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Assessment of the growth in social groups for sustainable agriculture and land management

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Non-technical summary

Until the past half-century, all agriculture and land management was framed by local institutions strong in social capital. But neoliberal forms of development came to undermine existing structures, thus reducing sustainability and equity. The past 20 years, though, have seen the deliberate establishment of more than 8 million new social groups across the world. This restructuring and growth of rural social capital within specific territories is leading to increased productivity of agricultural and land management systems, with particular benefits for those previously excluded. Further growth would occur with more national and regional policy support.

Technical summary

For agriculture and land management to improve natural capital over whole landscapes, social cooperation has long been required. The political economy of the later twentieth and early twenty-first centuries prioritized unfettered individual action over the collective, and many rural institutions were harmed or destroyed. Since then, a wide range of social movements, networks and federations have emerged to support transitions towards sustainability and equity. Here, we focus on social capital manifested as intentionally formed collaborative groups within specific geographic territories. These groups focus on: (1) integrated pest management; (2) forests; (3) land; (4) water; (5) pastures; (6) support services; (7) innovation platforms; and (8) small-scale systems. We show across 122 initiatives in 55 countries that the number of groups has grown from 0.50 million (in 2000) to 8.54 million (in 2020). The area of land transformed by the 170–255 million group members is 300 Mha, mostly in less-developed countries (98% groups; 94% area). Farmers and land managers working with scientists and extensionists in these groups have improved both environmental outcomes and agricultural productivity. In some cases, changes to national or regional policy supported this growth in groups. Together with other movements, these social groups could now support further transitions towards policies and behaviours for global sustainability.

Social media summary

Millions of geographically based new social groups are leading to more sustainable agriculture and forestry worldwide.

1. Collective management of natural resources and agriculture

For as long as people and cultures have managed natural resources, collective action has produced systems of efficient and effective off-take, as well as offering potential for sustaining natural capital and valued flows of ecosystem services (FAO, 2016b; Folke *et al.*, 2010; Kelly, 1995; King, 1911; Li Wenhua, 2001). A wide range of different types of more sustainable agriculture and land management have recently been developed and implemented, most centring on the notion that making more of existing land by sustainable intensification and collective action can result in greater and synergistic co-production of food and ecosystem services (Benton, 2015; FAO, 2016c; Foresight, 2011; Maréchal *et al.*, 2018; Pretty *et al.*, 2018). Yet at the same time, agriculture and land management have also contributed to biodiversity loss, nutrient loading of the biosphere, climate forcing, depletion of aquifers and surface water and pollution of air, soil and water (IPBES, 2019; Rockström *et al.*, 2009, 2017).

Humans have a long history of developing regimes and rules in both hunter–gatherer–forager and agricultural communities to protect and preserve natural resources in a steady state (Berkes, 2020; Cummings *et al.*, 2014; Denevan, 2001; Kelly, 1995). These diverse and location-specific rule systems form informal institutional frameworks within communities, legitimated by shared values. These social frameworks have regulated the use of private and common property throughout history, such as by defining access rights and appropriate behaviours (Ostrom, 1990). Where these systems are robust, they can maintain productivity and diversity without the need for external legal enforcement: compliance derives from shared values and internal rules and obligations (Agarwal, 2018; Bagadion & Korten, 1991; Gunderson & Holling, 2002). In some agricultural systems, there is evidence that social structures have sustainably governed resource use over millennia, such as *subak* irrigation groups in Bali (Yekti *et al.*, 2017) and irrigation tank groups in Tamil Nadu (Mosse, 1992). Elsewhere, the structure of farms in landscapes has been shown to shape wider social and political participation, such as in the classic study of small and large farmed communities in California (Goldschmidt, 1946, 1978; Lobao, 1990): social connectedness, trust and participation in community life were greater when farm size was smaller.

However, many of these inherited and legacy institutions have been undermined by choices made by the modern agricultural political economy: social institutions have been ignored, co-opted, undermined and deliberately broken (Cernea, 1991; Wade, 1989). The emergence of neoliberal forms of economic development prioritized the competitive choices and actions of individuals rather than cooperation (Dorling, 2020; Uphoff, 1992) and framed the approaches to technology adopted during the green revolution (Conway & Barbier, 1990). In some cases, state institutions were imposed on farmers as the price for obtaining modern varieties, fertilizers and pesticides, such as in Malaysia and the Philippines (Palmer, 1976); in others, local institutions lost power and withered, such as *kokwet* water systems in Kenya (Huxley, 1960), *warabandi* in Pakistan (Bandaragoda, 1998) and common property resources in India (Jodha, 1990). The collapse of institutions allowed over-extraction through the unfettered actions of individuals (e.g., of groundwater in Gujarat; Shah, 1990). Empty and paper institutions were also formed by states without local participation, such as for grazing in China (Ho, 2016) or irrigation in Thailand (Ricks, 2015).

Further changes to the social structures of communities were fostered by the conditional policies of structural adjustment adopted by international finance institutions from the 1970s and 1980s resulting in the destruction of public institutions (Crisp & Kelly, 1999; Forster *et al.*, 2019), and by the adoption of the Training and Visit (T&V) system of agricultural extension (Benor *et al.*, 1984). The T&V system was built on a linear diffusion model (or transfer of technology), first implemented on the recommendation of the World Bank in 1967, and resulting in disbursement to 512 projects valued at US$3 billion over 1977–1992. Structural adjustment brought free-market policies to 135 countries between 1980 and 2014, causing severe impacts on inequality (Forster *et al.*, 2019). At the same time, forestry management had also become centralized into state and private enterprises that took little account of existing cultural institutions and norms of co-management (FAO, 2016b). This era has been called the height of the "Capitalocene" (Haraway, 2015; Moore, 2018).

Concerns over the cost of ignoring local institutions and group approaches emerged, with project evaluations showing that the creation of farmer and rural institutions led both to sustained performance after project completion and to more efficient and fair use of natural resources (Cernea, 1987; Ostrom, 1990; Uphoff, 1992). New forms of participatory inquiry and systems of collective learning and action were field-tested, putting farmer knowledge and capacity to experiment at the centre of practices for improvement (Chambers, 1989; FAO, 2019; Pretty, 1995). By the mid-1990s, the linear diffusion model was increasingly seen as ineffective: non-adopters had been termed laggards, extension staff had become poorly motivated and research systems had been prevented from becoming learning systems (Antholt, 1994).

Since then, a wide range of new forms of social organization have been intentionally formed to support transformations in agricultural landscapes. These have sought to build political strength for land rights, to protect against resource extraction, to increase market strength and power (such as through formal cooperatives), to link farmers and consumers through food chains and to re-establish forms of co-management for natural resources (Berkes, 2020; Ostrom, 1990). All of these structures are forms of social capital (Coleman, 1990), in which it is recognized that personal relations of trust, reciprocity and mutual obligation can result in actions and change that benefit larger numbers of people and farmers, particularly those ignored or disadvantaged by past forms of development. In some cases, these have been supported by novel public policies that reversed decades of state control by devolving decisions to local communities (Bawden, 2011; FAO, 2016a; Rahman, 2019); in others, they have been organized to prevent the actions of the state (Veltmeyer, 2019).

Here, we assess the emergence of social groups within particular geographical territories, with a focus on group-based learning and co-management for integrated pest management (IPM); forest, watershed and irrigation; and groups and platforms for microfinance, innovation and direct connections with consumers. We seek to address two key research questions: to what extent have efforts to form social groups for agriculture and land management within defined territories resulted in the formation of persistent collective groups? And do the worldwide numbers indicate improved possibilities for transitions towards sustainable agricultural development that will lead to improved outcomes for farmers and the environment?

2. The emergence of social groups in support of sustainability

A wide range of advances in agricultural and land sustainability have been made in the past two decades, with a range of

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terminologies and priorities. These include calls for a doubly green revolution (Conway, 1997), for alternative agriculture (NRC, 1989), for an evergreen revolution (Swaminathan, 2000), for agroecological intensification (Garbach *et al.*, 2017) and for agroecological movements (Giraldo & Rosset, 2018), for evergreen agriculture (Garrity *et al.*, 2010), for save and grow agriculture (FAO, 2011, 2016c) and for sustainable intensification (Godfray *et al.*, 2010; Smith, 2013). All of these have in common a desire to optimize the use of natural, social, human and financial capital while also being vigilant about the direct effects of agricultural and land management practices on these assets. Sustainable forms of management thus seek to use and enhance these capitals and reduce the costs of externalities on ecosystems and human health. Most of these also emphasize outcomes applying to any size of enterprise and not predetermining technologies, production type or particular design components (Weltin *et al.*, 2018).

A recent global assessment of sustainable intensification (Pretty *et al.*, 2018) indicated that systems of agricultural management undergoing fundamental redesign produce beneficial outcomes over sustained periods of time across differing ecological, economic, social and political landscapes. Redesign is, however, as much a social and institutional challenge as it is a technical one (Gliessman & Rosemeyer, 2009), as there is a need to create and make productive use of human capital in the form of knowledge and capacity to adapt and innovate and of social capital to promote landscape-scale change, such as for positive contributions to biodiversity, water quantity and quality, pest management and climate change mitigation. As ecological, climatic and economic conditions change and as knowledge evolves, so must the capacity of farmers and communities improve to allow them to drive transitions through processes of collective social learning (Hill, 1985).

Social capital has become a term used to describe the importance of social bonds, trust and reciprocity and collective action through institutions (Putnam, 1995). It was defined by Coleman as "the structure of relations between actors and among actors" that encourages productive activities (Coleman, 1990); by Bourdieu (1986) as "a durable network of institutional relationships of mutual acquaintance and recognition … to membership of a group, which provides each of its members with the backing of collectively-owned capital"; and by Bhandari and Yasunobu (2009) as a "multifunctional phenomenon comprising stocks of social norms, values, beliefs, trusts, obligations, relationships, friends, memberships, civic engagement, information flows and institutions that further cooperation and collective action for mutual benefits."

These aspects of social infrastructure act as resources for individuals to realize personal and community interests. As social capital lowers the costs of working together, it should facilitate cooperation. Individuals have the confidence and the means to invest in collective activities, knowing that others will do so too. They are also less likely to engage in unfettered private actions that result in resource degradation, though this is no guarantee that tragedies of the commons will not occur (Wade, 1989). Social capital can also have a 'dark side', with exclusion and elite capture resulting in non-democratic outcomes for some (Putzel, 1997; Reddy & Reddy, 2005; Verma *et al.*, 2019). It may also be deployed deliberately to offset the existing structures of states and international institutions (Forssell & Lankowski, 2015). The literature emphasizes the importance of building relations of trust, reciprocity and exchange, agreeing common rules and sanctions and developing connectedness through groups (Pretty, 2003; Veltmeyer, 2019).

Social capital is thus generally seen as a prerequisite for the sustainable management of resources and for the development of approaches and methods across all geographical territories (Agarwal, 2018; Leisher *et al.*, 2016; Waddington *et al.*, 2014). It does not, however, guarantee sustainable outcomes. It is common for fishing communities to want to believe that fish stocks are not being eroded, even though the evidence might indicate otherwise. Not all farmers know that the application of insecticides harms populations of beneficial natural enemies. In The Netherlands, farmers recently organized a backlash to demonstrate against environmental objectives and the addressing of climate change by farm policy (van der Ploeg, 2020). It is also true that not all transformation towards sustainability requires the formation of local social capital: a simple intervention heuristic in Vietnam ("no-spray in first 40 days of rice cultivation") contributed to farmers cutting pesticide use on rice (Escalada & Heong, 2004); and the aerial releases of parasitoid wasps (*Anagyrus lopezi*) in Africa to control cassava mealybug did not require active farmer involvement (Wyckhuys *et al.*, 2018).

Many forms of social capital have emerged in support of transitions towards greater sustainability and equity. These include transnational farmer movements, such as La Vía Campesina with 200 million families represented worldwide (Martínez-Torres & Rosset, 2014), national land rights and anti-land-grab movements, such as Movimento dos Trabalhadores Rurais Sen Terra and the resettlement of 0.37 million families on 7.5 Mha over 10 years (Veltmeyer, 2019), national rural unions (Welch & Sauer, 2015) and agroecology and social movements (Veltmeyer, 2019). In some cases, these have led to active conflict and 'peasant wars' (Giraldo & Rosset, 2018; Levien *et al.*, 2018). At the same time, organization around food has advanced in the form of food sovereignty and justice movements (Edelman *et al.*, 2014; McMichael, 2013) and alternative food networks (AFNs) and alternative food movements (AFMs), particularly from urban food production landscapes, and with many involving consumers as well as growers/farmers (Desmarais & Wittman, 2014; Forssell & Lankowski, 2015; Hoey & Sponseller, 2018; Plieninger *et al.*, 2018; Saulters *et al.*, 2018; Si *et al.*, 2015).

Our focus here is on a subset of this social capital, specifically social groups within defined geographical territories (Flora & Delaney, 2012; Ostrom, 1990). We use numbers of established groups as a proxy for social capital within communities, as each provides the context for innovation, negotiation and experimentation, bringing together individuals with different skills and knowledge. Such groups also require forms of engagement by professionals (researchers, extensionists, advisers) largely different from those dominant in the previous era of transfer of technology.

The concept of system redesign implies the establishment of new knowledge economies for agriculture and land (MacMillan & Benton, 2014). It is clear that the technologies and practices increasingly exist to provide both positive food and ecosystem outcomes: new knowledge needs to be co-created and deployed in an interconnected fashion, with an emphasis on ecological and technological innovation (Willyard *et al.*, 2018). There have been many adaptations in terminology for these systems of co-learning: farmer field schools (FFSs), learning labs, science and technology backyard platforms (STBs), science field shops, junior life schools, innovation platforms, farmer-led councils, agro-ecosystem networks, farmer cluster networks, joint liability groups, landcare groups and epistemic communities. What is common to these social innovations has been an understanding that individual farmers, scientists, advisors and extensionists also undertake a transformative journey. Their worldviews are challenged and change, resulting in the formation of broader epistemic communities of common interest (Norgaard, 2004) that utilize, synthesize and apply knowledge and skills from many sources. For sustainable outcomes, cognitive social capital in the form of beliefs and worldviews also changes.

3. Assessment methods

For this assessment of territory-based social groups, we have analysed agriculture and natural resource systems worldwide, drawing upon both published literature and the knowledge and networks of the co-authors. We searched online research platforms for published literature in Agricola (USDA National Library; https://agricola.nal.usda.gov), Agris (UN FAO; http://agris.fao.org/agris-search/index.do), CAB Abstracts (https://www.cabi.org/products-and-services/publishing-product/online-resources), Google Scholar (https://scholar.google.com) and Google (https://www.google.co.uk), Scopus (https://www.scopus.com/home.uri) and Web of Science (https://clarivate.com/webofsciencegroup/solutions/web-of-science) for published records over the past 10 years, and we drew on the collective knowledge of the assessment team and their personal contacts regarding further unpublished material from government and non-government initiatives. Projects and programmes in all countries were eligible. We selected terms for searches drawn from our knowledge of programmes in the field: social + capital; sustainable + agriculture; sustainable + intensification; joint/participatory + forest + management; agroforestry + groups; integrated + pest + management; farmer + field + schools; watershed + management; conservation + agriculture; irrigation + management; water + user + groups; pasture/grazing + management; microcredit/microfinance + groups; innovation + platforms; participatory + methods/approaches; farmer + organisations/institutions. A number of international analyses were drawn upon (e.g., of farmer fields schools: FAO, 2019; van den Berg *et al.*, 2020b; of community forestry: FAO, 2016b).

We organized the findings into eight functional categories of redesign, each with different types of enabling social intervention (Table 1). We report on data gathered from 122 initiatives in 55 countries across 6 continental regions, and we have applied no lower limit to the number of groups reported per initiative. Of the 55 countries, 13 were in industrialized countries and 42 in less-developed countries.[i]

We gathered data on numbers of social groups, numbers of farmer members and numbers of hectares under interventions for co-management. We have excluded data on groups where there is evidence of misreporting or the phenomenon of paper or empty groups – those reported to meet political targets but that do not exist on the ground (Ho, 2016; Ravindranath & Sudha, 2004; Ricks, 2016; Ricks & Arif, 2012). An unintended outcome of positive policy support for group formation has led to some inaccurate reporting to meet targets in some locations, such as for participatory irrigation management and forest co-management. We have also not made assumptions about intended adoption: for example, an EU Directive (2019) now requires all farms to use IPM, but preparations for implementation have not yet led to significant uptake of agricultural practices that significantly benefit ecosystem services (Buckwell *et al.*, 2014). We have not included reporting of area of land under co-management where group data do not exist, such as for large tracts of forest now under community-based forestry (FAO, 2016b).

As indicated above, we also did not include here analysis of non-territorial social capital in the form of cooperatives, farmer organizations, federations and movements. Many rural and agricultural cooperatives (focusing on milk processing, input supply, collective marketing and sales) are not geographically based. In the USA, there are 2047 rural cooperatives (though down from 10,040 in 1950) (USDA, 2018), in Brazil there are 1620 (with 1 million members) (Dias & Teles, 2018), in China there are 2.2 million (MARA, 2019) and in the UK there are 420 rural cooperatives (6% of UK farm market share by value; market shares by farm cooperatives are higher in The Netherlands (68%), France (55%) and Spain (45%)) (Cooperatives UK, 2018). In a number of countries, dispersed clusters of farmers collaborate on common research interests, but they may not result in natural capital improvements within whole territories. In India, there are >3000 farmer producer organizations with 0.3 million members, but these tend not to be geographically based (SOIL, 2017; Verma *et al.*, 2019). Federations, food networks and movements are also effective at transforming agriculture and food systems across and within countries, working at both national and international levels, such as in Canada (Desmarais & Wittman, 2014; Levkoe, 2014), in the European Union (EU) and in Japan (Plieninger *et al.*, 2018). La Vía Campesina works across 81 countries (182 member groups; La Vía Campesina, 2020) and the International Partnership for the Satoyama Initiative works across 71 countries (258 member groups; Kozar *et al.*, 2019). These forms of social capital are not included in this assessment, but they comprise a rich field of study for further work on transitions towards sustainability in agriculture and land management.

Layers of federations can be important in ensuring local priorities reach upwards to influence policy and practice. In Andhra Pradesh, for example, the 830,000 women's self-help groups (SHGs) are organized into village-level federations (of 15–30 SHGs) each, and these are organized into distinct federations of 40–60 village organizations (Bharucha *et al.*, 2020; Kumar, 2017). In Japan, 1000 *teikei* purchasing groups are linked to organic and natural farming and have organized into federations, with some leaders coming to be elected as members of parliament (iPES-Food, 2016; Kondoh, 2015).

This assessment of social group formation also does not imply that numbers of farms and hectares are fixed: on the ground, there will be a flux in numbers resulting from both adoption and dis-adoption. This may arise from farmer choice and agency, but equally from the actions of vested interests, input companies, the consolidation of small farms into larger operations, changes in agricultural policy or shifts in market demand and discrepancies between on-paper claims and what farmers have implemented. We have excluded data on groups formed during the assessment period but since abandoned by changes in development assistance funding and/or national priorities. In the 1990s, for example, 4500 catchment groups were formed in Kenya by the Ministry of Agriculture; the catchment approach ended in 2000 and evolved into a National Agriculture and Livestock Extension Programme with common interest groups, but since then the focus has changed away from these groups (Pretty *et al.*, 2011). In Southeast Asia, some recorded participatory irrigation groups later also become ineffective (Ricks, 2015, 2016).

4. Outcomes: group numbers

We organized the findings into eight categories of agricultural and land management intervention that are contributing to the

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Table 1. Eight categories of social group interventions for sustainable agriculture and land management.

Category	Social intervention types
(1) Integrated pest management (IPM)	Farmer field school (FFS), push–pull systems of IPM, IPM clubs and FFS alumni groups
(2) Forest management	Joint forest management (JFM), community-based forestry (CBF), participatory forest management (PFM), agroforestry
(3) Land management	Watershed and catchment management, conservation agriculture (CA), integrated biodiversity, farmer clusters
(4) Water management	Participatory irrigation management (PIM), water user groups (WUGs), farmer water schools, farmer-led watersheds
(5) Pasture and range management	Management-intensive rotational grazing groups (MIRGs), veterinary groups, dairy groups, agropastoralist field schools
(6) Supporting services	Microfinance groups, multifunctional farmer and non-farmer groups, farmer business schools
(7) Innovation platforms	Research platforms, co-production groups, science and technology backyard platforms (STBs), field science labs, joint-liability groups
(8) Intensive small-scale systems	Community-supported agriculture groups, biogas–pig–vegetable groups, aquaculture

Note: Previous assessments of social capital used 5 categories (mapping here onto (1)–(4) and (6)) (Pretty & Ward, 2001). A global assessment of sustainable intensification used seven categories (mapping here onto (1)–(5), (7) and (8)) (Pretty *et al.*, 2018).

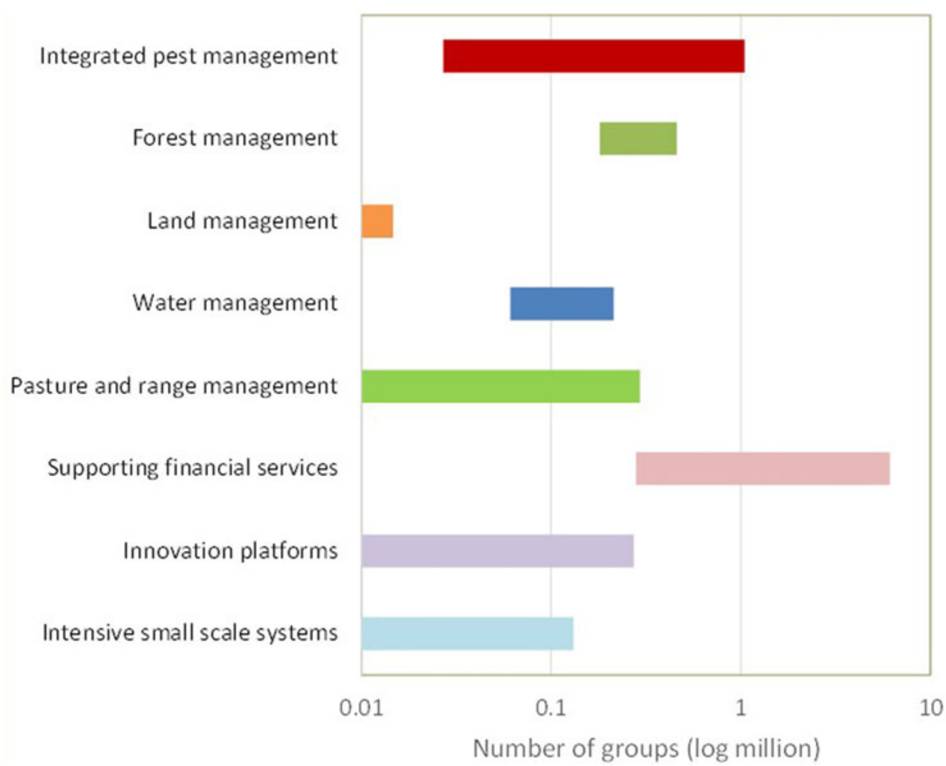

Fig. 1. Increase in numbers of social groups in eight categories of sustainable agriculture and land management (2000–2020).

emergence of new knowledge economies (Table 1). Across the eight categories and 122 distinct initiatives, we recorded 8.54 million intentionally formed social groups worldwide. These comprise groups collectively managing 299 Mha of agricultural and non-agricultural land. This represents growth in these types of groups from 0.005 million at the end of the 1980s (primarily in participatory irrigation management) to 0.48 million in 2001 (Pretty, 2003; Pretty & Ward, 2001), and now to 8.54 million by 2020 (exponential fit: $R = 0.982$). Figure 1 shows the marginal increase between 2000 and 2020 in the groups in each of the eight categories.

Most social groups surveyed contain 20–25 members (range 15–30), with occasional numbers progressing towards 100 (e.g., for microfinance groups). Group sizes have remained constant over time. Small groups provide for more effective communicative interactions and permit the agreement of common goals and practices, the sharing of planning and evaluation and the agreement with norms and rules that work for all. As groups progress to larger sizes, they are generally more effective if divided and then federated. Small groups of approximately 25 members are generally able to survive with the presence of small numbers of free-riders (those that do not actively contribute to collective

Table 2. Social groups and land area across eight categories of agriculture and land management (2020).

Categories	Social groups (millions)	Area (Mha)
Integrated pest management	1.045	24.98
Forest management	0.459	150.39
Land management	0.015	38.03
Water management	0.214	50.16
Pasture and range management	0.294	2.08
Supporting services	6.105	23.41
Innovation platforms	0.273	8.51
Intensive small-scale systems	0.131	2.08
Total	8.536	299.63

outcomes but benefit from these outcomes) (Dannenberg *et al.*, 2015). Using the mean membership of 20–30 people per group, this assessment suggests that there are 170–255 million members of social capital groups providing both private and public benefits. Though not all of these are farmers (e.g., non-landowners with rights to jointly managed forests), a midpoint (assuming membership of 25 per group) represents 39% of all 570 million farms worldwide (Lowder *et al.*, 2016). The distributions of groups and areas are shown in Table 2 and Figures 2 and 3. The majority of groups have been formed in less-developed countries (98.2%), as is the majority of the area (93.6%). The distribution of groups across six continental regions is shown in Figure 2.

5. Outcomes: documented impacts

Across all of the literature, there is considerable evidence of improvements within agroecosystems, landscapes and farm household economies as a result of the formation of intentional social capital within geographical areas (Agarwal, 2018; Cernea, 1991; Leisher *et al.*, 2016; Ostrom, 1990; Uphoff, 1992; Waddington *et al.*, 2014). Comparisons have been made between projects/programmes working with groups compared with individuals, with prior degraded natural systems (e.g., forest or eroded landscapes), with prior agroecosystems harmed by compounds used in agriculture (e.g., harmful pesticides) and with agroecosystems with legacies of low productivity (e.g., that have not seen productivity improvements in recent decades).

The overwhelming evidence from the field and reported in the published literature is that collective management of resources can lead to redesign and also result in net increases in system productivity. There have been few counterfactual examples, such as where groups could have been formed to increase resource exploitation or extraction (e.g., water or forest capture). In Malawi, for example, where village management committees were imposed without taking account of existing institutional arrangements for resource management, this resulted in the clearance of trees, heightened conflict within communities and the destruction of existing institutions (Kamoto *et al.*, 2013). There are also other institutions, corporations and groups of individuals engaged in resource depletion to serve private and generally short-term interests.

It is also clear that any social capital established in the form of groups can lead to suboptimal outcomes for certain population subgroups. By definition, groups comprise members, and those outside of the groups may be excluded from the benefits of membership. This phenomenon of ‘the dark side of social capital’ (Coleman, 1990; Putzel, 1997) has seen both elite capture (the already wealthy or more powerful individuals using groups to strengthen personal benefit at the expense of others), exclusion (group membership restricted to only some members of a population or location) and negative selection (where individuals are actively excluded). Nonetheless, the majority of the literature points to the benefits of social capital to (1) individuals and groups/communities, (2) agricultural systems and (3) wider landscapes and ecosystem services.

(1) To individuals and groups/communities: evidence of changes to personal capabilities and growth, to worldviews and locally generated resource availability:
- Emergence of new leaders of groups, especially by women (Agarwal, 2018), and changes in the relationships between women and men (Westerman *et al.*, 2005).
- Positive role of women leaders in group effectiveness and conflict resolution over common resources (Coleman & Mwangi, 2013).
- Changes in the worldviews of farmers (Campbell *et al.*, 2017; van den Berg *et al.*, 2020b) and of scientists and extensionists working with farmers in novel innovation platforms (Zhang *et al.*, 2016).
- Increases in the savings and repayment rates of members of microfinance groups (BRAC, 2019; Rahman, 2019).

(2) To agricultural system net farm productivity: evidence of increased system outputs and reduced input needs:
- Increases in crop productivity, such as by FFSs on all crops (Chhay *et al.*, 2017; FAO, 2019), and in grazing and pasture productivity (NRC, 2010).
- Increases in tree and agroforestry cover on farms (Bunch, 2018; Garrity *et al.*, 2010; Reij *et al.*, 2008).
- Reductions in the use of pesticides in IPM (Pretty & Bharucha, 2015; Yang *et al.*, 2014).
- Adoption of organic and zero-budget systems (Bharucha *et al.*, 2020; Reganold & Wachter, 2016).

(3) To natural capital and key ecosystem services: evidence of increased productivity and reductions in the use of harmful or potentially harmful compounds and releases:
- Increases in irrigation water availability and efficiency of use (Ricks, 2016; Zhou *et al.*, 2017).
- Improvements in forest productivity of wood, forage and secondary products (FAO, 2016b; Ravindranath & Sudha, 2004).
- Increases in carbon sequestration in soils by conservation agriculture (CA) (FAO, 2011; Lal, 2014).
- Reductions in surface water flows and soil erosion (Reij *et al.*, 2008).

6. Key findings for the eight functional categories

6.1. Category 1: integrated pest management

There are 1.045 million FFS and IPM groups covering 25 Mha (FAO, 2016a, 2019; van den Berg *et al.*, 2020a, 2020b). Notable country leads include Indonesia, Burkina Faso, Kenya, Sri Lanka, China and Vietnam. IPM is the integrated use of a range of pest (insect, weed or disease) control strategies in a

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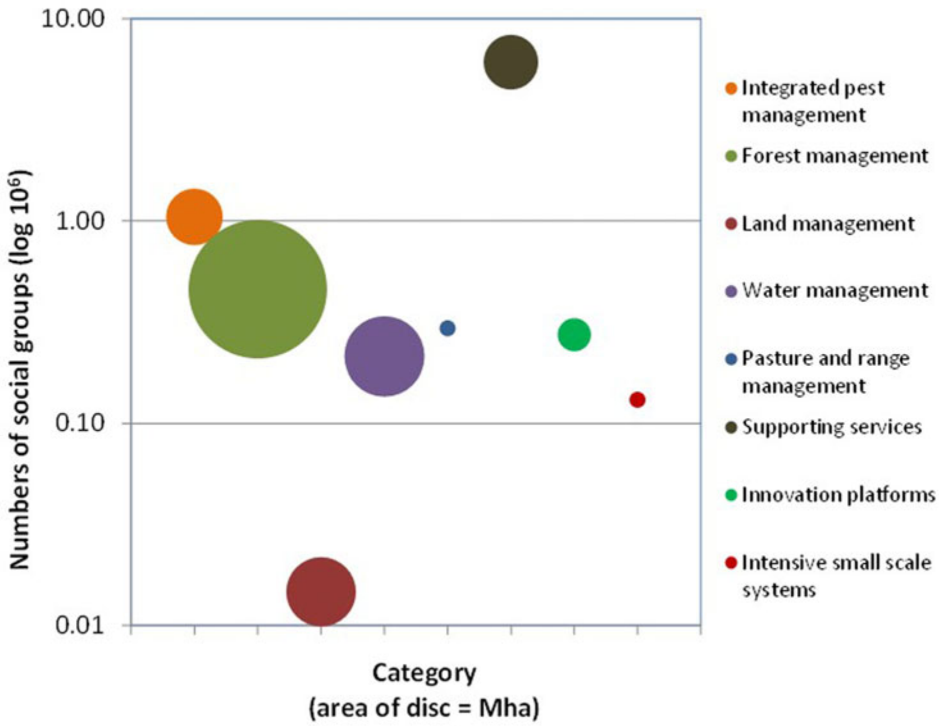

Fig. 2. Social groups formed in categories of agricultural and landscape redesign (122 initiatives, 55 countries): disc area = Mha.

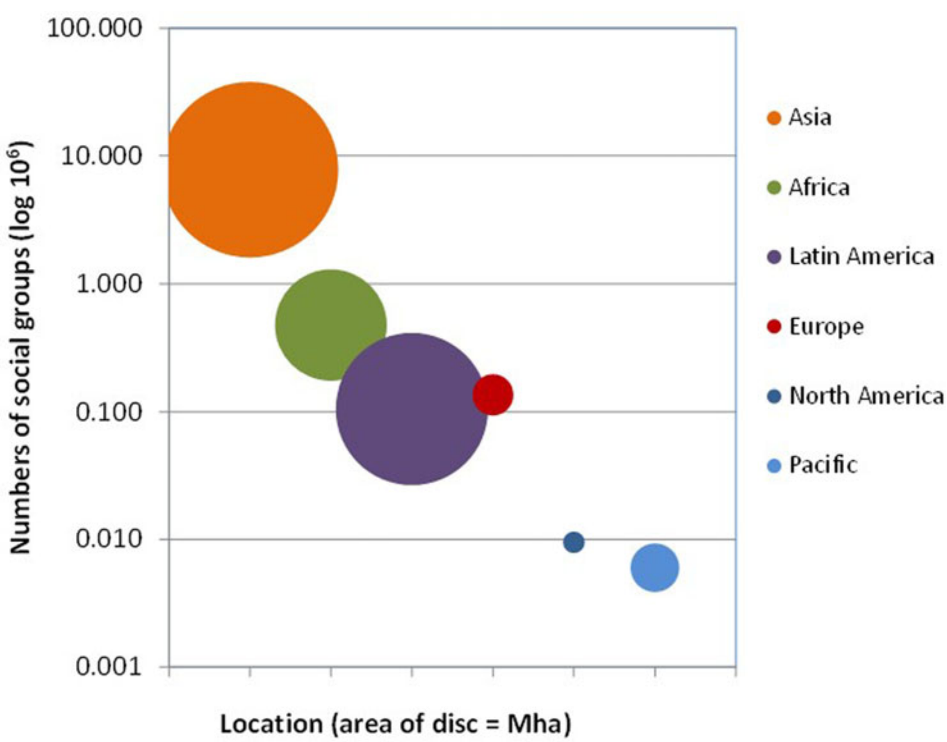

Fig. 3. Social groups formed across six continental regions (122 initiatives, 55 countries): disc area = Mha.

way that reduces pest populations to non-economically important levels, minimizes risks to human and animal health and can be sustainable and non-polluting. Inevitably, sound application of IPM is a more complex and knowledge-intensive process than relying on spraying of pesticides: it requires a high level of human capital in the form of field observation, analytical and ecosystem literacy skills and understanding of agro-ecological principles; it also benefits from cooperation between farmers.

FFSs (also 'schools without walls') centre on groups of up to 25 farmers meeting weekly during the entire crop season to engage in experiential learning (Braun & Duveskog, 2009). The roots of FFSs are in adult education using discovery-based learning, particularly drawing on the work of Freire (1970): the aims are thus co-learning and experiential learning so that farmers' innovative capacity is improved. FFSs are not only an extension method, but also increase knowledge of agroecology, problem-solving skills, group building and political strength. Over the years, the FFS has evolved to include crops, livestock, agroforestry and fisheries. Meta-analyses and in-country-level analyses have shown increases in farm productivity, reductions in pesticide use and improvements in ecological literacy (Pretty & Bharucha, 2015; Settle & Hama Garba, 2011; van den Berg *et al.*, 2020a; Waddington *et al.*, 2014; Yang *et al.*, 2014). Other innovations in IPM using close farmer engagement in groups include push–pull redesign in East Africa, with 130,000 farmer adopters (FAO, 2016c; Khan *et al.*, 2016). In Cambodia, 270 FFSs produced a range of innovations to increase both wet and dry season rice yields (Chhay *et al.*, 2017). Nonetheless, it is difficult to overcome the fears many farmers have: that insects always cause harm and so banned compounds are sprayed at night (Hoi *et al.*, 2016; Palis *et al.*, 2006).

6.2. Category 2: forest management

There are 4000 Mha of forests globally, with 28% now reported to be under various forms of community management (FAO, 2016b), variously termed participatory conservation, joint forest management, community forestry, forest user cooperatives, forest user groups, forest farmer cooperatives (FFCs) and forest protection councils. All are designed to increase the role of local people in governing and managing forest resources, including drawing on inherited indigenous practices as well as the more recent government-led management. Only those locations where numbers of groups can be identified have been included here: this category contains 0.41 million groups covering 150 Mha and includes a number of initiatives involving the redesign of agro-ecosystems with trees and shrubs (Garrity *et al.*, 2010). Significant country innovations include the establishment of forest protection committees in India and Nepal following key policy changes in 1990 and 1993, respectively (Fox, 2018; Paudel, 2016). In both China and Vietnam, land-use certificates have been issued to 250,000 FFCs, and these are now managing 73 Mha of local forest. Some 30,000 forest user groups have been formed in Mexico. Other countries with significant uptake of community-based forestry include Tanzania, Niger, Burkina Faso, the Democratic Republic of the Congo and Ethiopia, together with fertilizer tree groups in Malawi and Zambia.

Where successful, positive outcomes include increased forest cover on landslide-risk slopes, fewer patches and greater margins of forest cover, reduced incidence of fire and use of slash and burn, more wood value, better incomes for households (Pagdee *et al.*, 2006; Sundar, 2017) and improved health and wider social benefits (Tirivayi *et al.*, 2018). Increased tree cover in the Sahel has amended local climate, increased wood and tree fodder availability and improved water harvesting (Bunch, 2018; Sendzimir *et al.*, 2011). Elsewhere, there is evidence of forest departments, such as in some Indian states, seeking to maintain control over local groups, including examples of rent-seeking (Behera & Engel, 2006). Nonetheless, despite difficulties, old attitudes have changed, as foresters came to appreciate the regeneration potential of degraded lands and the growing satisfaction of working with, rather than against, local people (Ravindranath & Sudha, 2004).

6.3. Category 3: land management

This category has seen the establishment of 0.015 million groups on 37.2 Mha, and it includes the largest national initiative in industrialized countries (Landcare in Australia; Campbell *et al.*, 2017) and the mobilization of social capital in watersheds above New York City to ensure the production of clean drinking water, resulting in savings of foregone engineering costs (Pfeffer & Wagenet, 2011). Following decades of limited success with often enforced soil and water conservation technologies, governments and non-governmental organizations (NGOs) from the late 1980s came to realize that the protection of whole watersheds or catchments could not be achieved without the engagement of local people. This led to an expansion in programmes focused on micro-catchments: areas of usually no more than several hundred hectares in which people can trust each other. Where successful, programmes report public benefits in the form of groundwater recharge, reappearance of springs, increased tree cover and microclimate change, increased common land revegetation and benefits for local economies. A number of integrated watershed development programmes did, however, turn to enforcement or payment for participation or led to the greater extraction of groundwater (Bharucha *et al.*, 2014; Blomquist & Schlager, 2005).

CA, using zero tillage to improve soil health, has grown to cover over 180 Mha worldwide (Pretty *et al.*, 2018), and it now covers >50% of cropland in Australia and southern Latin America and 15% of cropland in North America. A number of countries have built territory-based social capital (e.g., in the maize mixed-farming system of East and Southern Africa and in the rice–wheat farming systems of South Asia), though more often regional and national networks have been the vehicles for engagement and spread. In the UK, 452 catchment-based projects have delivered collaboration across farms, citizen scientists, wildlife experts and water companies, resulting in the engagement of 28,000 people, the reduction of pollution, riverbank restoration and habitat creation and the removal of fish barriers (CaBA, 2018). In the USA, a number of farmer-led watershed councils are advancing redesign, each usually with small numbers of farmers (FLWC, 2015), and in the UK, 120 Farmer Clusters have been formed to address landscape-scale transformations in order to improve biodiversity (GWCT, 2019).

6.4. Category 4: water management

This category has seen the establishment of 0.213 million water user associations (WUAs), participatory irrigation management groups, water user schools and farmer-managed irrigation systems on 48.7 Mha worldwide. Notable country examples include the Philippines (3100 groups managing 82% of irrigated area; Bandyopadhyay *et al.*, 2009), Sri Lanka, India, Nepal, Mexico, Turkey, China and Vietnam (Rap, 2006; Uphoff, 1992; Yildiz, 2007). Once again, experiments in participatory irrigation management and the establishment of water user groups and associations began in the 1980s, with many building upon existing legacy systems (De los Reyes & Jopillo, 1986). Without regulation or collective control, water tends to be overused by those who have access to it first, resulting in shortages for tail-enders, conflicts over water allocation and waterlogging, drainage and salinity problems. The same challenge exists for watersheds crossing national boundaries (e.g., the Mekong). Where social capital is well developed, then groups with locally developed rules and sanctions are able to make more of existing resources than individuals working alone or in competition.

Where effective groups operate, there emerged good evidence of increases in rice yields, higher farmer contributions to the design and maintenance of systems, changes in the efficiency and equity of water use, decreased breakdown of systems and fewer complaints to government departments. In China, a quarter of all villages have WUAs, and these have reduced maintenance expenditure whilst improving the timeliness of water delivery and fee collection. Farm incomes have improved whilst water use has fallen by 15–20% (Zhang *et al.*, 2013; Zhou *et al.*, 2017). WUAs have become the primary vehicle for local water management in Mexico, where 2.0 Mha of the 3.2 Mha of government-managed systems have been transformed by WUAs; half of the systems in Turkey have been turned over to local groups, increasing cropping intensity and yields by 53% (Groenfeldt, 2000; Uysal & Atış, 2010). In India, WUAs cover 15 Mha, but still only 12% of the irrigated area, even though they lead to increases in area under irrigation, greater equity (improved benefits for tail-enders) and greater recovery of water charges (a measure of improved yields) (Sinha, 2004). Some are thought to exist only on paper, and in some areas they have been subject to variable performance, elite capture and irrigation department control (Reddy & Reddy, 2005). In some contexts, rights' transfers to landowners and tenant farmers have led to landless and fisher families losing access to wild foods.

Water user groups have been subject to direct political interference, such as in Indonesia, or have seen low implementation successes where irrigation departments have been unable to devolve decision-making to farmers: in Thailand, official records indicate the presence of 13,000 water user groups, but most exist only on paper (Ricks, 2015). Elsewhere, elite capture and continued irrigation department control continue to restrict success, such as in India, as well as a lack of involvement of women, and there is selection bias in the tendency to research those groups that work (Meinzen-Dick, 2007). WUAs and water user groups have been taken up in Central Asia, such as in Azerbaijan, Tajikistan and Uzbekistan, but farmer numbers tend to be large per social group (>2000 and 76, respectively), and thus the large coverage (1.5 Mha) may not be matched by effective social capital at the local level (Balasubramanya *et al.*, 2018).

6.5. Category 5: pasture and range management

Notable pasture examples of social capital include the establishment and spread of management-intensive rotational grazing groups (MIRGs), which require new thinking and methods for grazing practices, diversification of cropping, including organic agriculture, and new approaches for agropastoralism. In Brazil, redesigned *Brachiaria* forages in maize–rice and millet–sorghum systems have increased net productivity and have led to large increases in all-year forage, used both for livestock and as a green manure (FAO, 2016c). MIRGs use pasture redesign centred on short-duration grazing episodes on small paddocks or temporarily fenced areas, with longer rest periods that allow grassland plants to regrow before grazing returns (NRC, 2010). Well-managed grazing systems have been associated with greater temporal and spatial diversity of plant species, increased carbon sequestration, reduced soil erosion, improved wildlife habitat and decreased input use (Sprague *et al.*, 2016).

Group innovations have occurred in Uganda with the development of agropastoral field schools (APFSs) and with the training of a large pool of facilitators and trainers (FAO, 2016a). The primary aim has been to build resilience for communities subject to recurrent hazards such as droughts, flooding and animal diseases, some of which are accentuated by climate change. Some 4400 APFSs have been deployed, with the training of 850 facilitators and master trainers. Agropastoralists enhance their livelihood resilience by increasing the number of intervention options, including pest and disease management, tree nurseries, watershed management, group marketing, vegetable production, improved seeds and livestock nutrition. In Kenya and Uganda, volunteer farmer trainers have helped facilitate >300 diary producer groups (Kiptot & Franzel, 2019). As in all categories, there are examples of empty social groups having been formed by states (Ho, 2016).

6.6. Category 6: supporting services

A significant social innovation has been the emergence of informal microfinance systems emerging from local collective action, particularly for groups of poor families without access to formal capital and collateral. These have been enablers for agricultural and land transformations, such as for index-based insurance for livestock herders in the face of climate change (Amare *et al.*, 2019). The largest numbers of groups have been formed in Bangladesh (1.80 million groups), India (4.16 million groups) and Pakistan (0.12 million groups). Many groups or programmes begin with microfinance and evolve to become multifunctional groups representing the specific needs of members at their locations. A major change in thinking and practice occurred when professionals began to realize that it was possible to provide microfinance to poor groups and still ensure high repayment rates. When local groups, in particular of women, are trusted to manage financial resources, they can be more effective than banks. The systems work on trust, and payback rates typically reach 98% (Rahman, 2019). In Cambodia, IPM farmers' clubs have become SHGs, with members putting in their own money via savings funds to help members access financial assistance instead of borrowing from other sources that charge high interest rates (FAO, 2018). The microcredit and microloan programmes in industrialized countries, such as in the USA, are not included in this analysis.

Three leading innovative institutions are from Bangladesh: the Grameen Bank, the Bangladesh Rural Advancement Committee (BRAC) and Proshika (BRAC, 2019; Grameen Bank, 2019; Proshika, 2019). All of these groups work primarily with women, and the members of groups save every week in order to create the capital for relending. Grameen Bank has 8.9 million members in 1.38 million groups spread over 81,000 villages: 97% of its members are women. BRAC has 5.4 million members in 108,000 groups, and it takes a deliberately integrated approach to poverty pockets, especially in wetlands, on riverine islands and for indigenous populations. Through a single platform, they provide agricultural and skills support, education, legal services, healthcare, and loans. More than 130 of its women members have been elected into government structures. BRAC has also diversified into social enterprises for artisans, livestock insemination services, cold storage for potato farmers, milk processing, services for fish farmers, tree seedlings, iodized salt and sericulture.

6.7. Category 7: innovation platforms

This category centres on the co-production of technologies to advance the sustainable management of agriculture and land. There are a growing number of successful platforms for such engagement, including in West Africa, China, Bangladesh, Cuba, India and Indonesia (Agarwal, 2018; Winarto *et al.*, 2017). Most, though, remain at a small scale. Innovation platforms in West

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Africa have resulted in increased yields and incomes for both maize and cassava systems (Jatoe *et al.*, 2015). Farmer collectives have put agroecological and cultural objectives higher than just productivity in China (Zhou *et al.*, 2017), and in Bangladesh, similar platforms have led to the adoption of directly seeded rice and early-maturing varieties that have changed patterns of both wet and dry season farming, increasing incomes by US$600 per hectare and substantially reducing labour costs (Malabayabas *et al.*, 2014). In all of the successful cases, there have been facilitators curating the redesign.

The concept of STBs was established in China's Quzhou County (Zhang *et al.*, 2016). This is an innovation deployed to increase the sharing of knowledge and skills between scientists and farmers. STBs bring agricultural scientists to live in villages and use field demonstrations, farming schools and yield contests to engage farmers in externally and locally developed innovations. Reflections of success centre more on in-person communications, sociocultural bonding and the trust developed amongst farmer groups of 30–40 individuals. In Cuba, the Campesino-a-Campesino movement has developed an approach to agroecological integration that is redesigning systems (Rosset *et al.*, 2011). It is also centred on Freirian social communication, in which farmers spread knowledge and technologies to each other through peer-to-peer exchanges, teaching and cooperatives. There are 100,000 peasant farmer members of Campesino-a-Campesino in Cuba.

Social groups have been formed in industrialized countries to develop cooperative approaches towards sustainable practices, and they include concept-orientated research clusters and Groupement Agricole d'Exploitation en Common in France (Agarwal & Dorin, 2019; Caron *et al.*, 2008), Practical Farmers of Iowa (2019), No-Till on the Plains (2019) in Kansas and the Ecological Farmers Association of Ontario (2019). Across all of the EU, 900 EIP Agri-Operational groups have been formed to aid farmer innovation (EIP Agri-Operational Groups, 2019); and within 10 countries, 34 projects investigated as part of the PEGASUS project have been engaged in rehabilitating orchards, wilding headwaters, improving groundwater quality, creating biosphere reserves, developing IPM and creating new haymilk systems for upland farmers, with the aim of achieving persistent improvements in natural capital by engaging in social action within defined geographical areas (Maréchal *et al.*, 2018).

6.8. Category 8: intensive small-scale systems

Social capital has been formed to aid with the intensive use of small patches of land and water, particularly for the cultivation of vegetables and for rearing fish, poultry and small livestock. It has also been developed to link farmers directly to consumers, particularly through community-supported agriculture (CSA) farms and Japanese *teikei* in industrialized countries (Urgenci, 2016). Across the EU, there are 2800 CSA farms directly linked to consumer members. Further examples include allotments, community gardens, urban farms and vertical and hydroponic farms. In less-developed countries, small patches are often located in gardens, at field boundaries and in urban and rural landscapes. Patch intensification for aquaculture ponds and tanks has been shown to raise protein production, reduce nitrogen requirements for crops and positively impact agricultural productivity (Brummett & Jamu, 2011). Raised beds for vegetables in East Africa have been beneficial for large numbers of women, homestead garden production has spread in Bangladesh and in China redesign has been exemplified by the development of integrated vegetable and fruit, pig and poultry farms with biogas digesters: farm plots are small (0.14 ha), yet farmers recycle wastes, produce methane for cooking and reduce the burning of wood and crop residues, with implementation on 50 million household plots (Gu *et al.*, 2016). In Brazil, the government's food purchase program (Programa de Aquisição de Alimentos; PAA) and *Fome Zero* project supports 364,000 family farmers in groups through direct purchase for schools, religious projects, hospitals, municipal departments and jails (Wittman & Blesh, 2017), and in Cuba, urban *organopónicos* have contributed substantially to the effectiveness of food systems (Cederlöf, 2016).

7. Securing sustainability

We have shown that over the past two decades a variety of novel social infrastructure has created platforms for collective transitions towards greater sustainability of agriculture and land management amongst rural communities across the world. These have led to greater flows of knowledge and technologies and built trust amongst individuals and agencies. The cumulative increase in numbers of social groups from 0.5 million to 8.5 million over two decades implies that there have been transformations in capacity and personal benefit combined with improved environmental outcomes for agricultural landscapes.

The marked difference in implementation and uptake of social capital between industrialized and less-developed countries is striking. In industrialized countries, farmers have also tended to be self-organized into value chain-based groups of common interest rather than into groups within specific geographical territories, though this could change with growing interest in policy support for landscape-scale change to deliver public goods, such as in the UK's 25 Year Environmental Plan (Defra, 2019). The latter needs facilitation and support, a particular challenge where investments in extension are small or where public extension systems no longer exist. Nonetheless, where geographically based groups are formed, both productivity and natural capital outcomes can be substantial (Maréchal *et al.*, 2018).

This shift towards sustainable redesign in agriculture and land management has been successful where individual worldviews have changed, emerging from the processes of co-production embedded in groups. Many programmes have built on the principles of adult learning, social ecology, liberation education and epistemic change. Social capital can provide a supportive context for transformations, both in practices (behaviours and choices) and personally (the inner journey) (Bawden, 2011; Norgaard, 2004). Through experiences in the world, each person comes to see and know it from a particular epistemic position that reflects a set of assumptions about reality. These assumptions and worldviews shape the way each person chooses to act and behave. Such epistemic change is called for in turbulent times, as there is an inseparable interconnection between cognition and action (Fear *et al.*, 2006). It has previously been argued that social groups, movements and campaigns comprise an 'immune system' for the planet (Hawken, 2007), in that they offer platforms for collective action and larger-scale action towards greater sustainability and equity.

Social media and mobile platforms for information will play complementary roles in information access and exchanges, as well as in helping to keep people connected (FAO, 2019). The term 'sustainable' suggests an incorporation of the need for improvement (e.g., to well-being, food production and natural capital), and thus it requires the need to change the way individuals think about and come to know about the world (Norgaard, 2004). To date, epistemic communities and networks of social capital have been established in many locations and could build distributed expertise and trust over time (de Bruijn & Gerrits, 2018; Granjou & Arpin, 2015), particularly where there is a greater number and diversity of engaged actors (Grêt-Regamany *et al.*, 2019; Hazard *et al.*, 2018). Social capital in a variety of forms could help to open up science to innovation, particularly where problems are complex and solutions unknown and where the values of all actors are salient (Richardson *et al.*, 2018).

Nonetheless, there will be constraints and countervailing pressures. Land tenure and secure rights are preconditions to local people making long-term investments in natural and social assets. When Burkina Faso and Niger granted rights to individuals to use their own trees as they wished (mid-1980s), this resulted in an increase in tree cover as there were now incentives for the long-term rather immediate resource extraction (Godfray *et al.*, 2010; Sendzimir *et al.*, 2011).

Though state and international organizations have contributed to the advance in numbers of social groups, the evidence for positive actions from the private sector is weak, with many not matching up to their own statements on corporate social responsibility (Elder & Dauvergne, 2015). There is evidence (from the field) that pesticide companies have promoted and run FFSs precisely to sell more product, and thus not to develop forms of IPM that reduce negative impacts on the environment and human health. It has been argued that big retail power will not be interested in social groups in rural areas unless they serve their own purposes, and thus that the 'dance of the supply chain' (Freidberg, 2020) cannot produce progressive outcomes. At the same time, apparent inflows of foreign direct investment into poorer countries may continue to lead to outflows of capital in profits and returns on investments (Veltmeyer, 2019).

We have found that social groups have emerged from both government and non-government contexts. Some have required critical changes to policy or regulation, often being more effective at the state or district level. Changes to water rights allowed for the emergence and spread of participatory irrigation; changes to forest and tree use rights were essential platforms for joint and participatory forest management programmes to be established and devolve decision-making to local people; changes to lending assumptions allowed banks to lend to NGOs and social groups, which then provided security rather than individuals. Further policy changes and support will be important to help these projects spread. Extension systems, for example, will need to adopt more cooperative models rather than seeking only to work with compliant individuals (Clark *et al.*, 2017).

It will be important to be mindful of the past failures of state organizations that have undermined, ignored or suffocated local resource-based institutions (Levien *et al.*, 2018; Jodha, 1990; Palmer, 1976) or have created paper or empty institutions (Ho, 2016). Many members and activists in social and agroecological movements would also argue that it is the structures of the world economy (and its capitalism) that prevent effective transformations towards sustainability and equity (Giraldo & Rosset, 2018; Moore, 2018). Nonetheless, as social groups federate into higher-level structures, they too are able to act to deliver greater agricultural and natural capital benefits, as well as returns to farmers (Kondoh, 2015). Though we were unable to gather data on the gender mix between and within social groups, it is clear that mixed groups of women and men are more effective (in terms of farm and/or forest productivity) than single-gender groups, and groups of women are more effective than groups just consisting of men (Agarwal, 2018; Leisher *et al.*, 2016; Westerman *et al.*, 2005). Programmes seeking to form social groups will thus need to be aware of how to ensure full and proper participation by women.

A separate but important evidence base points towards the health and well-being effects of the greater trust and reciprocity that inhere when social capital is high. Social capital is known to have positive effects on well-being (Holt-Lunstad *et al.*, 2017) and on life satisfaction and longevity (Graton & Scott, 2016; Layard, 2020). Though not part of the recorded benefits of these social groups, it can reasonably be assumed that members will be receiving personal benefits over and above the functional improvements to farm productivity and income. The socially connected live longer and are happier (Holt-Lunstad *et al.*, 2017), and countries with higher levels of trust in other people are happier (WHR, 2019, 2020). Volunteers who contribute to the well-being of others and to the quality of lived environments tend to have healthier lifestyles, lower incidence rates of mental ill health and to live longer (Anderson *et al.*, 2014; Borgonovi, 2008; Layard, 2020). On the other hand, net well-being across populations is reduced by growth in inequity (Wilkinson & Pickett, 2009, 2018), breakdown of social structures and support (Piketty & Saez, 2014) and lack of access to natural and green spaces (Mitchell & Popham, 2008; Mitchell *et al.*, 2015).

This platform of 8.5 million social groups distributed across 55 countries, but comprising 3% of the world's population, could comprise an opportunity to consider greater challenges, such as advances towards meeting the Sustainable Development Goals and addressing climate change. If different worlds are to be brought forth as a function of a quest to transform the way we live and consume, we will need to modify the epistemes that have come to dominate modern consumption cultures (Bawden, 2011). Some social capital is already influencing global systems, resulting, for example, in mitigations of climate change, biodiversity loss and air pollution, as well as increases in net food production. Platforms of groups, for example, could engage in the co-production of new patterns of material consumption and ways of living within global boundaries and limits (Dorling, 2020; Jackson, 2009; Pretty, 2013). Some argue that large-scale advances in sustainability and equity are impossible if capitalism and class are ignored (Levien *et al.*, 2018).

It is clear that considerable changes will be required worldwide to limit the advance of the climate crisis, both in individual choices and behaviours and in the policies developed by all countries. An era of 'degrowth' may be needed (Gerber, 2020), and certainly of green restructuring of economies directly to reduce material consumption and substitute it with sustainable or green alternatives (Ivanova *et al.*, 2020). There may be, in short, possibilities of the good life within planetary boundaries (Dorling, 2020; Layard, 2020; O'Neill *et al.*, 2018). We have not analysed the political philosophies or aims of these social groups. Clearly, individuals will have many reasons for organizing and taking collective action, and given the context for these changes, it is likely that many individuals will continue to support sustainability and equity outcomes. But there is no guarantee that such values will remain unchanged.

Can these groups survive and flourish? Threats to these groups will come from external and internal sources. External sources could include major social and economic disruption (e.g., following the COIVD-19 pandemic), climate-driven forced abandonment of

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farms and territory, policy changes in support of land grabs and large commercial monoculture operations (e.g., for oil palm) and state support for only empty or non-credible groups. Internal disruptors could include stresses arising from benefit capture by individuals, gender imbalances in benefits and farm abandonment in favour of employment in urban areas. Nonetheless, many advantages have been found in the sharing economies of connected food systems where goods and services are pooled (Miralles *et al.*, 2017), such as a more even distribution of power, increased collaborative consumption, higher trust and more efficient use of resources. Agricultural transformations will be critical in the coming years both for contributing to reducing climate forcing and for mitigating negative effects. Some have called for adventurous food futures (Carolan, 2016). It would appear that social groups and movements have already created opportunities for individual and collective transformations.

8. Concluding comments

This assessment has shown growth in the numbers of groups engaged in platforms of innovative and sustainable management within geographical territories of engagement over the past two decades. These groups deliver individual and public benefits, improve well-being and natural capital and provide platforms for wider progress towards sustainability. These groups provide the basis for further progressive change towards sustainable policies and behaviours, with opportunities to help mitigate the advance of some global environmental challenges. We further note this social infrastructure has already changed worldviews and capacities to redesign towards sustainability and increased net productivity of agricultural and land systems.

Attention will need to be paid to ensuring that access to groups is equitable and that there is further research on the causative links between all forms of social capital and the emergence of more sustainable practices. In a number of contexts, social groups exist only on paper to meet policy objectives, and any increase of this phenomenon will undermine the wider goals of seeking further social capital formation. At the same time, some wider political and economic structures will make the formation of social groups harder to sustain. Nonetheless, the redesign of all agricultural and land management remains a critical global challenge, and though the growth in the number of groups has been substantial, in many cases supported by novel policies and regulations within countries, more support is needed to ensure best practice is spread to aid the transitions towards more sustainable and equitable forms of farmed and managed landscapes worldwide.

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Note

[i] There is no completely acceptable terminology for the grouping of types of countries. Terms relate to past stages of development (developed, developing, less developed), state of economy or wealth (industrialized, affluent, G8, G20), geographical location (Global South or Global North) or membership (OECD, non-OECD). None are perfect: China has the second largest economy measured by gross domestic product (which does not accurately measure all aspects of economies, environments and societies), yet might be considered to be still developing or less developed; the USA has the largest economy by gross domestic product, yet has nearly 50 million hungry people. Here, we have simply used *industrialized* and *less developed*, and we acknowledge the shortcomings. We use the term *pesticide* to cover all forms of insect, weed and disease control compounds; similarly, *integrated pest management* is taken to cover insect, weed, disease, mammal and bird management. We use *extensionist* to describe agricultural extension workers or service providers, as it is in common use in the sector; here, we suggest that the role has greater effectiveness when centred on engagement and the co-production of knowledge, rather than simply on knowledge transfer.

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