Sainath and Mukherjee 2014). They are often unable to access banking loans, receive less exposure to extension services and education, generally receive lower salaries, and at the household level are often allowed to only take up unpaid activities in the field. Furthermore, many women's contributions to maintaining on-farm and dietary diversity, knowledge of low-input practices, and preparation of healthy, diverse diets for their families is poorly recognized and undervalued when not omitted from consideration entirely. Whereas dietary diversity and women's empowerment and knowledge are crucial foundations to address many serious nutritional deficiencies, particularly amongst adolescent girls, youth, and pregnant women, government policies such as the PDS tend to promote the import of polished rice and wheat from other areas of the country, and subsidize diets heavy in oil, sugar and salt.

Agriculture and food security in Osmanabad

The Osmanabad district, the site of the studied work in India, is located in the southern part of the state of Maharashtra (Figure 4). As it is in a semiarid region, the average rainfall is about 660 mm. The predominantly agriculture-based economy is correspondingly restricted by the dry environment. The local partner organization Swayam Shikshan Prayog (SSP) has been working in Osmanabad for several decades. Over the course of its work, the organization observed that many rural households were unable to provide for their nutritional requirements through self-provision or purchase. Farming families had mostly taken up cash crops like sugarcane, cotton and soybean, while food crops like pulses were neglected. Millets, such as sorghum and pearl millet, and vegetables such as spinach, fenugreek, okra, eggplant and coriander, were only grown in a very limited manner. The dietary diversity and nutritional requirements that could be provided for with millets and vegetables went largely unmet, as the market prices of these (unsubsidized) commodities were too high. With most markets additionally located far away from the studied villages, the short shelf life of many vegetables increased the difficulty of procuring them in sufficient quantity and quality. This was part of the impetus for SSP's support of diversified, agroecological approaches (Box 3). Dialogue with women farmers in Osmanabad further led to a shared analysis of problems facing their communities, such as increasing dependence on external inputs such as seeds, fertilizers, pesticides, and herbicides; neglect of traditional crop varieties and agricultural techniques; and falling prey to the "gimmicks" of agricultural input vendors. Focus on single cash crops instead of mixed cropping also increased the risk of crop failure, potentially increasing farmers' risks and costs and making farmers more vulnerable to debt traps. A decline in animal husbandry also reduced farmers' abilities to take advantage of the kind of crop-animal integration advocated for by many agroecologists. All this, paired with poor economic conditions and low purchasing power contributed to malnutrition and poor health, particularly for of women and children.

Box 3

Swayam Shiksan Prayog (SSP)

In the aftermath of a massive 1993 earthquake in the state of Maharashtra, SSP formed as a widespread network of women and sought to strengthen grassroots institutions. SSP promotes the formation of savings and credit groups to provide social, economic, and political competency for its members, and to enhance access to finance, markets and local institutions. SSP further focuses on the linkages between agriculture, food security and nutrition, seeking to empower women farmers with information and knowledge of agroecology, enhanced skills, and practical solutions to their challenges. Drawing from this, women in turn have asserted their rights to be recognized as farmers and leaders in their communities, and to play key roles as community advocates and coordinating collaboration with other groups and local government institutions.

The one-acre model: Step-by-step changes and woman-to-woman learning

SSP's starting point towards creating more resilient farming and food systems has been the "one-acre model". It is based on the recognition that women's access to land and the ability to make farm-related decisions – from planning what crops to grow to marketing and sales – are crucial entry points for the socioeconomic and nutritional security of households. At the same time, changing systems where men often exercised sole decision-making power, and where the focus was on cash crops rather than diverse foods for home consumption, obviously posed significant challenges. Thus, the one-acre model was developed: rather than seeking to rapidly change entire farming systems, diversified, agroecological approaches would be "tested" on a small area of the family's land (which in practice may be larger or smaller than one acre [0.4 ha]). The model seeks to reduce the use of costly synthetic inputs, favoring instead the establishment of local seed banks, use of manure, vermicomposting, and neem-based compounds; improved water irrigation, for example with microirrigation and the use of bunds and trenches; replacing cash crops with food crops, particularly vegetables and pulses; and otherwise using mixed cropping systems to increase crop and dietary diversity, and therefore food security. These approaches, alongside the women-led ethos, echo many of the central goals of agroecology and food sovereignty, including systems change to increase justice and equity (Gliessman 2015, pp. 277-78).

Women farmer-networks share and co-create knowledge.

Country context: Brazil

Brazilian policy environment for agriculture and food security

Until recently, the agrifood policy environment in Brazil effectively consisted of a two-track system, where government support for agriculture went to both large agribusiness concerns and to small-scale family farmers through land reform and agroecology programs. Former President Lula "thought he could find a way for agribusiness and peasant collectivism to co-exist" (Sauer and Wolford 2018). As such, while agribusiness profited mightily during the 2000s, Brazil also became home to some of the most comprehensive food security and family farming policies in the world – although as with a large number of Brazil's social programs, many of these policies have been defunded or otherwise cut back under the current president, Michel Temer.

Civil society in Brazil is already experiencing a retrocession with regard to supportive policies and human rights, and the long-term effects from these cutbacks (as well as worsened economic fortunes) are still developing. However, it is important to note that the food and agriculture programs developed in Brazil over the past two decades, from its National Food Security Council and constitutionally-protected right to food to its Zero Hunger programs, National Program to Strengthen Family Farming (PRONAF), and national and regional policies supporting agroecology, made it a pioneer of food security and sustainable agriculture. Between 2003/2004 and 2013, overall food insecurity fell 12.3%, and severe food insecurity dropped by more than half – from 6.9% of the population to 3.2% (de Mattos and Bagolin 2017). This has also been accompanied by notable drops in income inequality and poverty severity (Rocha 2009). Of course, current economic conditions and the current government hostility to social programs pose significant threats to these programs and their gains (Bizzotto 2016).

However, the on-going work presented here largely took place while government policies supporting food security and family farming were still running. In 2014/2015, the Brazilian government budgeted over R$29 billion (approximately US$9 billion in 2015 dollars) to support family farming with "operating loans, crop insurance, agricultural extension, home-grown school feeding and other public nutrition programs", which represented more than a seven-fold increase in spending compared to ten years prior (Ministério do Desenvolvimento Agrário 2015; Wittman and Blesh 2015). At the same time, this was approximately one fifth of the 2013/14 budget of R$136 billion allocated to credit, investment, and grants for the agribusiness sector, despite the fact that Brazil's family farming sector produced around 70% of the food consumed domestically on less than 25% of total agricultural land according to its 2006 census (Wittman and Blesh 2015). The census also revealed that family farmers made up 84% of all farms in Brazil, and in some regions, provided 15 times more jobs per hectare (de França et al. 2009). Thus even under the Brazilian government's two-track approach, industrial agriculture and agri-business still received disproportionate amounts of federal support.

Gender and agriculture in Brazil

Brazil has often been referred to as a patriarchal country, particularly with regards to its rural areas (Schwendler and Thompson 2016). Dynamics in rural labor reflect the general trends in less-industrialized countries, where

> the labor burden of rural women exceeds that of men, and includes a higher proportion of unpaid household responsibilities related to preparing food and collecting fuel and water… Invariably women are over represented in unpaid, seasonal and part-time work, and the available evidence suggests that women are often paid less than men, for the same work (SOFA Team and Doss 2011).

As a country, Brazil ranks 92nd in gender equality (UNDP 2016), and faces serious on-going problems with violence against women, particularly in the North and Northeast regions, and against Afro-Brazilian and indigenous women (Gukovas et al. 2016). However, progress towards improving gender equality has been noted, particularly in education, maternal health, and creating improved legal and institutional frameworks to address violence against women. Numerous social policies have also "disproportionately benefit[ed] women and reduce[d] gender inequality," as women make up "62 percent of rural beneficiaries of public social security" and have been the main recipients of the Bolsa Família conditional cash transfer program, which "prioritizes women as the recipients of the cash" (Gukovas et al. 2016, 14).

Programs supporting family farming even offered dedicated lines of credit to women agriculturalists. All the same, economic opportunities and women's agency have not necessarily seen as much improvement as

other areas, and sometimes fall short of the ideal – for example, accessing the credit programs can be very difficult in practice – and many of the policies supporting gender equality have similarly been scaled back or placed under threat by Brazil's current administration.

Agriculture and food security in Brazil and Pernambuco state

Despite Brazil's recent agrifood policies and successes, nearly a quarter of Brazilians are estimated to still suffer from some degree of food insecurity, including one third of rural residents (de Mattos and Bagolin 2017). When food insecurity is viewed in terms of the three forms of malnutrition outlined earlier – undernutrition, obesity, and micronutrient deficiencies – further millions of Brazilians face significant challenges to their long-term health and well-being. Importantly, the depth of the challenges varies greatly by region, with over 35% of the residents of the North and Northeastern regions (where Pernambuco is located) facing food insecurity (in comparison to 14.5% in the Southeast and 18.2 % in the Center-West [IBGE 2014]). Brazil's semiarid region also receives less than 800 mm of annual rainfall, and has the lowest indicators for human development in the country – with most of Pernambuco state lying within the semiarid region. There is a high degree of rural poverty (28-47 %) in the specific localities of Pernambuco state that are the focus of this study.[12] Nearly 50,000 families in the area, representing as much as 83 % of the total residents, are dependent on government income transfer programs to assure their food security.

In terms of the types of agriculture practiced in the studied areas of Pernambuco (Figure 5), dominant forms are extractive forestry for firewood and charcoal, animal pastures, and traditionally extensive homegardens, which contain a variety of crops for self-consumption and sale. There is also a tradition of agroforestry in much of the region, and generally a small amount of area dedicated to row-cropped vegetables. Agroforestry is one of the particular areas of focus of MISEREOR's partner in the region, Centro Sabiá, in its efforts to advance family farming, agroecology, rural development, and sustainability (Box 4).

The studied work took place in two areas of Pernambuco, the Agreste and the Sertaõ. The Agreste is a transition zone between the humid Atlantic Forest and the scrubland desert of the Sertão, with drier areas broken up by enclaves, or virtual "islands", of humid forest. The Agreste is also closer to urban centers and their larger, more dynamic markets, than the Sertão. Across the two areas, family farms make up 95 % of the total number of farms, while occupying just under two-thirds of agricultural land. This is quite similar to the averages for Pernambuco state and the Northeast region as a whole and reflects national patterns of large-scale inequality in control of land. On the 35 % of agricultural land in the studied areas that are operated by the 5 % of farms that are not family farms, there is a focus on irrigated production of cotton and sugarcane, and on intensive vegetable and fruit production.

[12] With the exception of one municipality which had a 9% rate.

Figure 5: **Location of the studied localities in Pernambuco**

Box 4

Centro Sabiá

Field-experiment with self-created drip irrigation to resist the drought

Centro Sabiá (CS), or the Sabiá Center is an NGO headquartered in Recife, the capital of Pernambuco state. Like many Brazilian civil society organizations, CS was formed in the beginning of the 1990s as a result of the process of re-democratization that took place as Brazil came out of over 20 years of military dictatorship (1964-1985). CS operates in practically all regions of Pernambuco, working directly with over 6,000 families in almost half of the state's 185 municipalities.

CS's institutional mission is to "cultivate life towards a better world, develop agroecological family farming and citizenship". As part of this mission, CS embraces the challenges of interacting with diverse sectors of civil society and developing innovative approaches to work with youth, women and men in family agriculture.

The activities carried out by CS include technical assistance and agricultural extension, capacity-building, commercialization of agricultural products, support for building collective structures (groups, associations, and cooperatives), and spaces for the maintenance of indigenous seeds.

General principles and methods: From agroecology to convivência

CS supports an approach to agroecology that recognizes the need for radical changes in the dominant agricultural systems: productive strategies ought to be based in knowing and following the dynamics, functions and patterns of natural ecosystems rather than a logic of control and domination. Their recognition of agroecology as a science, practice, and movement also therefore seeks to avoid synthetic inputs; values and manages soil fertility and biodiversity; integrates approaches from social and natural science disciplines; promotes multi-dimensional sustainability; is guided by an ethos emphasizing humans' connections to each other and nature; values and protects traditional knowledges, and collaboratively integrates them with academic knowledge in the construction of agroecology.

CS has a specific emphasis on agroforestry systems as well, specifically a conceptualization of agroforests as complex ecosystems that combine annual crops and trees in the same area. Agroforestry should reflect and replicate the biome and native vegetational structure it is located in and be composed of a diversity of species of natural and economic interest. Agroforesty can thus support biodiversity conservation, and address climate mitigation (through increasing carbon sequestration) and adaptation (through increased resilience for practicing farmers).

Relationships of solidarity and cooperation are also fundamental to CS's work, including the relationships between men, women, and children, and between the different organizations that interact and represent different groups. Practically speaking, this ethos is seen in CS's numerous collaborative activities, including mutual aid work groups (*mutirões*), community seedbanks, rotating solidarity funds, agroecological fairs and construction of spaces of shared learning and celebration.

Finally, CS promotes *convivência com o semiárido* – "living with the semiarid region" – a paradigm shift from notions of combating drought. This approach of *convivência*, or deep co-existence, is one of the primary operational principles of the Sabiá Center. The logic of *convivência* understands prolonged dry periods and other challenges of the semiarid region to be intrinsic characteristics of the biome, to be lived with rather than fought or "beaten", using appropriate practices and knowledge developed by the thousands of families that have lived in the area over a great many years.

In its approach and philosophy, CS allies with and participates in numerous existing programs and networks, from the Forest Agroecological Network and National Council of Rural Development to the Brazilian Semiarid Articulation and the Agroforestry and Solidarity Economy Program.

Country context: Senegal

Food and agriculture policy environment in post-independence Senegal

With regards to relevant national public policies in Senegal, three major periods can be described since Senegal achieved independence in 1960: state productivism, structural adjustment, and economic liberalism. From 1962 to 1979 Senegal operated under a productivist agricultural policy, characterized by a strong intervention of the state through a dense system of supervision of producers alongside strong subsidies for industrial agricultural "packages", including fertilizers, hybrid seeds and agricultural equipment (Tourte et al. 1971). Priority was given to groundnuts, introduced under colonization and the country's main source of foreign exchange and farmers' incomes; and to millet and irrigated rice production in the Delta and Senegal Valley. The use of chemical fertilizers and mechanization favored the decreased use of fallows and the extension of the cultivated areas, especially in the groundnut basin, to the detriment of drylands and forests, leading to increasingly impoverished soils. The situation only worsened after the early 1970s after a series of successive droughts.

Farmers in the Senegal face peak labor periods during the short rainy season. The use of ploughs makes field preparation less laborious and quicker.

Amongst the farmers in the studied area[13] it was found that a majority of farmers now cultivate only the two main crops of millet and groundnuts; about a third of the households also grow rice and cowpea. Other crops such as vegetables are cultivated by only about 10% of households.

Agricultural policy changed during the 1979-2000 period, following structural adjustment policies and the adoption of a new overall agricultural policy in 1984. These changes had devastating effects on smaller farms, particularly the many who had become dependent on external inputs. Numerous peasant farm cooperatives were dissolved, and the subsidies for fertilizers and agricultural equipment were sharply reduced. To make peasants nominally more responsible for their own welfare and less dependent on the state, new forms of producer organization were promoted, such as "village sections" and "economic interest groups".[14] But a lack of preparation and the brutal disengagement of the state, along with preferential tariffs on groundnuts, left farmers in a difficult situation: Senegal lost its preferential market to France, as the European Economic Community (and its policies on oilseeds) turned to a focus on protecting its own agricultural producers.[15] Furthermore, the world oil seed market underwent significant restructuring after World War II, beginning a period of significant loss of world market share for groundnuts (Berlan et al. 1976).

So-called "economic liberalism" was subsequently reinforced by political changes taking place in 2000. Since then, agricultural policies have encouraged corporate agriculture and agribusinesses as replacements for small-scale agriculture. At the same time, the state has re-engaged in agriculture but with a focus on a limited set of crops, particularly groundnuts, for their economic value and importance to national oil mills. Horticulture has also been a focus as it is envisioned to increase export gains (mango, beans, melon, etc.) or to cover domestic needs (onion, potato); and rice is promoted for import substitution to decrease expensive imports. Traditional food crops (millet, sorghum, maize and cowpea) receive less attention from public programs, and support for rice has reordered the population's dietary

[13] Specifically, three communities in the Fatick region; described further in Agriculture, food, and environment in Senegal, and Box 5.

[14] *Section villageoise*, and *groupement d'intérêt économique* in French.

[15] This was partly lifted under the McSharry Reform of 1992 and by Agenda 2000, but this liberalization was only implemented gradually (ADE 2001).

Figure 4: **Location of the Fatick district**

habits and consumption patterns. The current program to accelerate the "pace" of Senegalese agriculture (called PRACAS) at a cost of about 425 billion West African francs (FCFA) over the period 2014-2017 focuses on rice, peanut, onion and horticulture. It set the production targets at 1,600,000 tonnes for paddy rice, 350,000 tonnes for onions, and 1,000,000 tonnes for peanuts in 2016 – 30-200 % higher than their 2010-2013 averages. A similar average annual growth of 10 % is expected from the horticulture sector with a target of 35.5 billion FCFA of export earnings in 2017, despite decades of research showing, at best, an uncertain and inconstant relationship between agricultural exports and improved outcomes for farmers' food security, decreased volatility, or increased sustainability (e.g. Iwamura et al. 2016; Lappé and Collins 2015; Weis 2007).

Gender and agriculture in Senegal

In rural areas only 11.3 % of households are headed by women (Bachmann and Seck 2018). Land is predominately managed by the male household head and women are consulted in decision-making to limited degrees. Only a very small proportion of a household's total land is managed by women alone (~0.2 ha out of an average of 3.6 - 3.7 ha). The National Census of Agriculture (Ministère de l'Agriculture 1999) showed that women-owned plots are generally smaller; and that regardless of plot size, the proportion of the holdings owned by men is far greater than that of women. The 2015 Joint Agricultural Sector Review notes that women heads of households are typically older than men heads of household – women generally occupy this position after the death of a spouse or a divorce. In the 18-35 age group, only 7 % of women are recorded as household head, compared to 93 % for men (MAER 2016). And despite the fact that 62.6 % of women participate in rural agricultural work, few have access to factors of production. Within households, equipment is mostly owned by men and used primarily for their fields before those of women, which translates into delays in crop planting and care for the latter, with negative effects on their production. The Rural Food Security and Nutrition Survey (SECNSA 2014) showed that whereas an average of 60 % of agricultural households owned a seed drill, the proportion fell to 31 % among households headed by women; for the possession of a horse, the proportions were 50.3 % and 17.2 % respectively.

Women are also not given equal chances for education, which must be seen as a major factor why women have lesser access to appropriate employment opportunities, stipends and pensions. Bachmann and Seck (2018) propose that women' agency will thus not only depend on giving them access to resources such as land, seeds and technologies, and the high-income off farm activities that men perform. Rather, they propose a need to generally encourage less-dominant values, in contrast to individualism, profit and competitiveness within a community; to maintain solidarity practices and reinforce values recognizing that not everything is, or should be, thought of in monetary terms. In this way, according to them, old traditions can be modernized to make them economically more attractive (rather than losing them). A shift in perspective at both policy and community level could help lend further support to agroecology and rural development aimed at improving the security and capacities

Fields in Diouroup, Senegal: One EP farmer uses agroecological practices to make best use of scarce water while improving soil fertility, too.

of the poorest, and at providing egalitarian access to the inputs needed for diversified cropping (including tree-based systems, drought-tolerant varieties, and recipe-processing technologies for drought-tolerant crops such as millets).

Agriculture, food and environment in Senegal

The study in Senegal investigated the work by MISEREOR partner ENDA Pronat (see Box 5) with family farms in the Fatick region, a rural area 140 km south of Dakar. It included farmers and villages in the three communities of Diouroup, Diarrere and Tattaguine.[16] The population density in the study area (100 inhabitants/km^2) is 25% higher than the national average (80 inhabitants/km^2) (World Bank 2016). Like the other study regions, it is a semiarid zone with limited annual rainfall, averaging about 600 mm per year. However, it is important to note the particular challenges for the low-lying coastal area of Fatick (0-15 m.a.s.l.), where there is a constant flow of salt water pushed inland. As a consequence, the soils contain a very high level of salt, making much of it unsuitable for agricultural production and therefore reducing yields drastically. In addition, the saltwater coming in from the sea can contaminate fresh water resources. This condition, together with the low annual rainfall and poor connection to irrigation systems, makes effective irrigation very scarce and further contributes to a uniquely challenging biophysical environment for agricultural production.

Furthermore, soil fertility in the area would have to be characterized as in critical condition. Due to a general scarcity of land for small-scale family farmers, 72 % of all farms studied had stopped the practice of fallowing completely. Land held per farm has been decreasing by 4.3 % annually, and analysis of soil samples collected during the study indicated that average soil carbon content is very low (0.24 %).[17] Production and input information indicates that current conditions and practices are insufficient to maintain soil fertility: this is a major risk factor for the long-term soil fertility development in the study area that was unique to the Senegal study.

Notwithstanding these harsh conditions, people have long managed and modified this environment to

[16] It should be noted that 70% of the households in the EP sample have worked with the group for only 4 years or less; only 30% have been involved longer.

[17] Studies generally indicate that fertile savannah soils should have carbon contents in the range of 0.5 to 1.2% in this geographical zone (Bhattacharyya et. al 2004; Müller-Sämann 1986).

Box 5

ENDA Pronat

➤ ENDA Pronat ("Protection of nature") is a federation and part of ENDA Third World, an international NGO. ENDA Pronat (EP) was set up in 1982 with the objective of providing an alternative to the massive use of synthetic agrochemicals. EP became known for the successful experiments it conducted with farmer organizations in four of Senegal's six agro-ecological zones, including the middle valley of the Senegal River, where large-scale irrigation is being developed, and especially the Fatick area, an area that has historically focused on intensive production. Since the late 1990s, ENDA Pronat has gradually expanded its activities to promote agroecological practices (including crop diversification and organic pest and disease management, composting and mulching, livestock integration) alongside its work on environmental education, gender issues, promotion of savings and credit, and sustainable development for family farms. One particular recent focus has also been the defence against land grabbing that has been taking place in many areas of Senegal, as it has in many other areas of Africa, in the wake of the food crisis of 2008 (Bachmann and Seck 2018).

EP's Strategy: Farmer-led action research

A key tactic of EP is the reappropriation of research and extension by small-scale family farming (peasant) communities. Projects supported by ENDA Pronat have been co-designed with farmers' organizations and are part of a continuous process of research-action-training involving participatory diagnosis for villagers to identify possible solutions before problems are directly confronted. Their hypotheses are then tested through field experiments and assessed with the communities each year so as to reorient the actions. For example, the Diouroup soil regeneration project (2011-2013) started with village ecological diagnoses in 2011, where farmers defined the main constraints, namely: a decline in soil fertility; salinization of land and water; and the loss of biodiversity through the disappearance of vegetative cover and seed capital. To overcome these challenges, ENDA Pronat and UCT, a local cooperative, undertook a series of complementary experiences and experiments, including the enhancement of soil fertility for rainfed crops such as millets, groundnuts and rice. After it became evident that mainly women were attending trainings in farmer field schools, and men were receiving less support this way, the learning process was reoriented towards an alternative means of experimentation through agroecological pilot fields, led by heads of households (men and women). All producers were gathered for practical trainings that created "model fields" for exchange visits. Another example of experience-based reorientation occurred during the implementation of tree nurseries and reforestation with halophilic and fertilizing species in community areas, that, due to animal diversion and rainfall deficit, was changed to assisted natural regeneration (ANR) as it requires fewer resources and appeared to yield better results.

This whole narrative is in line with EP's self-organization strategy, which consists in believing that, rooted in an awareness of the deterioration of living conditions and the processes of impoverishment, collectives of farmers can be formed into explicit associations in order to defend their rights, search for solutions to their problems, and to implement them. EP supports these collectives to widen its reach to an appropriate critical mass that enables them to realize economic and political power (e.g., organization of local micro-finance, trading on the marketing of products and purchases, etc. or influencing local authorities and extending their voices to national levels). ➤

produce, market, share and preserve their agricultural goods and food traditions. A diversity of grains, nuts, vegetables and fruit trees have been historically cultivated. In Senegal, small-scale, family farming constitutes the majority of all farms by number (70.1 % of farms are between 1 and 5 ha, whereas 16 % range from 6 to 10 ha). And both livestock and crop diversity are often maintained through a variety of solidarity mechanisms. For instance, in the studied communities, local seed exchange and community granaries help ensure the maintenance of locally-adapted diverse varieties and are important elements in the economic and social fabric of food communities, along with cultural traditions that often see households donating 12-35 % of their agricultural production for social ends (Bachmann and Seck 2018). ➤

Research findings

The case studies in all three country studies (Senegal, Brazil and India) provide evidence of positive changes in terms of farmers' **economic viability and income, productivity and diversity in production systems, food and nutritional security, and social change and women's empowerment**. The agroecological approaches promoted and implemented showed multiple advantages, particularly for poorer farmers. This is especially notable as careful examination by scholars has found that the mainstream approaches to rural development have often passed over or even further disadvantaged the poorest farmers (Freebairn 1995; Nyanktakyi-Frimpong and Bezner Kerr 2015). In contrast, the results we review indicate distinctly pro-poor effects from the studied agroecological interventions. Below we present the main results, point to similarities and points of departure between cases, and begin to examine what can be learned from the experiences of the parallel projects in Brazil, India and Senegal.

Economic viability and income

As seen in Table 2, results from all countries showed an increase in the economic viability for small-scale family farmers. Economic gains have been achieved both through greater on-farm income and increased value of self-supply.

Table 2: **Median farmer income and agriculture expenditures (cash and cash equivalents), in international $ (PPP)**[18]

		India	Brazil - Agreste	Brazil - Sertão	Senegal
Agricultural sales	AE farms	2,372.37	3,575.80	1,623.24	722.79
	Ref	1,326.33	931.51	586.00	531.21
AE %adv (%disadv)*		79 %	284 %	177 %	36 %
Home consumption	AE farms	1,529.18	1,158.22	784.43	1,819.26
	Ref	917.57	720.55	452.05	1,590.88
AE %adv (%disadv)*		67 %	61 %	74 %	14 %
Non-farm income	AE farms	4,004.00	4,136.99	4,998.17	3,314.78
	Ref	3,973.97	5,413.70	4,887.67	3,030.05
AE %adv (%disadv)*		1 %	(24 %)	2 %	9 %
Farming costs	AE farms	1,641.64	682.65	432.88	327.23
	Ref	1,466.47	283.11	298.17	284.73
AE %adv (%disadv)*		(12 %)	(141 %)	(45 %)	(15 %)
Net income[19]	AE farms	6,582.73	13,423.74	8,791.10	5,529.60
	Ref	5,003.75	9,034.70	6,954.57	4,867.41
AE %adv (%disadv)*		32 %	49 %	26 %	14 %

* Figures should be read as follows: Figures without brackets show an advantage of the respective mode of production, while figures in brackets indicate a disadvantage.

[18] Purchasing Power Parity, here expressed as "international dollars", attempts to standardize income comparisons by taking into account the fact that currency exchange rates do not fully reflect that different amounts of goods can be purchased for the nominally same amount of money in different contexts. PPP conversions in this report are based on World Bank (2016).

[19] Note that the medians in each category will not necessarily add up precisely to the median net income because of slight differences in the exact distributions.

Beyond the fact that net income was higher for agroecological farmers in all three countries by margins from 14 % to nearly 50 %, it is particularly notable that cash income from the sale of agricultural products is higher for all agroecological farmers, and in fact rose most sharply amongst the poorest farmers (Table 3). Median improvements in agricultural sales income were most notable in Brazil (177-284 %) and India (79 %), but also showed strong improvement in Senegal (36 %) compared to the reference group. But for the poorest 10 % of farmers in Brazil and Senegal, income from agricultural sales was between ~PPP$65 and PPP$650, compared to zero annual sales for reference group farmers.[20] In India, where the poorest 10 % of reference group farmers saw sales of ~PPP$75, income for agroecological farmers was nearly five times higher, at almost PPP$430 per year.

Agroecological approaches are meant to lower dependency on external inputs and, as has been observed in numerous cases, lower costs (e.g. LaCanne and Lundgren 2018). The fact that total farming costs were higher for agroecological farms in the studied cases (Table 2) may therefore appear surprising. While further study is needed to fully disentangle the current results, it is of course notable that the benefits appear to have exceeded the costs in all cases. Furthermore, the total costs hide more complex and interesting pictures. For example, in Brazil expenditures for seeds, fertilizers, and pesticides were much higher for reference farmers than for agroecological farmers, while costs of commercialization for agroecological farmers in the Agreste region were much higher than reference famers, comprising 47 % of their total costs. This is because the principal market

> “I have been working as a migrant worker in various areas in India. Without any of my own land my life used to be very difficult. […] One of my sons is working in Pune; another son is work-ing abroad in Dubai. They have sent me money and with that money I bought one acre of land. With the training of SSP I learned how to grow everything organically. My life is so much better now. I even have become a farmer leader, teaching other women how to do all this.”
>
> **Ms Nana Garud, farmer in Osmanabad district, working with the one-acre model**

Table 3: **Income from agricultural sales and home consumption (cash and cash equivalents) for the bottom income decile, in International $**

		India	Brazil - Agreste	Brazil - Sertão	Senegal
Agricultural sales	AE farms	426.68	647.49	63.29	84.14
	Ref	75.08	–	–	–
AE %adv (%disadv)*		468 %	N/A	N/A	N/A
Home consumption	AE farms	357.86	305.98	263.94	558.52
	Ref	215.47	181.32	83.61	351.03
AE %adv (%disadv)*		66 %	69 %	216 %	59 %

> “As we use our own seeds and own manures, food produced on our farm is far cheaper than what we buy from outside.”
>
> **Quotation from a group interview with farmers in Masala Khurd village, Osmanabad district, India**

[20] PPP = Purchasing Power Parity, or International Dollars. See footnote 18.

> The State should also subsidize organic fertilizers in the same way as chemical fertilizers because the organic matter is insufficient. The State must include agroecology in agricultural policies by for example promoting cattle fattening and small biogas plants. Without the government's commitment, it might take some time."
>
> **Quotation from a group interview with EP farmers in Dioral village, Fatick district, Senegal**

strategy for many of these families was to sell at specific "agroecological farmers' markets", allowing them to get much better prices, but also raising the costs of commercialization and transportation to these specialized markets. In India, the median expenditure on pesticides and herbicides for both reference and agroecological farmers was zero, and agroecological farmers universally spent less on seeds. However, wealthier and median agroecological farmers had similar or higher expenditures in other inputs, such as chemical fertilizer, as reference farmers, showing room for further understandings of local contexts and needs. The need for further work was also clear in Senegal, where spending on inputs also showed few clear differences between reference and agroecological farmers.

Finally, in terms of an often-overlooked element of farmer livelihoods and wellbeing, agroecological farms in all three countries saw clear advantages in the value of self-supply of agricultural products. Agroecological farms in Brazil had a median economic advantage of 61-74 % higher income in cash equivalents from self-supply compared to reference farms; median income from self-supply was 67 % higher for agroecological farmers in India; and there was a 14 % median advantage in Senegal. However, self-supply also shows a pattern of pro-poor advantage from agroecological intervention, particularly in Senegal and the Brazilian Sertão region. In those areas, agroecological farmers showed the equivalent of a 59 % (in Senegal) and 216 % (in the Sertão) increase in income from self-supply compared to reference farmers. These pro-poor effects are particularly significant because of the classic finding of Freebairn (1995), whose review covering over 300 studies on the Green Revolution indicated that in the majority of cases conventional technology packages of the Green Revolution led to increased inequality between farms and between regions. In other words, intensive, industrial agriculture is not, in fact, "scale-neutral" nor "pro-poor": farmers who already benefited from access or membership in credit schemes, better soil fertility, or who held larger amounts of land were further advantaged by the technical package. And in fact, the self-supply advantage found here provides benefits in terms of resilience – for example, granting farmers greater resilience in years where staple prices increase significantly, and in times of market instability, e.g. when grain imports compete with local produce (see Isakson 2009 and Jaffee 2007 for particular examples of this from Latin America).

> With twelve years of work, the results are significant, the soil has recovered, we have diversified the production and the neighbors who previously criticized us are starting with agroforestry."
>
> **Elisângela Gomes da Silva & Pedro Custódio da Silva, farmers with 2.5 hectares in the Agreste region**

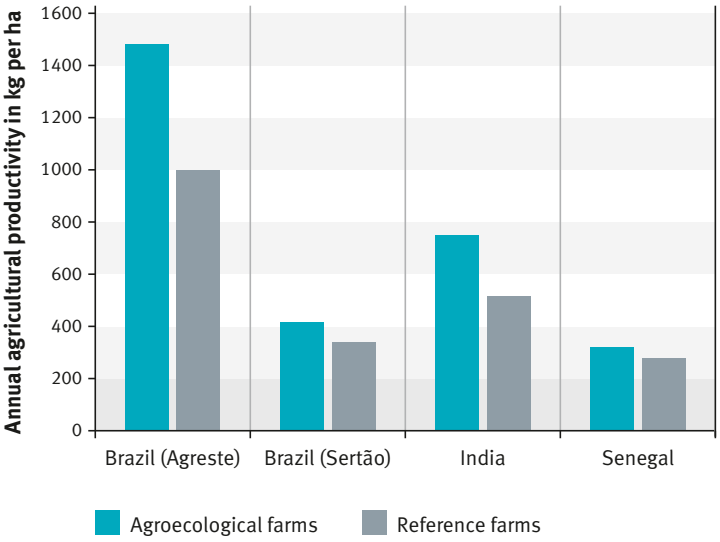
Productivity and diversity

In all three country cases, a significant increase in livestock and crop production was achieved. Based on calculations by the project team advisers (see Figure 6), the total per unit area productivity of four main crops (millet, groundnuts, cowpea, and rice) in Senegal was 17% higher than in the reference peer group. In India, total per-hectare productivity was 45% higher in the 14 most important crops; and in Brazil the total productivity per hectare of agroecological farms (including all plant and animal products) was 21% higher than reference farms in the drier Sertão area, and 49% higher in the more humid Agreste. Unsurprisingly, these numbers mirror the improvements seen in income, as examined in the previous section. It is interesting to note that productivity for both agroecological and reference farms in the more humid Agreste area of the Brazilian semiarid region was the highest, followed by productivity at Indian sites. This is all the more notable in the case of India, given that this productivity was achieved during a particularly dry period: the 2015-2017 period was amongst the most severe droughts in 75 years. Thus it is relevant to note that previous scientific evidence has overwhelmingly pointed to diverse, agroecological systems as being particularly robust in terms of climate and economic resilience, often outperforming conventional or un-intensified systems under adverse conditions (e.g., Gil et al. 2017).

> When working with agroforestry the plants have better resistance to drought, as they protect each other.

Quotation from a group interview with farmers in Feijao - Bom Jardin, Agreste, Brazil

Figure 6: **Agroecological and reference farm productivity in each of the study countries**



Integration of crops and livestock is also an important element of agroecological methods. Appropriate livestock management not only potentially provides meat, dairy, and other direct agricultural products, but can also provide sources of concentrated fertility, reducing or eliminating the need for energy- and economically-expensive synthetic fertilizer. Livestock, of course, can be managed inefficiently and cause environmental harm as well, but evidence is growing for the benefits of appropriate management (Stanley et al. 2018). And of course, the over-intensive, excessively meat-heavy habits of ultra-large-scale agricultural operations should not obscure the nutritional, environmental, and agronomic value of appropriate livestock management for small-scale producers (Lin et al. 2011). In Brazil and India, the results indicate increases in livestock keeping and production for most categories (Tables 4 and 5). Additionally, the

Table 4: **Percentage of farms reporting "X" number of livestock in India case**

No. of animals	Oxen		Dairy cows		Goats	
	Ref %	AE %	Ref %	AE %	Ref %	AE %
0	60.2	52.7	71.5	59.0	86.5	82.5
1	6.6	11.5	17.0	27.5	5.5	3.0
2	28.3	29.7	7.5	9.5	2.0	3.0
3+	4.8	6.0	4.0	4.0	6.0	11.0

Table 5: **Animal production in Brazil case (average per household)**

Parameter	Agreste			Sertão		
	AE	Ref	Dif. (%)	AE	Ref	Dif. (%)
Number of farms in the sample	75	69		138	113	
Bovine (kg)	45.6	30.8	48 %	28.1	19.8	42 %
Number of farms producing	39	24	63 %	73	49	49 %
% of farms producing	52 %	35 %		53 %	43 %	
Milk (liter)	593	188	215 %	109	194	(44 %)
Number of farms producing	16	15	7 %	21	18	17 %
% of farms producing	21 %	22 %		15 %	16 %	
Poultry (kg)	140.3	57.2	145 %	76.4	34.8	119 %
Number of farms producing	59	47	26 %	120	85	41 %
% of farms producing	79 %	68 %		87 %	75 %	
Eggs (dozen)	1391	1139	22 %	881	825	7 %
Number of farms producing	54	47	15 %	116	78	49 %
% of farms producing	72 %	68 %		84 %	69 %	
Goat (kg)	15.8	10.4	52 %	141.1	26,48	433 %
Number of farms producing	15	9	67 %	36	29	24 %
% of farms producing	20 %	13 %		26 %	26 %	
Sheep (kg)	18.2	31.3	(42 %)	67.1	22.6	197 %
Number of farms producing	11	10	10 %	51	24	113 %
% of farms producing	15 %	14 %		37 %	21 %	
Pig (kg)	87.7	47.7	84 %	63.1	18.0	251 %
Number of farms producing	27	18	50 %	51	27	89 %
% of farms producing	36 %	26 %		37 %	24 %	

per farm productivities of most livestock products are higher in Brazil (with partial exceptions in sheep-keeping and milk production). The higher number of farms reporting the keeping of various kinds of livestock in India and Brazil also means that diversification has also extended to on-farm animals, at least when looking at the groups as a whole. In Senegal, however, ownership of most kinds of livestock in the studied region has declined across the surveyed farms; the decline appears to have been slightly lower on reference farms.

However, across the studied countries, we can see overall increases in both the productivity and diversity of agroecological farms in other categories. Looking at 14 of the most commonly grown crops in India, agroecological farmers saw higher per-farm productivity for 9 crops, with increased productivity ranging from 11 to 100 %. Weighting per-farm productivity across all 14 crops by the number of farmers cultivating them yields an overall 23 % productivity advantage for agroecological farmers (Table 6). The greater diversity of crops grown is also seen in the higher numbers of agroecological farmers cultivating each of them (except sorghum). Moreover, in terms of less-commonly cultivated crops, agroecological farmers in India produced over 20,000 kg of 21 different

crops on 135 ha, while reference farmers produced only 11,600 kg of 17 of the same crops, on 110 ha of land.

And in addition to the significant increases in crop and livestock productivity seen in both areas in Brazil, Centro Sabiá's work with smallholder family farmers in the semiarid has also seen great progress with regards to diversity. Agroforestry has been in use in various traditional systems in the region (and elsewhere in the world) well before involvement by CS, but the current study showed that agroecological households in Brazil produced a greater diversity of agricultural goods than non-agroecological ones. Collectively, agroecological households in the Agreste produced 133 distinct types of goods, while reference farms produced 105 (out of a total of 142 products listed in the survey questionnaire). In the Sertão, agroecological households produced 119 different products and reference households produced 106. The high baseline diversity – over 100 types of goods in even the reference households – perhaps reflects the pre-existing influence and practices of agroforestry, while still reflecting increased diversity for agroecological farms. Indeed, individual farmers were recorded as growing up to 41 different species of trees, with almost 500 total trees reported on one farm.

Table 6: **Crop production data for most widely grown crops in India (medians)**

	No. of growers		Production in kg per farm		Production Difference
	Reference	AE	Reference	AE	
Grains					
Sorghum	147	143	200	300	50 %
Soybean	126	129	250	300	20 %
Wheat	46	73	150	100	-33 %
Bengal gram	89	116	80	100	25 %
Pigeon pea	47	57	50	100	100 %
Cluster bean	11	41	22.5	25	11 %
Black gram	43	78	30	20	-33 %
Green gram	58	91	22.5	20	-11 %
Vegetables					
Spinach/Palak	12	43	30	42.5	42 %
Fenugreek/Methi	18	48	20	40	100 %
Eggplant/Brinjal	13	46	50	40	-20 %
Ladies finger	12	38	26.5	25	-6 %
Coriander	17	44	15	20	33 %
Chillies	10	42	15	20	33 %
Total	**649**	**989**	**961.5**	**1152.5**	20 %
Av. no. grain growers	71	91			
Av. no. vegetable growers	14	44			
Overall production difference (weighted)					22.74 %

> Since all the training on the natural regeneration of trees, people pay much more attention to trees and avoid cutting them. It was also a good idea to have trained the children, because that is an investment for future generations. Only we now really regret not having started with the natural regeneration much earlier."

Quotation from a group interview with women farmers from Senghor village in Fatick district, Senegal

Planting trees in the dry lands is a long-term investment for small-scale farmers and they require a great deal of care from the farmers.

In Senegal, ENDA Pronat worked with farmers to increase the varieties of crops grown, encourage seed exchange, and identify the best performing varieties and variety mixes of millet and cowpea: 75% of farmers were found to have taken up one additional variety, 17% took up two new varieties, and 8% took up three new varieties. Significantly, these crops are the most important sources of energy within the local diet. Thus, the identification of the best-suited varieties of millet and cowpeas, and the best-performing mixed cropping patterns, is a vitally important area of previous and on-going work. There also have been efforts to promote agroforestry, which has shown ample promise in cases around the world (not least in the current case from Brazil). While the number of trees per hectare is still low, data from a separate study by EP showed that the majority of trees on farmers' property (84%) are young, indicating a potentially promising trajectory. Additionally, as we will examine in the next sections, supporting increased production diversity may go hand in hand with improving food security and nutrition, and increasing sociopolitical capacity and power for all farmers, particularly women farmers .

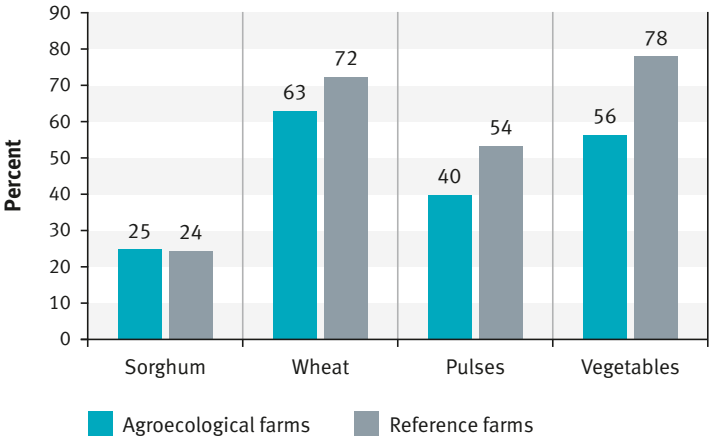
Food and nutritional security

While superficially simple, food security and its measurement are, in reality, notoriously difficult (Vaitla et al. 2017), and complexly tied to numerous interrelated sociopolitical and environmental factors (Smith and Haddad 2015; Wittman et al. 2017). Thus, the results discussed above and below (income, productivity, and empowerment) all themselves are indicators of likely improvements in food and nutritional security. For the most part, more direct indicators in each of the studies also bear this out; but each study also presents some challenges to adding to the picture. In other words, although the three cases were conducted with the intention of comparability, not all indicators and questions ended up being precisely parallel due to variations in sociocultural context and other factors. But taken as a whole, the results examined in this section further reinforce the benefits from agroecological systems with regards to food and nutrition security.

In terms of more direct indicators, both regions of Brazil (the Agreste and the Sertão), survey responses indicated that agroecological households had more diverse diets, as well as larger amounts of food coming from self-supply, compared to reference households. Families in the Agreste reported consumption of 1.3 kg of food each day from their own production, compared to 0.71 kg/family/day for reference farmers, a difference of 87%; in the Sertão this difference was ~13 % (0.52 versus 0.46 kg/family/day). The diets of both groups contained ample variety, with 15 kinds of food (various fruits, vegetables, meat, dairy, and pulses, as well as sweets or snacks) composing 60-80 % of their consumption. Both groups of farmers also reported substantial improvements in their perceived food security compared to ten years ago, which is in line with the fact that, before recent political changes, Brazil achieved widely-acclaimed food security improvements under its national Zero Hunger policies. This makes it difficult to analyze improvements in food security from the promotion and adoption of agroecology per se. Nonetheless, focus groups with the women farmers in Brazil carried out as part of the study generated unanimous feedback that beginning to work with agroecology was a major factor in improving their diets – particularly in terms of increasing variety and consumption of fruits and vegetables, and decreasing health problems. And as noted in the previous section, agroecological farmers as a whole reported growing 13-28 more types of agricultural products than reference farmers.

Also as noted in the previous section, Indian agroecological farmers not only saw higher productivity, income, and self-supply, but similarly reported notable increases in the diversity of food groups grown. Other, more direct measures of food security and nutrition also showed some improvements, although these were perhaps more modest. Specifically, the percent of households reporting no farm production and therefore needing to buy all of their food from the market was 9-18 % lower for agroecological farmers in India for wheat, pulses, and vegetables; the percent relying entirely on the market for sorghum was approximately the same for both (Figure 7). At the other end of the spectrum, the proportion of farmers reporting full self-sufficiency in vegetables and pulses throughout the year was consistently ~10% higher amongst agroecological households (~18-36 % versus ~8-27 %).

Figure 7: **Percentage of households in Indian case that purchase all food from the market**



And when comparing reported household consumption of four significant dietary areas for agroecological

> “It is necessary to take care of people‘s health and nature. Using pesticides damages nature and our food, too. Agroecology involves several things, from giving a right destination to waste to re-processing resources and materials.”
>
> **Quotation from a group interview with farmers from Feijao-Bom Jardin, Agreste, Brazil**

Table 7: **Food consumption per person and recommended annual consumption in India**

	Recommended annual consumption	Median household		Sufficiency vs. recommended consumption	
		Ref kg	AE kg	Ref	AE
Cereals & Millets (kg)	149	98	106	66 %	71 %
Pulses and non-veg (kg)	30	11	18	37 %	60 %
Milk (liter)	100	43	37	43 %	37 %
Vegetables (kg)	100	72	82	72 %	82 %

farmers to reference farmers, notable improvements are seen as well (with the exception of milk consumption). At the same time, the results show ample room for further work as all reported consumption is very far below recommended levels, indicating on-going and stark challenges for food security in the area (Table 7).

With regards to Senegal, despite the improvements in income, self-supply, and productivity reported above, the results for food security measures are more modest. For example, looking at self-sufficiency in millet, between 3 and 35 % of reference households report needing to purchase millet to supplement their production at various points during the year; around 2 to 32 % of agroecological households reported the same. Similarly, depending on the point in the year, 70-100 % of reference households reported needing to purchase rice, and 20-65 % of reference households had to purchase groundnuts. For agroecological households, these proportions were approximately 59-97 % and 15-55 % for rice and groundnuts, respectively. So at the same time, these modest results are not out of line with the 14 % and 17 % increases in income and productivity, and may reflect other constraints (discussed further in the Conclusions).

> “Eating habits have changed because trees producing forest fruits are rare. Ditakh, tamarind and oule (nététou) are no longer available. If you want to prepare these dishes, you have to buy these fruits and we don’t always find them.”
>
> Quotation from group interview with women farmers from Fayil, Fatick district

Social change and women´s empowerment

Social capacity-building and technical training are integral parts of agroecological interventions: a central component of agroecology is the dynamic self-organization of farmers and the strengthening of their space and abilities to speak directly for themselves at all levels of the food system. This way, farmers can advance production and food systems based on their own knowledge and resources, and merge traditional practices with academic support in a way that empowers further innovation and action towards sustainable and productive livelihoods. Specifically with regards to gender, women's equality, capacity, social organization and empowerment have all been shown to be tied to increased agricultural productivity, decreased malnutrition, increased dietary diversity, better family health, and even improved environmental conservation (Chappell and Varghese 2016, at note 17; see also Asher and Shattuck 2017). Thus the final elements of the three cases we assess here are social change and empowerment.

There was evidence across the cases of greater participation and capacity-building, particularly where women on agroecological farms showed higher participation in various forms of social networks. For example, in India, women in the agroecological households had higher levels of membership in various pertinent organization (Table 8). While in the reference group, more than half of all women were not organized in any way (59 %), amongst the SSP respondents nearly all were members of at least the self-help group (SHG, the village-level entity for SSP) in addition to other farmer groups. Amongst women who were trained in group leadership, 25 % went on to take up roles as leaders, 22 % as agroecological trainers, and in 10 % of the cases both. The process of enabling women farmers to learn from the experiences of existing female leaders whose socioeconomic background was similar to theirs was noted to be especially effective. SSP also made a considerable effort to link with existing groups and organizations which women farmers are members of, including groups involved in supporting women in rural marketing and distribution, developing skills and entrepreneurship, providing innovative finance, and working towards preventive health services.

In Brazil, women's increased participation and empowerment was seen in the form of higher participation in structured organizations (municipal council, cooperatives, fairs, and nonprofits and political parties in particular) and improved utilization of public support policies, such as government purchase programs and income transfer programs. (Although participation and utilization varied from under 5 %, to 29 % of agroecological farm women.) Women and families also took part in knowledge-building activities, such as courses, field days and technical exchanges. In such activities, women and families in general took part as active participants in the design and dissemination of innovations and social approaches, which are both fundamental for the promotion of social and environmental development. Further, although differences were minor, women working in agroecology in Brazil generally spent proportionally less time in activities classified as domestic and more time in activities classified as productive compared to their counterparts.

Table 8: **Women's membership in organizations in the India case**

Organizations	AE %	Reference %
None	2	58.5
SHG	97.5	30.5
Farmer group	74.5	18
Gran Panchayat	0	0.5
Village development committee	0	0.5
Other	1.5	1.5

In Senegal, fewer direct indicators around social change and empowerment were available, but some potentially promising trends were observed. Over half the households working with EP received training and information on the intense sociocultural pressures on women, their frequent marginalization within organizations, and the adoption of a national law for gender equality – important work, given that in Senegal's rural areas "few women are aware of the legal rights that are in place to protect them" (OECD Development Centre 2016). Surveys indicated that the level of application and adoption of knowledge from EP trainings was "very good" for 27% of attendees and "low to medium" for 45% – a start in a situation where 41% of the beneficiaries report no expe-

rience of formal education. 67 % of farms working with EP were trained in management of savings and credits, with 47 % of them subsequently indicating high proficiency with the materials, with 41 % attaining at least a basic level. There is also the potential that working with EP affected women's capacity beyond the producer organizations: in Diouroup, women obtained near parity in representation on the municipal council (22 of 46 city councillors); important progress, though similar to food security in Brazil, but hard to disentangle from the larger political environment and policy changes. However, some interesting results relating to agroecological interventions and gender are apparent when comparing women-headed households and male-headed households. At the median, women-headed households in the agroecological group saw a 28% improvement compared to men's 12.6 % improvement in total income (self-supply included), although, women in the 5th and 10th lowest percentiles actually saw decreases in income of 12.4 % and 14.5 %, while men's income in those percentiles increased by similar proportions. This pattern remains to be explained and explored. Work in Senegal on women and gender empowerment also included various elements to structurally strengthen their economic position, which is one crucial component of longer-term empowerment. EP sought to leverage three major approaches: enabling women's access to land for rice cultivation; access to capital by saving and credits; and enabling women to add value to raw products. Where women are enabled to increase their economic and food sovereignty, it will also help them gain an appropriate voice in the political arenas in rural society.

Conclusions and outlook

In line with agroecological principles, the results of the three case studies reinforce the interconnections between livelihoods (economic viability and income), diversity and productivity, food and nutrition security, and social change and empowerment. Together they portray a strong testimony to the gains to be achieved from holistic approaches to agroecology.

Limitations and areas for further work and social change are also apparent from the cases. For example, it is clear that policy support and government programs can make significant differences. In India, some of the studied villages had benefited from funding for much-needed bunds in the past. There also exists some degree of government support for agricultural extension, participatory guarantee systems, organic agriculture, and basic food access, which provided further elements of a strong enabling background. In Brazil, government programs have notably supported irrigation and water storage systems, alongside a number of other support programs for food security and family farms from the former Zero Hunger programs and related initiatives. We can further see the significance of social support in the climatically-more-favorable Agreste study area, where government benefits made up about 25 % of cash income for both agroecological and reference farms. In comparison, in the environmentally harsher Sertão, government benefits were, at the median, 45 % of cash receipts for agroecological farms and 60 % for reference farms.

Other contextual factors must be noted as well. For example, many farms have long benefited to varying degrees from off-farm income to supplement their livelihoods, or even to make a rural livelihood at all possible. However, high degrees of dependency on off-farm income have become increasingly notable, raising difficult questions in rural development (van der Ploeg 2009). Thus, it becomes especially important to consider socioeconomic viability in a larger sense and not limit considerations to direct farm receipts. For example, considering the economic value of food consumed by the farm households themselves makes the picture more complete and can allow changes in farmers' relationships with society and markets by increasing their autonomy – as does the reduction in input costs, at least in terms of seeds, fertilizers, and pesticides, which was seen in most cases examined here. A more complete picture also must include important sociocultural and economic activities like donation and sharing of a portion of production; the setting aside of some production as stocks; and larger shifts in the focus from commodity-based exchange to approaches that integrate a multiplicity of values and seek an ethos of co-existence, autonomy, self-respect, and resilience. Thanks to increased production of seed and vegetables, and in some cases livestock, agroecological households across the cases donated their produce (to needy families, food banks, social assistance programs, and other charitable recipients) to a greater

extent when compared to the reference group. Returning to non-agricultural income, with the exception of the Brazilian Agreste, off-farm income increased slightly amongst agroecological farms. Although the size of the difference is small, this possible effect could be due to increased capacity, capital, and flexibility from increased on-farm income. In other words, looking beyond the merely economic dimension, farm households' food sovereignty increased, as their ability to give and connect to their communities increased, their dependence on (some) purchased inputs decreased, self-supply and agricultural income increased, and off-farm income may have increased.

In line with the increasing prominence of gender in agroecology and food sovereignty (Chappell 2013), women were supported to become more vocal and active participants and leaders in the studied agroecological programs. Although support for changing gender power relations was most clear in Brazil and India, its importance was recognized and the need to broaden and deepen this work is reinforced by the very large relevant literature examining agriculture, nutrition, and food security. For example, Lemke et al. (2003), who found that certain categories of female-headed households and households [in South Africa] based on partnership relationships, despite more limited resources, achieved a better or an equal economic status and better nutrition security than those households led by men, with the latter often being considered an economic liability. The reliance on and fostering of social ties and networks appeared to be of central significance.

As can be seen in Figure 8, gender is one of many factors playing into dietary diversity and food security. In India, improved productivity and food security can be linked to the re-diversification of leguminous crops, led by women, to tackle the lack of nutrition security linked to adverse policy environments.[21] And while diversification can be linked to empowerment of women in and beyond their traditional roles as guardians of the kitchen

[21] We use the phrase "re-diversification" here because Indian food systems were traditionally quite diverse, with many vegetables and pulses. Thus this is mainly a "re-diversification" to overcome the losses which accompanied cash crop and export-oriented policies.

Figure 8: **The most salient relationships between determinants and outcomes of dietary diversity**

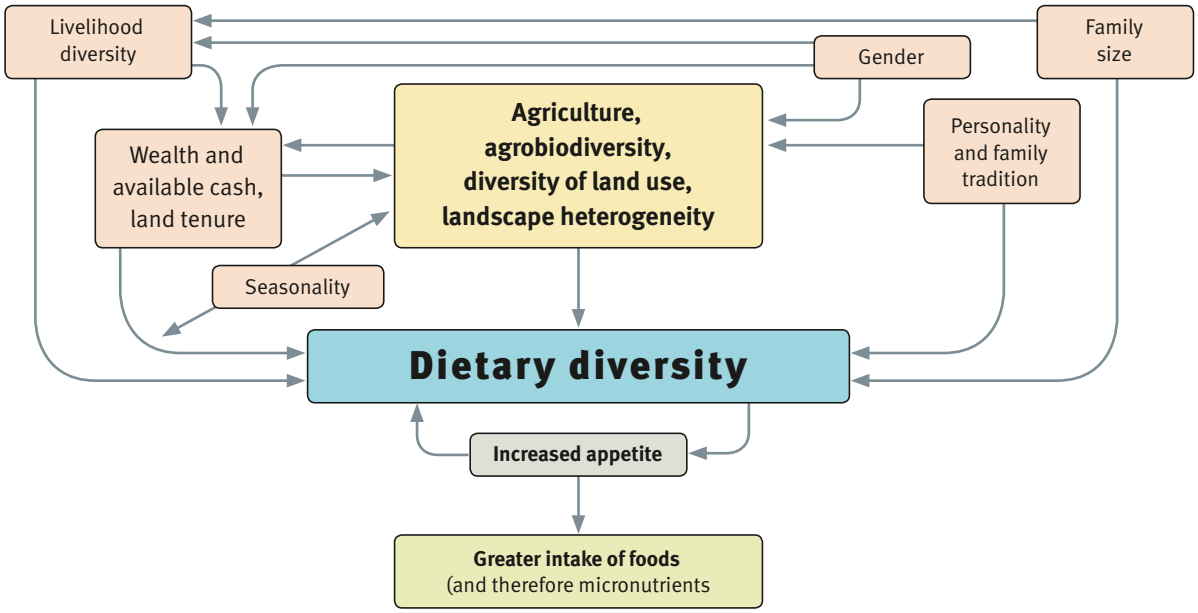


Diagram of the most salient relationships between determinants and outcomes of dietary diversity, showing an interpretation of how they interact within the social-ecological system (arrows indicate associations that can be either positive or negative, they are not meant to indicate causation). Reprinted from Powell et al. (2017). "The determinants of dietary diversity and nutrition: ethnonutrition knowledge of local people in the East Usambara Mountains, Tanzania."

and kitchen gardens, diversification of vegetables also had a positive impact on men and other members of the family who enjoyed the diverse and healthy diet. Qualitative interviews revealed a number of families who felt that their health had improved, and that their consumption of processed foods had gone down, as had their health expenditures. Women's increased agency also potentially increased the respect and conviviality within families and across genders. And so the results from India, reflected in Brazil, and to some extent in Senegal, indicate that all three of the forms of hunger discussed at the beginning of this report have been addressed to some degree: productivity increased, and higher dietary diversity provided a broader array of required micronutrients; and some survey and focus group responses indicated decreases in the intake of processed foods, in turn decreasing the risks and likelihood of obesity. (However, direct indicators to determine effects on obesity were not obtained.) All in all, the connections between women's empowerment and improved food and nutrition security echoes the very strong links researchers have consistently found between gender empowerment and decreasing hunger and child malnutrition (Smith and Haddad 2015).

Still, without an enabling social and political environment communities are often not able to fully utilise and benefit from the diversity in their system (Chappell et al. 2013). For example, one barrier may be local eating habits that are less accustomed to or less eager for diverse diets. Other projects in Africa have found that "traditional African vegetables have been stigmatized and their use has declined over the past 100 years," (Herforth 2010). Kenyan ethnobotantist Patrick Maundu said of his experiences as a child at school: "If you brought traditional vegetables, you hid yourself over lunch hour to eat alone," (Maundu 2004). At the same time, focused programs to support diverse and traditional varieties have seen success, including media pushes and participatory programs that reconnect and re-empower people to take an interest in reinvigorating their own dietary diversity (Herforth 2010). Furthermore, people's perception of, ability to obtain, and desire for diverse and traditional foods are influenced by a range of factors (Figure 8), meaning there are both many opportunities for supporting diversity, but also that doing so is fraught with complex, contingent, and contextual dynamics.

Women farmers have increased the diversity on fields and plates.

Final remarks

While agroecology is a powerful science, practice, and movement for better food systems, it is of course not without limits. Indeed, the limits of agroecology to address larger structural problems itself are a significant part of why social movements are increasingly calling for food sovereignty to be integrally connected to agroecology. It has additionally been argued that food justice should make up a third "pillar" of sustainable and just food systems (Chappell and Schneider 2017) in order to fully recognize the changes, voices, and movements needed. Such approaches acknowledge, as the Nyéléni Declaration on Agroecology emphasizes, that without political reform, social action, new and deeper forms of governance, and empowered participation across lines of gender, culture, and class, it will not be possible to reach a future of secure, sustainable livelihoods for farmers, and indeed, all eaters. We are all increasingly at risk from climate change and the negative effects of biodiversity loss and pollution with a third of people worldwide suffering from at least one of the three forms of malnutrition – undernutrition, hidden hunger, or

obesity. Insofar as agriculture plays an unequivocally key role in each of those issues, we will need a transformational agroecology, alongside food sovereignty and food justice, to address it.

One viewpoint on this type of a transformational agroecology is prominent agroecologist Steve Gliessman's "Five Levels" (Box 6). While as originally outlined, the "levels" imply a linear transformation (and assume industrialized agriculture as a starting point), we propose it can be usefully thought of more generally in terms of types of transformation, which may occur at different times, in partial ways, and in a different order. We introduce it here, however, because it is potentially useful for thinking about different areas of strength and weakness in agroecological interventions. For example, an important part of the successes in Brazil include Level 4 and 5 changes – the creation and availability of agroecological markets that provided CS famers with better prices and therefore improved livelihoods (an L4 change), and the broad set of policies in Brazil that (previously) supported social change for food security, agriculture, and rural development (L5 changes). Brazil has also famously had ambitious struggles for agrarian reform and land redistribution, with important implications for food security, agroecology and rural development (Wittman and Blesh 2015; Wittman et al. 2017).

Similarly, in Senegal, securing farmers' land titles and agitating for better governance of natural resources have been focal areas for EP, and it has involved grassroots members in reflections and proposals on agrarian reform in Senegal. The actions contributed towards improving the national legislation and raising awareness of discrimination between men and women for access to the land. Due to the fact that land-grabbing has not yet been a major direct threat to farmers in the study region, only 5.3 % of EP farmers have followed up on securing their land titles as a precaution. Of course, titling is also just one aspect of agrarian reform, but the changes to structural power and relationships that make up agrarian reform do represent an important requisite and reinforcing factor for success in agroecological transitions.

Thus under a framework of transformative agroecology, in line with previous and ongoing work by MISEREOR, the cases reviewed present achievements and contributions to a paradigm shift, while acknowledging current limitations and challenges. From these studies, much can be learned in order to build on current successes and expand the scope of agroecology's ability to help family farmers in positions of precarity, such as in the world's semiarid regions. Levidow et al. (2014) have argued for the distinctness of agro-food research led by communities themselves, based on methodology and problem definitions co-developed with researchers and framed within skill-building processes. The work MISEREOR supports, in allyship with its partners, embraces the transformative traits of agroecology, and provides evidence on the effectiveness and challenges of agroecology. Deliberation and on-going participation with the communities in each of the three regions offer immense potential for further learning to improve the lives of the farmers living there, and the 1.5 billion other smallholder farmers in the Global South.

Box 6

Levels of Transformation to Agroecology

- Level 1:
  Increase the efficiency of industrial/conventional practices to reduce the use and consumption of costly, scarce, or environmentally damaging inputs.
- Level 2:
  Substitute alternative practices for industrial/conventional inputs and practices.
- Level 3:
  Redesign the agroecosystem so that it functions on the basis of a new set of ecological processes.
- Level 4:
  Reestablish more direct connections between those who grow the food and those who consume it.
- Level 5:
  From the foundations of agroecosystem changes in L3 and strengthened relationships of L4, build new food systems based on equity, participation, and justice at all scales.

(Adapted from Agroecology: The Ecology of Sustainable Food Systems, 3rd ed., by Stephen R. Gliessman, pp. 277-278)

Political recommendations

MISEREOR's studies in the three countries have shown that pro-poor benefits arise not from technological "quick fixes" or silver-bullet solutions, but from an orientation towards changing the processes, capacity, organization, support and practices for farmers and the sociopolitical contexts around them. Based on these experiences, political recommendations stemming from both an ecological understanding of sustainable agriculture (diversification of crops, trees, animals, healthy soils) as well as a socio-political understanding (valuing and supporting women's and men's contributions, cultural flourishing, land access, and justice) are proposed. Rather than simply assuming that the latter will automatically be derived from diversifying ecological inputs or other practice changes; or simply by replacing chemically-intensive approaches with agroecological alternatives, these Political Recommendations embody processes to generate and maintain shared values of equality, solidarity and justice as guiding principles for the participatory development of innovations and as part of effective, agroecology-led rural development. We also note that many of them echo FAO (2013)'s Key recommendations for improving nutrition through agriculture and food systems.

Recommendation 1

Governments and other development funders should invest in agroecology for rural development, food security, and sustainability

1.1
The results reviewed in this study make it clear that agroecology offers unique opportunities for holistic, pro-poor development that can lead to increased income, empowerment, diversity, and food security in rural areas. The semiarid setting of these studies reinforces agroecology's applicability across countries and in challenging environments.

1.2
Agroecology has the potential to be less cost-intensive than conventional, external input-focused agricultural approaches, providing more benefits to society and the farmers themselves at lower cost.

1.3
Agroecology can help address all three elements of the current malnutrition crisis: undernutrition, micronutrient deficiencies, and obesity and overweight, in part through its amplification of dietary diversity and increased ability to avoid processed foods through self-provisioning. Self-provisioning also serves as a buffer (increases resiliency) against economic and environmental variation.

1.4
Appropriate policies should be significantly and specifically directed at helping small- and medium-scale farmers survive and thrive, as these farmers produce most of the world's food, and can support thriving rural economies without becoming large, export-oriented mega-operations.

Recommendation 2

Governments should increase provisions for developing and maintaining rural infrastructure, particularly sustainable access to safe, clean water, which will have significant positive "knock-on" effects for agricultural incomes, food security, health, and rural development.

2.1
Water is a crucial resource in semiarid areas, which need special attention from governments and other funders. Work and support for appropriate irrigation systems and water access in general must be expanded, with the provision of more funds, knowledge support and expertise, and attention to local needs and constraints. Where issues like salt infiltration threaten water quality and agriculture, policy and financial support will be necessary for true progress in rural development to occur.

Access to water is crucial for farmers in dry zones like the Senegal. The long dry season can then be used for vegetable production.

2.2
In addition to providing financial and socio-cultural resources, a holistic approach to water access, including its status as a basic human right, should be emphasized. Water access, sanitation, food and nutrition security, and gender empowerment are often correlated, and advancements in one area can be strengthened, or undermined, based on the level of support for the others.

2.3
Decentralized infrastructure for safe water storage and water-saving can be particularly effective and important in semiarid regions, allowing improved resilience and well-being during dry seasons and droughts. "Living with" (convivência) semiarid environments can be a more effective approach than "battling" drought.

2.4
Other basic infrastructure investments, like fencing to protect agroforestry and control livestock, as well as tools and equipment which facilitate farm work, processing and marketing, are also occasionally lacking, yet have tremendous potential to improve the success of agroecological measures and improve livelihoods.

Recommendation 3

Governments and funders should create and strengthen empowered, participatory, on-going policy spaces, where input and participation from civil society (such as farmers) directly influences policy decisions and budget allocations

3.1
The positive study results from Brazil demonstrate the importance of promotive public policies which create an enabling environment for agroecological initiatives. Therefore, new governance frameworks should be built up where participatory and cross sector policy dialogues can take place and effective public policies are developed, implemented and monitored in a participatory manner. An example for how such governance frameworks could function are the Food and Nutrition Security Councils (CONSEA) Brazil pioneered over the past three decades. Creating new protected political spaces for civil society participation and strengthening existing ones is particularly important in a time of shrinking participatory spaces.

3.2
In addition to the development of new governance frameworks it is also important to support the capacities of local communities, grassroots organizations and social movements to get organized at all scales (local to international), develop consolidated proposals to national and local governments, international bodies and development agencies, governmental and non-governmental funders and make public demands for inclusive, transformative rural development and an agroecological transition in the spirit of food sovereignty. Examples and information to build on include Baiocchi and Ganuza (2014); Carlson and Chappell (2015); Fung and Wright (2003); and Pimbert et al. (2010).

Recommendation 4

Build alliances between science, NGOs and social movements

4.1.
The development of common messages and the combination of scientific/academic research knowledge, farmers' knowledge and testimony from lived experiences will strengthen the science, movement, and practice of agroecology. Political demands should be drawn up based on bottom-up processes.

4.2
Collaboration between NGOs and social movements (such as the organic movement in India) could be beneficial to strengthen political voice and increase outreach.

Recommendation 5
Promote equality across gender and marginalized groups

5.1.
The work of MISEREOR partners in India, Senegal and Brazil has demonstrated that agroecology and women's wellbeing is enhanced when they are enabled to be leaders in practice but also in political decision-making. This type of approach should be continued and strengthened amongst all development funders both governmental and non-governmental. Deliberative discussions and events should be promoted on a regular basis, to further consider and develop what support is needed to expand the roles and capacity of both women and men, with particular attention to exploring the attitudes and policies that hamper women's agency. In India for instance, women may be more supported in their role as nurturers if men were also tend to cultivation of diverse (non-cash) crops. The work of SSP has already shown how men can value what women do. Keeping up with the same approach, diversification could then move from a women's practice to a community practice, which in turn could lessen the burden on women.

5.2
Mobilizing collective action is a key precondition for successful development work. The entry points of SHGs and farmers' groups, for example, have proven themselves to be good starting points. It remains to be explored how even the poorest in the villages (the landless, very small-scale landholders, the jobless, etc.) can be better integrated. Furthermore, dialogues and support for collective action will need to accommodate the fact that (for example) the interests of a family with even one or two hectares of land can be quite different from the interests of a landless family. Additional spaces or groups for these very vulnerable people should be created through participatory, deliberative processes. Appropriate processes of this type could help identify the undervalued knowledge and skills of the marginalized and better include them in viable pathways for inclusive and transformational rural development, increasing the pro-poor character of agroecology.

Recommendation 6
Enable local institutions for agroecological horizontal learning and sharing through public support

6.1
Non-profit and state-led agricultural extension services must be reinvigorated, properly funded, and work in synergy with horizontal knowledge-sharing and informal training and learning. The work of MISEREOR's partners has been successful because they operated on the principles of co-learning and co-design of practices. Problem statements and visions were proposed at the grassroots level and technical assistance followed local demands. This approach should be extended into other agricultural extension programs to transform current top-down extension services. Awareness of agroecology could be raised by including it in school curricula.

Recommendation 7
Encourage diversified and inclusive economies

7.1
It is a simple fact that farmers' livelihoods depend on both off-farm and on-farm income. The studies here have shown how participatory capacity building in production, marketing and processing is important and may contribute to both. The study results also showed that agroecology can be labor-intensive, as well as economically beneficial, and therefore has the potential to create positive employment opportunities in rural areas. But underlying requirements for continued progress include labor conditions that are fair in terms of reward and social conditions; and have increased recognition and valuation of self-supply of food in development policy. Farmers must be able to secure appropriate and sufficient prices for their production, allowing them room to operate and engage in larger social change and cultural activities. Diversified production and self-supply can also increase their resilience, providing food security even in the face of market and environmental fluctuations. Together, these factors can make off-farm income a valuable contribution while decreasing its centrality to survival. At the same time, landlessness is a key factor for reluctance or inability to engage in agriculture. Therefore, policies should address the historical root causes of landlessness as well as the current challenges of land-grabbing and accordingly engage in appropriately pro-poor agrarian reform and redistribution.

Local markets support local economies and offer fresh produce.

7.2
A variety of markets for agricultural producers should be supported, including local and regional markets, as well as links to public procurement systems and markets where agroecological farmers can receive premiums for their products. Sustainable inclusive economies will require the dismantling of existing policy barriers and implementation of appropriate supports – for example, most agencies and governments provide close to zero support for community-driven innovation for small-scale farming and circular economies. Yet the positive results seen in Brazil, and their connection to Brazil's national policies, show the high value and viability of doing so.

7.3
Import policies should protect local farmers against cheap imports that disrupt local markets and discourage local production. The kind of improvements in economic viability, food security, resilience and sustainability seen in the studied cases is not well-served by a prioritization of international markets or commodity crops. And the negative effects of cheap imports, particularly those that are "dumped" on international markets at prices below the cost of production, are visible and well-documented (e.g., in the case of rice imports in Senegal, or the presence of cheap milk powder across many parts of Africa).

Recommendation 8
Promote participatory breeding and maintenance of crop and animal diversity

8.1
Diversity (particularly at varietal level) continues to be a largely untapped potential in agriculture. Enhanced varietal diversity can contribute to pest and disease mitigation, nutrition, resilience and adaptation to drought. Where women, youth, or other marginalized groups continue to show particular interest in or knowledge of diversification of crops, development programs can respond to these motivations as a starting point. They can further encourage farmers to manage and maintain diversity, starting from documentation, through to saving and participatory breeding in farmer field schools, and building capacity for South-South exchanges. Seed diversity sourced through informal networks should be better documented, understood, and supported in cooperation with the worlds' many small-scale farmers preferentially over the promotion of external hybrid varieties.

8.2
Animal diversity is important culturally, socioeconomically, and for enhancing soil quality. Starting from small animals such as goats and chicken, and slowly progressing to larger animals can yield benefits both in terms of

Farmers use agroforestry to diversify the range of agricultural products for consumption and sale.

economic assets, food, and building up proper manuring practices to enhance fertility. Here too, participatory documentation and participatory action research that values and seeks to understand and support local breeds is an important process to allow equal access, benefits and sharing across different groups.

Recommendation 9
Encourage diversified diets for improved nutrition

9.1
The well-established role of women in improving nutrition has been confirmed in the case studies here. Diversification in production systems and diets should be strengthened through inclusive interventions that support women's voices, knowledge, and agency. Further, improved nutrition and diets can be linked to agroecological markets and related niches, including food fairs, regional markets, community-to-community cooking workshops and collaboration with restaurants. It will also be important to encourage diverse diets and nutritional knowledge in both rural and urban spaces to enable equal appreciation and access to such foods, and avoid phenomena such as "elite superfoods" and dietary "fads" that are trendy but inaccessible and not truly grounded in new or old traditions, knowledge, and practice.

Recommendation 10
Promote agroforestry and green manure

10.1
Agroforestry and generally increasing the presence of trees in agricultural systems is an effective climate change adaptation measure. Particular priority should be placed on fruit trees, fodder and leguminous ("green manure") trees. Training should include highlighted information on the proper pruning of trees to maximise their benefits, as farmers often fear shade competition. Community collaboration on fodder and green manure planting should be piloted.

10.2
The promotion of agroecological methods to manage fertility has contributed significantly to the improvements of soils, and helped towards more stable and increased yields. Development efforts should focus on methods such as green manuring, which can minimize the need for external inputs (organic or conventional) and reduce run-off. Leguminous crops can be used in versatile ways and generate multiple benefits besides fertility (pest control, fodder, etc.).

10.3
In many cases, strategies for soil fertility for farmers without their own livestock is required. In addition to green manure, such strategies could include further expanding agroforestry, and purchasing organic manure from other farmers. The best approach will vary contextually, but a large number of under-utilized possibilities lack significant support for research and application.

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Annex

A selection of recent notable reports and commentaries on agroecology

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Abbreviations

AE	Agroecology
AFIRD	Agency for Integrated Rural Development
AFSA	Alliance for Food Sovereignty in Africa
AGRA	Alliance for a Green Revolution in Africa
CIDSE	Coopération Internationale pour le Développement et la Solidarité ("International Cooperation for Development and Solidarity")
CS	Centro Sabiá ("The Sabiá Center")
EP	ENDA Pronat
FAO	Food and Agriculture Organization of the United Nations
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IPES-Food	International Panel of Experts on Sustainable Food Systems
KPMG	Klynveld Peat Marwick Goerdele (auditing company)
LVC	La Vía Campesina ("The Peasants' Way")
MASIPAG	Magsasaka at Siyentipiko para sa Pag-unlad ng Agrikultura ("Farmer-Scientist Partnership for Development")
m.a.s.l	metres above sea level
NGO	non-governmental organization
PDS	India's Targeted Public Distribution System
PPP	Purchasing Power Parity
SA	Sustainable Agriculture
SHG	Self-help group
SSA	Sub-Saharan Africa
SSP	Swayam Shikshan Prayog ("self-learning by doing")
WHO	World Health Organization

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