Environment & Development Series 19

Agroecology for Sustainable Food Systems

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TWN
Third World Network

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TWN
Third World Network
Penang, Malaysia

Agroecology for Sustainable Food Systems
is published by
Third World Network
131 Jalan Macalister
10400 Penang, Malaysia.
www.twn.my

Printed by Jutaprint
2 Solok Sungei Pinang 3, Sg. Pinang
11600 Penang, Malaysia.

ISBN: 978-967-0747-23-1

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Acknowledgements

This paper was prepared as a background document for the thematic session on ‘Agroecology for Sustainable Food Systems’ at the Global Science, Technology and Innovation Conference (G-STIC) 2017 (www.gstic.org). G-STIC 2017 was held in Brussels on 23-25 October 2017. I would like to thank the many experts and speakers from the session who contributed to this paper. The paper also draws many of its ideas from the publication: TWN and SOCLA (2015). *Agroecology: Key concepts, principles and practices*. Third World Network, Penang and Sociedad Científica Latinoamericana de Agroecología, Berkeley.

EXECUTIVE SUMMARY

THE 2030 Agenda for Sustainable Development recognizes that bold and transformative steps are urgently needed to shift the world onto a sustainable and resilient path. Numerous challenges such as persistent hunger and malnutrition, climate change and environmental degradation, and ever-tightening constraints on resources mean that no less than a transformation of our agricultural and food systems is needed.

The thematic session on agriculture and food at the Global Science, Technology and Innovation Conference (G-STIC) 2017 focused on 'Agroecology for Sustainable Food Systems'. This was chosen as the specific focus as the paradigm shift towards diversified agroecological systems is increasingly gaining recognition as one that could enable substantially better food production, while providing a set of farmer-friendly, regenerative solutions that can realize more resilient agricultural practices and provide people with access to sufficient and healthy food under changing climate conditions. Along with other sustainable innovations in agriculture that are environmentally sound and socially just, agroecology can effect the systemic change that is needed to provide sustainable food for all.

Key messages

- **'Industrial agriculture'** – the input-intensive crop monocultures and industrial-scale animal feedlots that dominate agriculture – has successfully produced large volumes of food, but this has come at a great cost to the environment, human health and animal welfare, while doing little to address the root causes of poverty and hunger.

- **Negative outcomes** have been generated on multiple fronts by industrial agriculture, such as persistent undernourishment and malnutrition while others are obese and overweight; environmental degradation and pollution that threaten the resource base that agriculture depends on; loss of agricultural biodiversity; high greenhouse gas emissions that contribute to climate change; inequities in access to food; and the marginalization of smallholder farmers, their practices, rights and knowledge systems.

- **What is needed** is a paradigm shift towards diversified agroecological systems. Agroecology applies ecological principles to the design and management of agroecosystems. Its technologies, innovations and practices diversify farms and farming landscapes, increase biodiversity, nurture soil health, enhance recycling, promote ecosystem services and stimulate interactions between different species, such that the farm can provide its own organic matter, pest regulation and weed control, without resort to external inputs.

- **Agroecology technologies, innovations and practices** have consistently proven capable of sustainably increasing productivity, rebuilding soil fertility and sustaining yields over time, providing a basis for secure farm livelihoods, especially for smallholders who constitute the majority of food producers worldwide. Evidence is particularly strong on the ability of agroecology to deliver strong and stable yields by building environmental and climate resilience, and to deliver production increases in the places where they are needed most. It can also help ensure adequate nutrition through diverse diets.

- **Given the challenges of climate change to agriculture**, agroecology technologies, innovations and practices are particularly important as they diversify species (including at the genetic level), farms and landscapes, build complexity into the system to provide vital ecosystem services, increase organic matter and ensure good soil structure, and improve water harvesting and water storage. This provides farmers a means to spread risks during adverse and extreme weather events, adapt to climate change and build climate resilience. At the same time, many of the practices can also contribute to climate change mitigation in the agriculture sector.

- **Agroecology is a science, movement and practice** that draws on social, biological and agricultural sciences and integrates these with traditional knowledge, farmers' knowledge and indigenous peoples' knowledge and cultures. Its technologies, innovations and practices are knowledge-intensive rather than capital-intensive, and it is based on techniques that are not delivered top-down, but developed on the basis of farmers' knowledge and experimentation, and through farmer-researcher participatory approaches.

- **Women play pivotal roles** in cultivating and providing food and nutrition, holding knowledge about seeds, agricultural biodiversity and agroecology technologies, innovations and practices. Nonetheless, women and girls across the globe continue to face many constraints and inequities based on gender. Overcoming gender inequalities and empowering women can have powerful social and economic impacts, delivering significant improvements to agricultural production, food security, child nutrition, health and education.

- **Agroecology technologies, innovations and practices are able to meet key technology assessment criteria**: they are technically feasible, low-cost and affordable, socially acceptable, locally adapted and environmentally sound. The principles of agroecology are applied in diverse technological forms, according to the biophysical and socio-economic needs and circumstances of farmers. Innovations are developed with the participation of farmers, through collective sharing of knowledge and know-how, and the flexible nature of the technologies allows them to respond and adapt accordingly.

- **Agroecology emphasizes the capability of local communities** to experiment, evaluate and scale up innovations through farmer-to-farmer research, sharing of experiences and grassroots extension approaches. However, few resources and little policy support have been directed to agroecology despite its potential to address the multiple challenges facing agriculture. The barriers to scaling up and scaling out agroecology need to be addressed, while a facilitative policy environment is needed to effect change and ensure greater impacts.

- **Support for agroecology** needs to be based on recognition that some technologies, innovations and knowledge systems developed by farmers and indigenous peoples are on par with those generated in formal institutions; and in marginal environments where the majority of small farmers live, these are often superior. Recognition of diverse sources of knowledge builds on acceptance of farmers as equal partners in research and development, not mere passive users of technologies generated by academia, government institutions and the private sector.

- **Agroecology could significantly contribute to achieving the Sustainable Development Goals (SDGs)** in an integrated, comprehensive and holistic manner that will directly involve and benefit those whom the 2030 Agenda aims to uplift. It has strong potential to contribute to meeting SDG 2's specific targets, such as: ending hunger and malnutrition, doubling agricultural productivity and incomes of small-scale food producers, ensuring sustainable food production systems and implementing resilient agricultural practices, and maintaining the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species. In addition, it can contribute to many of the other SDGs.

CHAPTER ONE

TRANSFORMING AGRICULTURE THROUGH AGROECOLOGY

Challenges for agriculture

THE latest report on *The State of Food Security and Nutrition in the World* makes sobering reading. In 2016, after a prolonged decline, the number of chronically undernourished people in the world is estimated to have increased to 815 million, rising from 777 million in 2015.[1] The food security situation has worsened especially in parts of sub-Saharan Africa, Southeast Asia and West Asia. These deteriorations have occurred most notably in situations of conflict and are exacerbated by climate change, conditions that are more likely to lead to migration of refugees. The report sends a clear warning signal that realizing the ambition of a world without hunger and malnutrition by 2030 – as envisaged by the Sustainable Development Goals (SDGs) – will be challenging.

There are therefore immense challenges related to agriculture and food. Among the pressing issues are persistent undernourishment and malnutrition while others are obese and overweight;[2] environmental degradation and pollution that threaten the resource base that agriculture is dependent on;[3] the loss of agricultural biodiversity that is critical to fostering resilience;[4] high greenhouse gas emissions that contribute to

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1 FAO, IFAD, UNICEF, WFP and WHO (2017). *The State of Food Security and Nutrition in the World 2017: Building resilience for peace and food security*. FAO, Rome.

2 Ibid.

3 IAASTD (2009). *Agriculture at a Crossroads. International Assessment of Agricultural Knowledge, Science and Technology for Development*. Island Press, Washington, DC. http://www.agassessment.org

4 FAO (2010). *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. FAO, Rome.

climate change;[5] inequities in access to food; and policies and laws that marginalize small farmers, their practices, rights and knowledge systems.[6]

While the dominant industrial food and agriculture system, perhaps embodied best by input-intensive and conventional monocultures, has enabled increased yields and food production, this has come at a great cost to the environment, human health and animal welfare, while doing little to address the root causes of poverty and hunger or to deal with inherent vulnerabilities to climate change.[7, 8]

The paradigm shift needed

The 2030 Agenda for Sustainable Development recognized that bold and transformative steps are urgently needed to shift the world onto a sustainable and resilient path. In order to meet the Sustainable Development Goal (SDG) of ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture (SDG 2), no less than a transformation of our agricultural and food systems is needed.

It is increasingly recognized that a paradigm shift towards diversified agroecological systems, as called for by several authoritative processes,[9, 10, 11, 12] is what is needed. Agroecology applies scientific ecological

5 Smith, P. et al. (2014). Agriculture, Forestry and Other Land Use (AFOLU). In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

6 IFAD (2013). *Smallholders, food security, and the environment*. International Fund for Agricultural Development (IFAD), Rome and United Nations Environment Programme (UNEP), Nairobi.

7 IAASTD (2009). Op. cit.

8 IPES-Food (2016). *From uniformity to diversity: A paradigm shift from industrial agriculture to diversified agroecological systems*. International Panel of Experts on Sustainable Food Systems, Brussels. www.ipes-food.org

9 IAASTD (2009). Op. cit.

10 Report submitted by the Special Rapporteur on the right to food, Olivier De Schutter, A/HRC/16/49, 20 December 2010.

11 UNCTAD (2013). *Wake up before it is too late: Make agriculture truly sustainable now for food security in a changing climate*. Trade and Environment Review 2013. United Nations Conference on Trade and Development, Geneva.

12 IPES-Food (2016). Op. cit.

principles to the design and management of agroecosystems.[13] Its technologies, innovations and practices diversify farms and farming landscapes, increase biodiversity, nurture soil health and soil biodiversity, close cycles and enhance recycling, promote ecosystem services and stimulate interactions between different species, such that the farm can provide for its own soil organic matter, pest regulation and weed control, without resort to external inputs.

The design of agroecological farming systems is based on the application of the following principles:[14]

- Enhance recycling of biomass, optimizing nutrient availability and balancing nutrient flow;
- Secure favourable soil conditions for plant growth, particularly by managing organic matter and enhancing soil biotic activity;
- Minimize losses due to flows of solar radiation, air and water by way of microclimate management, water harvesting and soil management through increased soil cover;
- Species and genetic diversification of the agroecosystem in time and space at the field and landscape levels; and
- Enhance beneficial biological interactions and synergisms among agrobiodiversity components, thus resulting in the promotion of key ecological processes and services.

Agroecological principles are applied in various technological forms or practices. For example, the principle of diversification in space and time at the farm level takes, in practice, the form of polycultures. Some specific examples are highlighted below.

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13 Gliessman, S.R. (2014). *Agroecology: The Ecology of Sustainable Food Systems*, Third Edition. CRC Press.

14 TWN and SOCLA (2015). *Agroecology: Key concepts, principles and practices*. Third World Network, Penang and Sociedad Científica Latinoamericana de Agroecología, Berkeley. p.8.

Temporal and spatial designs of diversified farming systems and their main agroecological effects[15]

Crop rotations: Temporal diversity in the form of cereal-legume sequences. Nutrients are conserved and provided from one season to the next, and the life cycles of insect pests, diseases and weeds are interrupted.

Polycultures: Cropping systems in which two or more crop species are planted within certain spatial proximity, resulting in biological complementarities that improve nutrient use efficiency and pest regulation, thus enhancing crop yield stability.

Agroforestry systems: Trees grown together with annual crops, in addition to modifying the microclimate, maintain and improve soil fertility as some trees contribute to nitrogen fixation and nutrient uptake from deep soil horizons while their litter helps replenish soil nutrients, maintain organic matter and support complex soil food webs.

Cover crops and mulching: The use of pure or mixed stands of grass-legumes, e.g., under fruit trees, can reduce erosion and provide nutrients to the soil and enhance biological control of pests. Flattening cover crop mixtures on the soil surface is a strategy to reduce soil erosion and lower fluctuations in soil moisture and temperature, improve soil quality and enhance weed suppression, resulting in better crop performance.

Green manures are fast-growing plants sown to cover bare soil. Their foliage smothers weeds and their roots prevent soil erosion. When dug into the ground while still green, they return valuable nutrients to the soil and improve soil structure.

Crop-livestock mixtures: High biomass output and optimal nutrient recycling can be achieved through crop-animal integration. Animal production that integrates fodder shrubs planted at high densities, intercropped with improved, highly-productive pastures and timber trees all combined in a system that can be directly grazed by livestock, enhances total productivity without need for external inputs.

[15] Ibid. Box 2, p.10.

Agroecology is capable of sustainably increasing productivity,[16] and has large potential to address hunger and poverty, particularly when the economic situation or climate is unpredictable.[17, 18, 19] Data show that agroecological systems can match industrial agriculture in terms of total outputs, performing particularly well under environmental stress and delivering production increases in the places where additional food is needed most.[20] There is also growing evidence of positive linkages between agricultural diversity and nutritional diversity, through the increased availability of nutrient-rich diverse foods throughout the year.[21]

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16 The UN Special Rapporteur on the right to food demonstrated in his report to the UN Human Rights Council (20 December 2010, A/HRC/16/49) that agroecology, if sufficiently supported, can double agricultural productivity in entire regions within 10 years (see 'Eco-Farming Can Double Food Production in 10 Years, Says New UN Report', 8 March 2011, http://www.srfood.org/images/stories/pdf/press_releases/20110308_agroecology-report-pr_en.pdf).

17 *Agricultural Technology for Development*, 6 August 2013. Report of the Secretary-General to the Sixty-eighth session of the UN General Assembly.

18 FAO (2015). *Agroecology for food security and nutrition*. Proceedings of the FAO International Symposium, 18 and 19 September 2014, Rome, Italy. Food and Agriculture Organization of the United Nations, Rome.

19 UNCTAD (2013). Op. cit.

20 IPES-Food (2016). Op. cit.

21 Ibid.

CHAPTER TWO

CLIMATE CHANGE ADAPTATION AND RESILIENCE

CLIMATE change is one of humanity's most important challenges. It will have tremendous impacts on agriculture, and is projected to undermine food security.[22] If no adaptation occurs, climate change is projected to negatively impact production of the major staples – wheat, rice and maize – in tropical and temperate regions, at local temperature increases of 2°C or more above late 20th century levels. Global temperature increase of ~4°C or more above late 20th century levels, combined with increasing food demand, is expected to pose large risks to food security.

There is convincing evidence, however, on the ability of agroecology to deliver strong and stable yields, and to continue to provide ecosystem services, even during climate change events, by building socio-ecological resilience.[23, 24] For example, data from a 30-year comparison conducted by the Rodale Institute in the United States show that organic maize yields were 31 percent higher than conventional yields in years of drought.[25]

The comparisons also showed that water volumes percolating through soil were 15-20 percent higher in organic systems featuring long rotation

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22 IPCC (2014). *Climate Change 2014: Synthesis Report.* Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva.

23 IPES-Food (2016). Op. cit.

24 Altieri, M.A., Nicholls, C.I., Henao, A. and Lana, M.A. (2015). Agroecology and the design of climate change-resilient farming systems. *Agron. Sustain. Dev.*, 35(3): 869-890.

25 Rodale Institute (2015). The farming systems trial. http://rodaleinstitute.org/assets/FSTbookletFINAL.pdf

and leguminous cover crops, relative to conventional systems, with more groundwater recharge and less run-off.[26] The increased water retention capacity and better infiltration are features of the improved soil structure that agroecology can bring about, through technologies, innovations and practices that add organic matter to the system, increase soil fertility, and improve soil health and biodiversity.[27] Other agroecological practices such as cover crop mulching and green manures also conserve soil and improve soil ecology, stabilizing and enhancing crop yields and water conservation.

Importantly, by maintaining genetic and species diversity in fields, agroecology practices spread the risks and reduce vulnerabilities in uncertain climate conditions. Agroecology creates both temporal (e.g., rotations) and spatial (e.g., multi-cropping) diversity. The result is the addition of functional diversity – the variety of organisms and the ecosystem services they provide to ensure continued functioning of the system – and response diversity – the diversity of responses to environmental change among species that contribute to the same ecosystem function – which together provide enhanced resilience to the system.[28]

At the same time, agroecological practices such as adding organic matter to the soil both avoid the need to use emissions-causing synthetic nitrogen fertilizers, and have large carbon sequestration potential.[29] These are valuable mitigation measures, with estimates that a widespread conversion to organic farming could mitigate 40 percent of the world's agriculture greenhouse gas emissions in a minimum implementation scenario, and up to 65 percent in a maximum carbon sequestration scenario.[30]

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26 Ibid.

27 Altieri et al. (2015). Op. cit.

28 Ibid.

29 UNEP (2011). Agriculture: Investing in natural capital. In: *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.* United Nations Environment Programme, Nairobi.

30 Niggli, U., Fließbach, A., Hepperly, P. and Scialabba, N. (2009). *Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems*. FAO, Rome. Rev. 2 – 2009.

Chapter Three

BUILDING ON FARMERS' KNOWLEDGE

AGROECOLOGY is a science, movement and practice that draws on social, biological and agricultural sciences and integrates these with traditional knowledge, farmers' knowledge and indigenous peoples' knowledge.[31] Its technologies are knowledge-intensive rather than capital-intensive, as agroecology builds on the knowledge and experiences of farmers. Farmers' knowledge is a basic and important component of the research/development continuum and research from the scientific community should complement and build on this knowledge.

Farmers' knowledge is based on observation and on experimental learning. This includes detailed local knowledge of productive resources and the surrounding environment (soil conditions, plants, rainfall patterns, etc.); time-tested, in-depth knowledge of the local context; identification of best practices for dissemination to other farmers and communities; use of locally-adapted crop varieties and animal species; and criteria for technology development which take into account local goals and priorities, gender preferences, etc.[32] Successful adaptations are passed from generation to generation, and historically, these have been widely shared with members of the community.

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31 Altieri, M.A., Funes-Monzote, F.R. and Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. *Agron. Sustain. Dev.*, 32:1-13.

32 TWN and SOCLA (2015). Op. cit.

The knowledge is rooted in a long history of traditional and peasant agriculture which exhibits not only high levels of biodiversity and resilience, but also cultural diversity. Human creativity and indigenous knowledge have developed ingenious systems and technologies of landscape, land and water resource management and conservation that have lessons for the management of agroecosystems, while depending on strong cultural values and collective forms of social organization such as customary institutions for agroecological management.[33] Agroecology therefore integrates the culture in agriculture, and supports the agricultural and food heritage of humankind.

33 Altieri et al. (2012). Op. cit.

Chapter Four

THE IMPORTANCE OF EMPOWERING WOMEN

WOMEN play pivotal roles in cultivating and providing food and nutrition; preparing, processing, distributing and marketing food; and holding knowledge about seeds, agricultural biodiversity and agroecology technologies, innovations and practices. Women play a crucial role in smallholder systems, which have been mapped and shown to produce more than half of the planet's food calories and convert more than 70 percent of the calories produced directly into the food that people eat.[34] In sub-Saharan Africa and the Caribbean, women produce up to 80 percent of basic foods, and in Asia, women constitute 50-90 percent of the labour force producing the staple food, rice.[35] Other data show that small farmers, largely women, are preserving landraces of important food crops including 75 percent of the global seed diversity of staple food crops such as maize, rice, wheat and potatoes.[36]

Nonetheless, women and girls across the world continue to face many constraints and inequities based on gender, including in accessing productive resources such as land, seeds, innovations and technologies,

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34 Samberg, L.H., Gerber, J.S., Ramankutty, N., Herrero, M. and West, P.C. (2016). Subnational distribution of average farm size and smallholder contributions to global food production. *Environmental Research Letters*, Volume 11, Issue No. 12.

35 FAO (undated). Women feed the world. http://www.fao.org/docrep/x0262e/x0262e16.htm

36 World crop diversity survives in small farms from peri-urban to remote rural locations. Penn State University, 13 February 2015, http://www.eurekalert.org/pub_releases/2015-02/ps-wcd021115.php

credit and extension services, resulting in barriers to the fulfilment of their right to food.[37]

Overcoming gender inequalities and empowering women can have powerful social and economic impacts, delivering significant improvements to agricultural production, food security, child nutrition, health and education.[38] Empowering women would be a shortcut to reducing hunger and malnutrition, and is said to be the single most effective step to realizing the right to food.[39] The Food and Agriculture Organization of the United Nations (FAO) estimates that if women had the same access to productive resources as men, yields on their farms would increase by 20-30 percent.[40] Closing the gender gap in agricultural yields would therefore increase agricultural output in developing countries by between 2.5 and 4 percent, in turn, reducing the number of undernourished people globally by 12-17 percent.

Agroecology can offer a means to recognize women as legitimate actors, and can open spaces for women to become more autonomous and empowered, if steps are taken to this effect.[41] Agroecology can play a role in helping rural women develop higher levels of autonomy through knowledge, resource independence, access to innovations and participation at various levels. Nonetheless, unequal gender relations can also limit agroecology's advance and thus action should be taken to ensure gender equity.

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[37] Report of the Special Rapporteur on the right to food, A/HRC/31/51, 14 December 2015.

[38] IAASTD (2009). Op. cit.

[39] Report submitted by the Special Rapporteur on the right to food, Olivier De Schutter. *Women's rights and the right to food.* A/HRC/22/50, 24 December 2012.

[40] FAO (2011). *The State of Food and Agriculture 2010-2011. Women in Agriculture – Closing the Gender Gap for Development*. FAO, Rome.

[41] Lopes, A.P. and Jomalinis, E. (2011). *Agroecology: Exploring opportunities for women's empowerment based on experiences from Brazil.* The Association for Women's Rights in Development (AWID), http://www.observatoriodegenero.gov.br/menu/noticias/2fpttec-agroecology-eng1.pdf

Chapter Five

MEETING TECHNOLOGY ASSESSMENT CRITERIA

TECHNOLOGIES need to be technically feasible, low-cost and affordable, socially acceptable, locally adapted and environmentally sound in order to be sustainable at economic, environmental and social levels. Agroecology can meet these key technology assessment criteria.

The following are some relevant elements of agroecology: it provides methodologies that allow the development of technologies closely tailored to the needs and circumstances of local communities; agroecological approaches are economically viable and avoid dependence by emphasizing local resources and inputs; its technologies are socially activating since they require participation; they are culturally appropriate as they build upon traditional farming knowledge, combining it with elements of modern agricultural science; and practices are ecologically sound since they optimize productivity without recourse to harmful external inputs.[42]

The principles of agroecology can be applied in diverse technological forms, according to the biophysical and socioeconomic needs and circumstances of farmers.[43] Innovations are developed with farmer participation, through collective sharing of knowledge and know-how, and the flexible nature of the technologies and practices allows them to respond and adapt accordingly. The distributed nature of these arrangements al-

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42 TWN and SOCLA (2015). Op. cit.
43 Ibid.

lows for the testing of new technologies, innovations and practices from the bottom up, and for assessing their suitability to local systems and circumstances,[44] making uptake much more sustainable and locally adapted.

44 Ibid.

Chapter Six

SCALING UP AND SCALING OUT AGROECOLOGY

AGROECOLOGY emphasizes the capability of local communities to experiment, evaluate, and scale up and scale out innovations through farmer-to-farmer training, sharing of experiences and grassroots extension approaches. Agroecological innovations are developed *in situ* with the participation of farmers in a farmer-to-farmer or horizontal (not top-down) manner. This horizontal exchange of ideas and innovations among farmers and with social movements has facilitated the spread of agroecology; this is the case in Latin America particularly.[45]

While showing great potential to address the multiple challenges facing agriculture, there have however been little resources[46] and policy support directed to agroecology. This needs to change, so that incentives are provided to encourage the transition to agroecology, in the form of resources, supportive policies and research priorities. There is therefore a need for reforms in policies, institutions, and research and development agendas to ensure that agroecological alternatives are adopted widely, made equitably and broadly accessible, and multiplied so that their full benefit for sustainable food systems can be realized.[47] As articulated by the UN Secretary-General, 'Effective responses necessitate improved and innovative approaches to the development, transfer and dissemination of sus-

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[45] Altieri et al. (2012). Op. cit.

[46] See, for example, DeLonge, M.S., Miles, A. and Carlisle, L. (2016). Investing in the transition to sustainable agriculture. *Environmental Science & Policy*, 55(1): 266-273. doi:10.1016/j.envsci.2015.09.013

[47] Altieri et al. (2012). Op. cit.

tainable agricultural practices that are resilient, accessible and beneficial for the most vulnerable people, including women and men smallholder farmers. Creating an enabling environment and the right incentives for the shift to sustainable food systems is imperative.'[48]

Simultaneously, the barriers to scaling up and scaling out agroecology technologies, innovations and practices need to be addressed. For example, there has been a rapid decline in traditional ecological (and agroecological) knowledge within peasant and indigenous communities throughout the world. If agroecology is to play a major role in global food production, the preservation and transmission of traditional knowledge should be a priority. Coupled with this, the lack of adequate extension services and technical assistance currently limits the spread of agroecology. Most professionals and technical extension agents are trained to disseminate simple technological solutions, often in a top-down manner. There needs to be a reorientation of training and extension to be reflective of an understanding and incorporation of complexity in production systems, and a bottom-up approach.

Other barriers to overcome include the lack of investment, resources and policy support directed to agroecology and the prevalence of perverse incentives and subsidies that promote unsustainable and high-emissions agriculture. Furthermore there are systemic 'lock-ins' preventing a transition to agroecology; these need to be dismantled and turned into entry points for change.[49] A key lock-in is that of the concentration of power in a limited number of actors, mainly large multinational corporations, reinforcing their economic and political dominance, and thus their ability to influence the governance of food systems.[50]

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48 *Agricultural Technology for Development*, 6 August 2013. Op. cit.

49 IPES-Food (2016). Op. cit.

50 Ibid.

Recognition of diverse knowledges

One important element that is needed to effect the transition to agroecology is to recognize that some technologies, innovations and knowledge systems developed by farmers, rural communities and indigenous peoples are on par with those generated in formal institutions; and in marginal environments where the majority of small farmers live, these are often superior. This recognition of diverse sources of knowledge builds on acceptance of farmers as equal partners in research and development, not mere passive users of technologies generated by academia, government institutions and the private sector.

The design of successful and efficient farming systems that apply the principles of agroecology should be based on a dialogue between traditional and scientific forms of knowledge. Of importance will be the direct involvement of farmers and scientists in the formulation of the research agenda and their active participation in the process of technological innovation and dissemination.[51] Farmers should be integrated into research and development systems, given tools to do their own on-farm research, and their capacity built to share their knowledge with other farmers in farmer-to-farmer networks. Research priorities need to be identified in a participatory manner, enabling farmers to play a central role in defining strategic priorities for agricultural research.[52] Increased networking and knowledge sharing between farmers and researchers is therefore crucial and will help implement a collaborative agenda based on innovative institutional arrangements.[53]

51 Altieri et al. (2012). Op. cit.
52 IAASTD (2009). Op. cit.
53 Ibid.

Chapter Seven

CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT GOALS

THE agroecological development paradigm based on the revitalization of small farms, which emphasizes diversity, synergy, recycling and integration, and social processes that value community participation and empowerment, is perhaps one of the few viable options to meet present and future food needs.[54] While industrial agricultural systems often improve one outcome (e.g., productivity) at the expense of others (e.g., environmental degradation, nutrient availability), agroecology shows major potential to simultaneously reconcile various priorities.[55]

Agroecology could therefore significantly contribute to achieving the SDGs in an integrated, comprehensive and holistic manner that will directly involve and benefit those whom the 2030 Agenda aims to uplift. SDG 2 aims to 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture'. Agroecology can contribute to meeting many of SDG 2's specific targets: ending hunger and all forms of malnutrition and ensuring universal access to safe, nutritious, sufficient and affordable food at all times of the year; doubling agricultural productivity and incomes of small-scale food producers; ensuring sustainable food production systems and implementing resilient agricultural practices; and maintaining the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species.

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54 Altieri et al. (2012). Op. cit.

55 IPES-Food (2016). Op. cit.

To elaborate, the UN Special Rapporteur on the right to food demonstrated in his report to the UN Human Rights Council that agroecology, if sufficiently supported, can double agricultural productivity (Target 2.3) in entire regions within 10 years.[56] Agroecology is also the embodiment of sustainable food production systems and resilient food production practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality (Target 2.4).[57] Because a key pillar of agroecology is agricultural biodiversity, aiming to enhance species and genetic diversification of the agroecosystem in time and space at the field and landscape levels, it is able to maintain, *in situ*, the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species (Target 2.5).

In addition to having a direct impact on universal access to safe, nutritious and sufficient food (SDG 2), agroecology for sustainable food production systems can also contribute to achieving the other SDGs. More resilient incomes for local communities of small-scale food producers will reduce the proportion of men, women and children living in poverty (SDG 1) and contribute to reducing inequalities (SDG 10), while by advancing employment, such systems will help promote sustainable economic growth (SDG 8).

Enhanced access to safe, nutritious and sufficient food will also contribute to health and well-being (SDG 3). In supporting positive economic, social and environmental links between urban, peri-urban and rural areas, agreocology can help to foster sustainable cities and communities (SDG 11), while contributing to sustainable consumption and production (SDG 12).

56 See Footnote 16.
57 Altieri et al. (2015). Op. cit.

Importantly, agroecology can strengthen resilience and adaptive capacity to cope with the impacts of climate change (SDG 13), at the same time contributing to the conservation and sustainable use of agricultural biodiversity and the restoration of degraded land (SDG 15). By avoiding the use of chemical inputs and hence polluting run-off, agroecology can help ensure clean water (SDG 6) and reduce marine pollution from land-based activities such as agriculture (SDG 14).

Agroecology can also be a means to contribute to gender equality (SDG 5), if conscious effort is taken to this effect. Finally, action is needed to ensure the promotion of the development, transfer, dissemination and diffusion of agroecology, as an environmentally sound technology, to developing countries (SDG 17).

AGROECOLOGY FOR SUSTAINABLE FOOD SYSTEMS

Numerous challenges such as persistent hunger and malnutrition, climate change and environmental degradation, and ever-tightening constraints on resources mean that no less than a transformation of our agricultural and food systems is needed. A paradigm shift towards agroecology – a science, movement and practice that applies ecological principles to the design and management of agroecosystems – is increasingly gaining recognition as one that could enable substantially better food production, while providing a set of farmer-friendly, regenerative solutions that can realize more resilient agricultural practices and provide people with access to sufficient and healthy food under changing climate conditions.

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ISBN 978-967-0747-23-1