Agroecological approaches and other innovations for sustainable agriculture and food systems that enhance food security and nutrition

e-consultation on the scope proposed by the HLPE Steering Committee

From 18 October 2017 to 1st December 2017

Synthesis by the HLPE Secretariat

15 January 2018

The electronic consultation on the scope of the HLPE report #14 on *Agroecological approaches and other innovations for sustainable agriculture and food systems that enhance food security and nutrition* attracted 169 unique contributions, from 47 different countries, totalling 286 pages and approximately 123 000 words. 13 contributions come from national governments, 36 from civil society and NGOs, 21 from the private sector, and 60 from academic or research institutes. 48% of the contributions come from developing countries.

This note proposes a synthesis of the comments received during this e-consultation. Written by the HLPE Secretariat, this synthesis does not represent the position of the HLPE Steering Committee. Being a short document, it is not meant to reflect with precision the richness and diversity of all the contributions received, but should only serve as a guide to ease the reading of the full proceedings of this consultation (reference is made here to the numbered contributions). The full proceedings are available to see online.[1] They will be examined by the HLPE (Steering Committee and Project Team) and used as a background document to develop the report.

Some contributions suggested useful references and interesting case-studies; not all have been mentioned in this synthesis, but the entirety of proposed references and case-studies will be carefully considered by the HLPE Project Team in the course of elaboration of the report. It should be noted here that many contributions focused mainly on “agroecology”, rather than on “other innovations”. Finally, beyond the comments on the proposed scope, several contributions also called for a process as inclusive and transparent as possible.

This note is organised in 4 sections. The first one discusses the scope and structure of the report, the second focuses on concepts and definitions, the third and fourth respectively on the obstacles to and enabling conditions for “agroecology and other innovations”.

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[1] See: http://www.fao.org/fsnforum/cfs-hlpe/sites/cfs-hlpe/files/files/Agroecology/HLPE_Agroecology_PROCEEDINGS.docx

1) Scope and structure of the report

The scope for the HLPE report is very good (85), very relevant (38), very clear and complete (33, 156), comprehensive and well-articulated (147, 152), ambitious (112), most welcome (39, 60, 77, 95, 107, 158), appreciated (63).

This report should adopt a human rights and people-centered perspective (71, 107, 122, 164). It needs a multi-disciplinary, inclusive and participatory, nuanced and holistic, multisectorial and systemic approach (40, 41, 47, 53, 67, 71, 83, 84, 86, 97, 100, 107, 108, 122, 135, 136, 150, 164, 165, 166, 171), encompassing the three pillars of sustainability (165). The report should not try to reach the "least common denominator" but describe in a balanced and comprehensive way controversies and ongoing debates (95, 132).

This report should adopt a food system perspective, that covers production and consumption, and not focus only on agricultural production (22, 25, 63, 99, 112, 131, 135, 136, 137, 160, 165). Understanding "food flow", its governance, and the respective roles and objectives of the different actors involved, would allow to see local and regional differences and make systemic changes to improve food access (74). The vast majority of people cannot be food self-sufficient and depend on food selling and/or food purchase to varying degrees (83).

Topic and title:

This topic is timely (20), especially important (42, 57, 87), in the perspective of achieving the SDGs, in particular SDG1 (end poverty) and SDG2 (achieve FSN) (63, 64, 76, 82, 83, 95, 112, 114, 125, 126, 135, 137, 145, 149, 156, 167). Over 800 million people are undernourished and many millions are inappropriately nourished (25, 148, 165). According to some estimates, 75 percent of undernourished people live in rural areas, 50 percent are small producers, 22 percent have no access to land, 8 percent are communities of fisherfolks, hunters and pastoralists (65). This problem is exacerbated by commodification and privatization of food, seeds, natural resources and life itself; as well as by large-scale, industrial, intensive food production, highly dependent on fossil fuel and on a reduced genetic diversity (41, 65, 69, 79, 108, 125, 149).

The challenging objective is to feed a growing population in an adequate, safe and sustainable manner, addressing major challenges including: depletion/degradation of natural resources (soil, air, water, biodiversity) and ecosystem services; climate change; migration and displacement; urbanization; changes in diets (25, 41, 73, 76, 88, 110, 113, 133, 137, 150). In that perspective, transformative efforts are needed in our currently vulnerable food systems: agroecological approaches and traditional production systems can contribute to improve resource efficiency, minimize ecological footprint, strengthen resilience, secure equity/responsibility and create decent jobs, especially for the youth (41, 43, 61, 89, 92, 105, 113, 137, 149). The report shall not only assess how agroecology and other innovations achieve these objectives, but also consider the trade-offs between these objectives, between short and long term benefits, across different scales (86, 101, 147, 158, 165, 166). Inclusive discussions and participative approaches in decision-making processes, including for the development of standards and regulations, can contribute to secure social equity and responsibility (61).

The report should challenge the **"growth" narrative** (71, 107): hunger and malnutrition are not caused by a lack of food supply but rather by poverty, exclusion of vulnerable groups, and unequal access to resources (71, 132).

A more appropriate title for this report would have been: ***Agroecological approaches for sustainable cultivation and the provision of culturally appropriate food*** (63, 139). The main focus of the report should remain agroecology (67, 90, 95, 137, 168) and the report should shed light on the relevance and importance of farmers' experience, and of indigenous and traditional knowledge to create sustainable agriculture and food systems by applying agroecological principles and practices (48, 67).

The report should focus on the urgent need for agroecology, resulting from the failure of "conventional"/"industrial"/"productivist" agriculture and food systems in terms of poverty alleviation, food security and nutrition, health, protection of the environment, climate resilience and social equity (71, 72, 73, 77, 107, 136, 139, 145, 148, 157, 169). The Green Revolution have reached its limits (41,

69, 72, 88, 124). Industrial agriculture and food systems have been unable to eradicate poverty and malnutrition (both under and overnutrition) (69, 125, 137). They have externalized their social, cultural, economic and environmental costs, generating: waste, pollutions, landscapes' and ecosystems' degradation; depletion of natural resources, including biodiversity loss; soil erosion and soil fertility loss; greenhouse gas emissions; job destruction in rural areas; migrations and displacement; globalization and simplification of diets; market concentration; concerns about health, food quality and safety (69, 72, 76, 115, 124, 137, 166, 169). "Industrial" livestock production have huge impacts on land use, water quality and availability (76). Livestock production is an integral part of many farming systems and has many positive environmental impacts (158). Agroecology is a powerful alternative to current "industrial" agriculture, able to reverse its negative social, economic, environmental and health impacts (82, 84, 90, 95, 107, 124, 136, 137, 148, 157, 163, 166, 168), empowering farmers (87), and reducing their dependency on external inputs (pesticides) and international corporations (82, 84, 95).

A more appropriate title for this report would have been ***Sustainable Innovation for Agriculture and Food System*** (16). An "innovation process lens" is useful to explore the topic of this report: opportunities exist for high-tech and low-tech innovations (6). Focusing on the advancement of agroecological principles should not come at the expense of other innovations and technologies that contribute to produce food safely, sustainably, and efficiently, including innovations which can be appropriately managed under risk-based regulatory systems (86, 165). Agroecological approaches and other innovations can be complementary: the report should be focused on best practices for improving FSN and offer a balanced assessment that does not pre-judge the contributions and limitations of various approaches or frame them in opposition to one another but foster the synergies between various approaches (86). Technological solutions (such as precision agriculture, integrated crop management, conservation tillage) should be recognized as a vital part of delivering on agroecology and as important improvements in farming (101).

This scope appears more limiting than the original CFS request, discussed in the MYPOW (101): it does not incorporate many of the elements that were agreed to by consensus during the CFS 2018-19 MYPoW elaboration process (86). New topics have been added, such as "the impact of trade rules and intellectual property rights" that were not part of the initial request approved by all CFS Members after a time-intensive negotiation process (86, 101).

Structure:

The first step for this report should be to assess the available innovative approaches, practices and technologies; the second step, to consider the appropriate regulations, standards, instruments, processes and governance mechanisms to support the implementation of promising options; taking into consideration regional contexts (19). The report should cover the negative impact of agribusiness on the environment, then explain the role of new technologies in terms of resource efficiency and minimization of environmental footprint (20).

The report should identify how agroecology can contribute to realize all human rights in their interdependence, meet food security and food sovereignty needs and the SDGs; how it can deal with the issue of resource management from a rights-based perspective; how it can empower women and small-scale food producers; what are the gaps; and how to make the needed changes happen through policies, programmes, regulations, research and other institutional changes that provide solutions adapted to the local context and addressing farmers' and local communities' collective needs (64, 71, 107, 145).

Main issues to be covered in the report:

According to the contributions received, this report should cover the following issues:

- **A new paradigm for development** (40, 42, 61, 68, 87): a major shift is needed from current systems (industrial agriculture or subsistence farming) to agroecology (90, 102); from centralized (top-down) to decentralized (bottom up) and participative approaches based on a territorialized vision of innovation and rural development (150, 153). Profound structural transformations are needed in farming and food systems (35, 40, 42, 58), as well as

innovative models of production and consumption, changes in consumption patterns (21, 22, 58, 63).

- **Tensions between/Coexistence of different production systems**: e.g. family farming and capital intensive agriculture (35, 65, 90); local/agroecological, vs. global/industrial food systems (107). Family farming gathers the huge majority of farmers and represents more than 50/70/80 percent of the food produced and consumed worldwide primarily through agroecological approaches, while controlling only one quarter of the world's land (67, 72, 75, 80, 83, 120, 162, 172). Unlike capitalist agriculture that focus on short-term profitability, family farming systems have a fundamental interest in the long-term preservation and improvement of diversified agroecosystems (72, 80). Given the population growth all systems (whether modern or traditional) will find their consumers, but local biodiversity and traditional local food systems must be preserved (30, 66, 131). Traditional food systems must be adapted to new situations (43). Agricultural prices and policies must generate a stable/enabling environment that support smallholder family farming (35, 72, 120, 172).
- **Technology and scale:** Potential of agroecological innovations and technologies in small, medium and large-scale farms (39). Agroecology can make an important contribution in places where subsistence smallholding remains dominant (60). The report should highlight how innovations related to agroecology integrate, rather than create further divide between smallholders and large scale farmers (26, 63).
- Impact of international **trade** rules, and of the inclusion of food in trade agreements, on scaling-up of agroecology and other innovative approaches (2, 35, 41, 43, 67, 84, 88). Impact of official development assistance (35). Impact of "cash" crops on FSN (83). Impact of financial systems on agroecology (68). Safe, local food should be proposed at affordable prices (44).
- Role of the **private sector** in innovation and agricultural development. The private sector largely influences scientific research (40, 41). Agribusiness, big/transnational corporations' control over agriculture and food systems, land grabbing, trade liberalization and market concentration, vertical integration and mega-mergers, might favour current dominant models of production and consumption (2, 35, 41, 63, 65, 85, 87, 95, 124, 136, 162).
- **Improved access to** land (agrarian reform), natural resources, inputs, services, technologies, extension, credit and markets, particularly for small food producers (35, 72, 93, 120, 122, 136, 149, 156, 162). Access to inputs is constrained by the price of agricultural products, the price of agricultural inputs, and the cost of credit (35). Farmers, in particular smallholders, should have a fair and convenient access to markets (61, 67). Rights of farmers, agricultural workers, small food producers, women and indigenous peoples, as well as collective and/or customary rights of local communities, over their knowledge, territories, land, seeds, genetic resources and other natural resources are often ignored and must be protected (35, 61, 63, 65, 67, 71, 72, 84, 87, 95, 107, 162).
- Innovation protection regimes, **intellectual property rights** (IPR) (2, 43). The discussion of innovation should be clear about who is carrying out the innovation and who benefits from it (41). Since agroecology is deeply rooted in sharing knowledge, resources and seeds between farmers (84, 95), IPR (especially on seeds) should be carefully discussed (84, 107, 123). The interrelation between agroecology and farmers' rights enshrined in the International Treaty on Plant Genetic Resources should be given a specific attention (84).
- **Investments**, including public investments to support family farming and transition towards agroecology (72). Transformation of **infrastructures** (including roads, rails, water and energy distribution, and communication networks) and public services – especially in rural areas- (6, 25, 35, 55, 120).
- Transformation of **institutional environment** for agroecology and other innovations, and for capacity building (35, 37, 95, 112, 153, 158). Agroecology requires policy coherence across sectors (food, health, agriculture, water, energy, environment, biodiversity, food safety,

research, extension…), as well as supportive governance structures, strategies, laws, rules, norms and governance mechanisms that frame an enabling environment for agroecology and other innovations (43, 45, 87, 107, 120, 122, 146, 153) and that correct 'disabling' environment and imbalanced structure of power in current food systems (67, 74, 90, 107, 108, 124, 136). An important challenge is the lack of policy support for agroecology, and the impact of existing agricultural policies and agricultural subsidies (including input and export subsidies) on agroecology and FSN (35, 65, 72, 73, 84, 122, 124). Governments can promote agroecology at local, national and international levels: through coherent policies, knowledge and experience sharing (72); through social and participative certification models (44, 69, 120, 166), through support to social economy (21), farmers' market and community supported agriculture (123); through social protection and insurance programmes (120). Specific public policies to promote agroecology have started to emerge in Latin America and the Caribbean (54). Policies, rules and norms should internalize the externalities to overcome current 'lock-in' favouring intensive agriculture (49, 137). It is essential to strengthen the regulation of agrochemicals and transgenic seeds (85).

- **Urbanization and rural transformations** (49). Urbanization increases the distance between food production and consumption and the ecological footprint of food systems and makes it difficult to set up a circular economy (69). Greening cities and agroecology (cities for food) (21). **Urban or peri-urban agriculture** (UPA) (21, 60, 127, 131, 157, 162, 166), home, rooftop gardening (131), vertical gardening and food sharing (157) contribute to FSN and food self-sufficiency (80); form a strategy of social inclusion (80), empowering in particular women, displaced people or rural migrants who have little access to formal employment (80); are based on circular economy, and on urban organic waste recycling (59, 80, 93, 155). Cities and local governments should support UPA through participative capacity building (80). The report should cover the importance of agroecology to local markets (67, 107, 136, 149). **Short food supply chains** (21, 54, 69, 72, 107, 120, 155, 157), **agroecotourism** (80, 120), and **tracability** (69) could improve the link between producers and consumers, between rural and urban areas, and contribute to FSN, while reducing the ecological footprint.

2) Definitions and typologies

This report should provide clear definitions, assumptions, positions and statements (63, 86, 151, 160, 172). The report should clarify the concept of "scaling-up" vs. "scaling-out" (67).

Agroecology:

'Agroecology' (or agroecologies) and 'agroecological methods' needs to be defined clearly and explicitly in the report (1, 19, 57, 63, 86, 136, 158).

Agroecology, more than a set of technical innovations, is a comprehensive/integrated paradigm/framework for redesigning ecosystem-based food and farming systems, that combines a broad range of innovations with a deep understanding of nature and that values traditional territorialised knowledge (77, 90, 93, 97, 100, 107, 114, 132, 134, 137). Specific technologies and innovations (social and technological) must be considered within agroecological systems – i.e., for their compatibility with agroecological principles, not as alternatives to them (90, 132, 137, 166, 168, 169). The report should focus only on agroecology and on "other *ecosystem-based* innovative approaches" (82, 95, 132, 168).

Agroecology is working with nature and people, not against both of them (71, 84, 91). Therefore it is important to draw clear lines between agroecology and other concepts and practices that cannot be considered as agroecology (such as precision agriculture, sustainable intensification, climate smart agriculture, and genetic engineering) (26, 63, 71, 84, 107, 124, 137, 166). Agroecological innovations are those which strengthen the rights and livelihoods of small food producers and sustainable local food systems (107). Agroecological innovations can be distinguished from other innovations; because they are built through bottom up (and not top down) processes, involving farmers and local actors, building upon their knowledge of the local context; and, because they promote holistic rather than only technical solutions (37, 71, 73, 89, 131, 132). Agricultural research, examining only a limited set of

variables or focusing on technical innovations, without looking at social innovations in a given socio-technical context cannot be considered as agroecology (26, 33, 63).

Agroecology, defined as the application of ecological principles and knowledge to the study, development and management of sustainable farming and food systems (41, 95, 124, 132, 136, 158, 165), is deeply rooted in (agro)biodiversity – ecosystem, species and genetic diversity - (71, 72, 84, 107, 134, 172). Some attention must be given to those areas that are the center of origin of crops and to the contribution of wild crop relatives and wild pollinators to food production – through domestication and diversification processes (134, 172). Agroecological approaches are a basis for sustainable agricultural intensification (17). Agroecology aims at minimizing risks and increasing **resilience** (17, 71, 72, 84, 92, 95) of agriculture and food systems to external threats, including: conflicts (42, 65, 80, 110, 113, 119); climate change and extreme climatic events, such as droughts or floods (6, 18, 21, 60, 65, 72, 76, 95, 100, 107, 110, 134, 149, 150). Agroecosystems must achieve economic efficacy, socioeconomic equity and sustainable management of natural resources (35). Agroecological food systems are based on and contribute to: circular economy; preservation of local biodiversity and natural resources; diverse and high quality diets, based on seasonal and local food, short value chains, fair prices and fair trade; gender equality; decent jobs, socially and ecologically useful (69, 72, 107, 136).

Agroecology has been defined as a science, a wide diversity of practices, and a social movement (21, 53, 57, 63, 67, 84, 86, 95, 97, 100, 106, 107, 114, 126, 132, 164, 169).Those three dimensions are interlinked in a dialectical dynamic (97, 114): each is essential and must be analysed in greater depth (107). Those three conceptions should not be conflated (86): social values and ecological mechanisms should be clearly distinguished (158). There are many conflicting definitions of agroecology: the HLPE, as the source of scientific advice for CFS, should focus on the scientific definition rather than on political and ideological debates (101, 158, 165). In this regard, we point to the following definition which will be informing other UN processes: “study of the relation of agricultural crops and environment” (United Nations Statistics Division) (101). Agroecology is a holistic approach: it has technical, social, economic, cultural, spiritual and political dimensions: the report must go beyond technical aspects (107, 123, 167).

Agroecology as a science should examine all agricultural systems for their functionality, respect of natural cycles, and productivity including ecosystem services (26). More than a ‘science’ agroecology represents ‘ways of knowing’ building upon different kinds of knowledge (107, 162). Agroecological methods should not mean disregarding technology: ancient techniques and modern technologies can help us understand how natural mechanisms work and the best way to support and protect them (26, 59). If agroecology is fundamentally about harnessing biology and biological processes then it could be argued that **genetic engineering** and **genomics** is one of the most powerful (potential) tools of agroecology (13, 49): genomics can respond to specific needs that have not been resolved otherwise (172).

Agroecological practices, knowledge and principles are already at the heart of many production systems (e.g. organic, biodynamic, permaculture and agroforestry) (26, 45, 52, 54, 58, 168, 169, 170). Agroecology covers a variety of systems linked by common binding principles that should be exposed in the report (107, 168). Agroecology is a labour intensive, knowledge-intensive, holistic and systemic approach of complex agricultural systems, less dependent on external chemical and/or non-renewable inputs, including fossil fuel, and relying more on biological processes, interactions and synergies among their biological components, with the view to enable these systems to optimize the use of natural resources (such as water, light and nutrients), in order to secure livelihoods and enhance human, animal and ecosystem health, animal welfare, biodiversity, soil health and fertility, productivity and crop protection (21, 44, 49, 50, 56, 61, 63, 65, 69, 72, 73, 90, 92, 95, 120, 134, 137, 158, 160). Agroecology often increases total output per ha, reduces its inter-annual variability with regards to conventional systems, while reducing to a minimum the expenses for external inputs, contributing to employment generation and increased net income (72, 92).

Agroecology is a powerful force for social change (107). Agroecology is not centered on profitability: it is a social process whose main goal is to guarantee human life in dignity while preserving ecological processes (130). Agroecology is a **social and political movement** that builds stronger relationships

between farmers and consumers (93, 107, 123). The report should not attempt to redefine agroecology in terms which are different that those established by the movements that characterized it first (26, 89, 107, 164, 169). Agroecological approaches are referred to as innovations in this scope even though they are largely linked with our cultural heritage and built upon traditional knowledge and age old agricultural practices (75, 146). Agroecology is grounded on traditional/local knowledge accumulated by local farmers and indigenous peoples over centuries, if not millenia (1, 63, 72, 82, 95, 126, 145, 149, 160). Traditional food systems, and their associated knowledge systems, are an important part of cultural and spiritual identity, in particular for indigenous peoples (65). Agroecological systems and local food cultures are the results of the co-evolution, over generations, of the entire social and ecological systems within specific unique contexts (21, 25, 63, 65). The concept of "social metabolism" could be used to think agroecology and FSN (85). Social justice, including but not limited to gender equality is an important feature of the holistic character of agroecology (26, 63, 107). Agroecological systems (such as chinampa or milpa in Mexico, and agroforestry systems), and their biological, social and cultural diversity, are a key component of **food security,** and **food sovereignty** (43, 45, 53, 59, 65, 69, 79, 92, 93, 95, 107, 120, 132, 136, 162).

Other innovations:

'Other innovative approaches' need to be more clearly defined (19, 40, 49, 63, 71, 86, 89, 90, 95, 101, 108, 135, 148, 158, 169). They include precision agriculture (based on digital transition and robotics) (49, 84), biofortification (116), and biocontrol (49).

Different approaches to innovation should be considered not in isolation but in combination in order to foster synergies and reduce trade-offs: even industrial systems could benefit from considering ecological principles, while new methods and technologies may be used in more ecological farming systems (58). There are two extreme views on sustainable production systems (**precision agriculture** with chemicals vs. **organic farming**): the best of both approaches need to be combined to achieve **ecological intensification** of farming systems (7). Both organically oriented and technically/chemically oriented solutions need to be covered in the report as both have their merits (19). Other innovations, more recent than agroecology, now fall under the title "sustainable intensification" (i.e. improving productivity while minimizing negative environmental impacts) (158).

There is a huge potential in reducing/filling/bridging the knowledge, skills, yields and other technological gaps (17, 18, 19). Therefore the report should not focus only on new technologies but also on diffusion of existing technologies and "low-tech"/"low-cost" innovations, more accessible/adapted to small food producers (6, 35, 39, 44, 58, 91, 92, 95, 121, 122, 161).

Typologies:

Different forms of agroecology have different impacts and should be distinguished (1, 63). A typology of sub-disciplines and approaches in agroecology would benefit general readers (158).

Different regions face different challenges, strategies and solutions must be context specific: a first broad distinction could be made between: (a) regions with higher yields and larger associated risks on environmental pollution; and, (b) regions with lower yields and higher need to intensify production and/or at risk of soil nutrient mining (19).

3) Barriers and obstacles to innovation

Any innovation generates rumors and false beliefs: implementation process and information sharing are, thus, key for the success of innovation (61, 165). Actors' **perception**, lack of information, training or knowledge, can hamper the adoption of innovative practices (32, 90, 152, 169). Communities already living on the line tend to be **risk** averse (61) and may be more reluctant to adopt innovative practices.

IPES-Food (2016) identifies 8 lock-ins that impede the emergence of agroecological alternatives to the dominant model (90, 132). Some technical, economic, social, structural, political, institutional, or ideological bottlenecks hinder a more widespread adoption of agroecological approaches (92, 98, 107, 130), including: lack of market opportunities (169); corruption (117); the transition phase, between the adoption of a new practice and its first results (e.g. no-tillage, agroforestry), during which farmers have

to learn new skills (92, 146) and make new investments; the knowledge intensive and context-specific character of agroecological practices which make them difficult to reproduce/scale-up (92, 146), although similar techniques might be used under similar climatic conditions (156). A lot of work has been done on the ecological benefits of agroecology but a better understanding of the economic benefits of different forms of agroecosystems is needed if agroecology is to be adopted on a large scale (1).

Create long-term agroecological demonstration plots and support farmers during the transition phase, both financially and technically, could contribute to overcome those obstacles (92). Education and research are key to enhance agroecology and to develop innovation from plot to regional scale (167). Political and institutional innovations (168), social organization and social/participative methodologies are key to scale out agroecology (107, 149).

4) <u>Opportunities/Enabling conditions to support agroecological approaches and innovation</u>

The report should recognize and clarify the principles that can be strenghtened, and the rights that must be guaranteed, to create enabling conditions: for local innovation (41); for innovative practices and technologies that enhance FSN (43) and food sovereignty (43). It is important to establish a strong legal basis that guarantees the right to adequate food (Art 11. ICESCR), and the right for small producers to exercise agroecology (81).

The value added of the report would be to identify under which enabling conditions/success factors/policy incentives/investments, an innovation is adopted/appropriated by local actors on a territory: the report should avoid generic statements and ground its analysis on concrete examples in various territories (146, 151, 156, 158, 168).

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Agroecological approaches could be further strengthened/developed by:

<u>Designing agroecosystems adapted to local conditions:</u>

Agroecology, in its study of ecological processes and ecosystem services, considers different scales, from the field, to the farm, **landscape** and **territorial** levels (32, 54, 73, 74, 93). Therefore, the report should also consider different scales in its analysis, from local to global (6, 25, 35, 67, 85, 107, 133, 135, 143).

The introduction of any innovation in a territory requires an in-depth knowledge of the area and its potentialities (34). Local actors, farmers and food producers, peasants and indigenous peoples, their local organizations and communities must be involved, and play a lead role, in the innovation and decision-making processes (29, 73, 87, 88, 89, 96, 97, 119, 145, 149, 150, 162, 164, 167). To be accepted and adopted by farmers and their local communities, any innovation has: to match their local objectives and priorities; to answer their local needs; and, to be adapted to local constraints and local sociocultural, economic and biophysical conditions (34, 73, 82, 96, 119, 131, 145). To be successful, development plans should involve local producers and not be based only on knowledge and technology imported from outside (29, 119, 158). However the report should also highlight the role of external innovation (86, 158).

Agroecological production systems are strongly linked to ecological/biophysical (climate, local natural resources including land and water, local genetic resources), social, cultural, economic and political realities at the **territorial** level (12, 32, 35, 36, 46, 89, 95, 146, 160, 167). **Labels** and **geographical indications** should support the development of agroecology (49, 72, 162). In arid pastoral areas animal breeds must be adapted to local conditions, able (like camels) to cope with consequences of climate change: upgraded breeds are unsustainable because they require upgraded inputs (veterinary, husbandry and fodder) (16).

Agroecology is often considered as an **incremental** improvement of conventional agriculture but the promotion of new crops, including long lived tree crops, offers the opportunity to **dramatically change** the form of agriculture (1).

Privileging diversification and integration rather than specialization:

Specialization at farm and/or territorial levels, which reduces the potential for on-farm recycling of materials, might induce an increased dependency on external inputs (fertilizers, seeds, …) (18), complexify the management of increased quantities of effluents and increase the risk of pollution (49). The low cost of fossil fuel, and transport, strengthen competition between regions and countries and is a driver of further specialization and a barrier to the emergence of alternative models based on local and circular economy (49).

Nutrient cycling (including energy, water and mineral cycles) and **circular economy** at farm and territorial level are essential in agroecological approaches (15, 18, 20, 49, 61, 69, 71, 84, 88, 89, 149). For instance, cassava starched water can be reused for fertilization of fish-farming waters and production of biogas; cassava peels can be used as ingredients for fish feed (27). About 80 percent of wastewater remains untreated in the world that, after treatment, could be used for irrigation (23, 76). Agroecological approaches are also good for the development of new fertiliser materials such as: slow and controlled release N fertilizers, fortified fertilizers, or customized fertilizers (14).

Ecologically sound, **diversified** and **integrated production systems** at farm, landscape and territorial levels, will minimize risks, improve **resilience** and **resource efficiency** (17, 49, 61, 83, 89, 90, 102, 134, 149). Human actions like deforestation of huge areas or damming of rivers have seriously threatened the resilience of our environment (25). **Agroforestry**, including silvopastoralism, covers a wide variety of multifunctional, resilient, dynamic, ecological and agrobiodiverse agroecosystems integrating simultaneously or successively crops, trees, medicines plants, and animals in the same place/plot/field – land sharing (11, 45, 52, 118, 129). Agroecological systems (including agroforestry, water harvesting in dryland areas, crop-livestock integration, syntropic agriculture, community supported agriculture) reconcile FSN and health objectives with income generation for the poorest smallholders, conservation and sustainable management of natural resources (soil, water, biodiversity), climate change mitigation and adaptation through carbon sequestration, and restoration of degraded forests/lands (45, 52, 60, 61, 72, 92, 95, 112, 114, 115, 137, 148, 166), through, for instance, "**Farmer-managed natural regeneration**" initiatives (61). Attention is turning once again on the ecological and nutritional benefits of incorporating aquaculture into farming systems in agroecological approaches (18, 20).

New technologies worth exploring in both rural and peri-urban areas include integrated multi-trophic aquaculture, which includes aquaponics (generally, closed recycle systems that utilize wastes produced by farmed fish or other aquatic animals to supplies the nutrients for plants grown hydroponically, which in turn purify the water), as well as the use of artificial substrates for periphyton production (18).

Implementation of more intensive closed-or semi-closed Recirculating Aquaculture Systems (RAS) configurations in fish farms have a potential to result in significant improvements of groundwater footprints and water resource efficiencies. Incorporation of a sludge and wastewater treatment units, capable of removal of ammonia (highly toxic for aquatic animals) and sludge (major source of nutrients in aquatic environment) will further increase environmental sustainability of the farm, reducing pollution of receiving water bodies, soil waterlogging and salinization. With RAS configuration, aquaculture-agriculture integration is very essential, as nutrient rich aquaculture discharges can be used for irrigation purposes, even in Aquaponics system. (20)

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The following enabling conditions must be considered to support innovation:

Develop organizational and institutional innovations:

Innovations are implemented by actors. Therefore, farmers, communities and their social organizations, cooperatives and interprofessional committees play a central role in agricultural development and in the implementation of agroecological and other innovative approaches (8, 35, 37, 40, 87, 115). Policy-makers and social movements should co-create a social infrastructure that favours self-organization, knowledge flow, coordination, cooperation and interactions among actors (26, 32).

Acknowledge the specific role of women and youth for innovation:

Gender is a cross-cutting issue missing in this scope (67, 151). As women are especially suffering from structural and institutional inequalities, gender inequality should be addressed explicitly in this report (71). Addressing **gender issues** is fundamental to achieve FSN: the specific roles of women (as food producers, child caregivers and actors in their communities) must be acknowledged and they must be granted equal rights (8, 55, 63, 87, 107). A gender sensitive and youth inclusive approach is essential (64, 95, 106, 107, 120, 123, 137, 158, 162, 166).

Improve access to information, education and create innovative R&D and education systems:

Basic education and professional training of farmers is a condition for the long term survival of family agriculture (35). Our educational systems need to support the emancipation of people, prompting them to think critically and make choices that favour them, and not the big corporations alone (26).

Proper diffusion of agroecological approaches will not be reached without working on the youth and rethinking our educational systems (33, 69, 121, 138). Agricultural education most focus more on ecological processes within agroecosystems and value more empirical farmers' knowledge (72, 105). We need knowledge systems that are open, resilient and diverse (26). Innovative education models, and exchange of experience and knowledge between food producers, through initiatives such as participatory seed breeding, peer-to-peer learning, "Farmers facilitators", "Farmers Field Schools" or the "Campesino a campesino" movement can contribute to reduce the yield and technological gaps and foster the adoption of innovative practices (59, 62, 65, 71, 72, 84, 87, 96, 107, 110, 113, 123, 138, 162, 164, 172).

Information and communication technologies (ICT) have the huge potential of disrupting established industrial market practices, and classical learning models (68, 116). Digital information in agriculture, including big data, might affect FSN and play a key role in the innovation process and in the transformation of agriculture and food systems (12, 49, 71, 91, 158). This report should pay a specific attention to the ways in which big data is gathered, aggregated, owned and used, identifying the various actors involved and the regulatory requirements to ensure that the use of big data do not exacerbate existing inequalities (91).

Agroecological approaches combine/integrate high level scientific research from multiple disciplines – new research tools and biological material - with traditional practices and techniques, and ground-rooted expertise of local, traditional and/or indigenous knowledge systems (33, 35, 40, 49, 65, 82, 84, 87, 90, 95, 96, 100, 105, 107, 110, 132, 137, 145, 158, 160, 162, 172), and ensure vertical and horizontal knowledge transfer, from science to the field and vice versa, and between different regions (82, 96, 132, 145). Universities should work with food producers and their communities to generate innovations, building on different forms of knowledge and practical experience, including local/traditional knowledge systems (8, 29, 46, 47, 63). Agroecology and agroecological innovations require participatory research and development that involve local actors (farmers, agricultural workers, small food producers, women and youth, indigenous peoples, consumers) and recognize their central role in the innovation process (71, 72, 73, 84, 107, 122, 131, 158, 160, 162). Research shall benefit those people and fit to the local context and conditions (71). The report should explore the dominant scientific paradigms in the FSN research community and the funding gap between research on conventional vs. alternative farming systems (158, 162, 163).

Assess the benefits and risks of innovations and new technologies:

This report should consider the **opportunities and risks** associated with each innovation (58, 61, 105, 161). The report should carefully scrutinize the implications that both 'agroecology' and 'other innovations' have for food producers (farmers, fishers, peasants, herders, etc.), consumers and ecosystems (41). **Appropriateness** of a tool/technology depends on its purpose, expected results, and impacts in a specific context (25). New / innovative technologies and practices should be tested in the target region and first on a small scale (61).

Given the complexity of agricultural and food systems, any particular action should be monitored and evaluated in a **trans-disciplinary** way, from a system perspective (29, 37, 38), using new evaluation paradigms, approaches, tools and indicators (33, 40, 49). There is an emerging literature on indicators

or metrics for sustainable intensification (158) and some sustainability assessment tools already exist such as the Dairy Sustainability Framework (165).

Appropriate, multi-criteria metrics, both quantitative and qualitative should be developed to assess and monitor the impacts of agroecology and other innovative approaches, practices and technologies on the three dimensions of sustainability (21, 49, 57, 61, 126, 158) and, more specifically:

- On **FSN** in its four dimensions: food availability; access to food, including food affordability; utilization, including consumer preferences, dietary education and cooking skills; and stability (25, 44, 49, 61, 67, 92, 99, 105, 107, 169, 171). Impacts on **food losses and waste** (5, 22, 25, 29, 67, 88, 93, 107) must also be assessed.
- On **Food sovereignty** (43, 44, 47, 95, 106, 107, 164, 168) and on the realization of the **right to adequate food** (67, 106, 107).
- On **Health** (21, 25, 61, 72, 106, 107, 169), on diverse, healthy and sustainable diets (90, 171), food quality (171), and on food safety (107, 113). Food, and food production, is at the heart of human, animal and ecosystem health (49, 69, 88, 113, 137). The precautionary principle is absolutely at the core of agroecology (69, 71, 84).
- On Human **well-being** and **livelihoods,** particularly in rural areas (25, 57, 90, 137, 165). This include gender impacts (90), as well as impacts on poverty reduction (35, 95), on **small-scale food producers** (67, 75), on **income** and **employment** generation, especially on youth employment (25, 90, 107), on working conditions and child labour in agriculture (107), on production and **business viability** (58), as well as on **urbanization and rural transformations** (25, 49). The role of agroecology in building social cohesion should also be assessed (67).
- On the **environment:** pollution (49), conservation/restoration of biodiversity and other natural resources (including land, water) and **ecosystem services** (25, 61, 72, 105, 164). Those criteria should reflect the dynamic of biological processes and the ecological impacts of food systems, including food miles (41, 49). Agrobiodiversity could be a good indicator to assess the sustainability of farming systems and territories (70, 134). Social and environmental long-term effects of GM animals and plants on other species are uncertain (25, 63, 85).
- On **Climate change** mitigation and adaptation (49, 67, 72, 105, 107).

Wherever possible, indicators should comprise data already collected (58, 147).