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CHAPTER 3
Transforming food production systems for rural people's well-being

Agriculture, beyond being a food producer, is a key source of income and employment for the world's rural poor – and with proper management it can sustain natural resources. A desirable food system transformation must include a concerted focus on small-scale agricultural production, including crops, livestock, fish and forest production. The objective must be not simply to integrate smallholders into efficient larger value chains, but also to diversify and improve small-scale production with knowledge-based and circular sustainable production methods, geared towards producing diverse and nutrient-dense foods. These shifts must be complemented with expanding the off-farm livelihood opportunities for rural people.

Efforts to leave no one behind and to meet the Sustainable Development Goals (SDGs) – particularly SDG 1 (Poverty) and SDG 2 (Hunger) – will hinge on the world's success in harnessing food systems for rural people's well-being (FAO, 2017). Such a transformation is essential not only to feed the world well and sustainably, but also to eradicate poverty and hunger while tackling the climate crisis. Agricultural production is both a major contributor to greenhouse gas (GHG) emissions and highly vulnerable to its effects, particularly in low-income countries. It is a primary driver of biodiversity loss. It continues to overuse freshwater for agriculture and degrade soils. And when mismanaged it drives down the productive capacity of land (Dasgupta, 2021).

An estimated 500 million small-scale farms are in low- and middle-income countries. These households account for as many as 3 billion people globally, more than a third of the human population (Woodhill et al., 2020). These small-scale farms produce much of the food consumed in low- and middle-income countries – but they also constitute the majority of people who live in extreme poverty and suffer hunger (Woodhill et al., 2020). And they are also among the groups most vulnerable to climate change. The challenge is thus to enable rural people to produce nutritious and healthy foods, while containing agriculture's environmental footprint and realizing the value of ecosystem services in production – all while expanding decent livelihood opportunities for poor and marginalized people.

This chapter develops four messages:

1. **Agriculture needs to shift towards producing more nutrient-dense foods – a shift that will require more diversified production systems, with markets to support them.** This can be achieved by policy actions informed by a better understanding of production requirements and economic viability for a portfolio of products based on agroecological conditions and marketing opportunities.

2. **Shifting to more knowledge-based, adaptive and sustainable production systems – and moving away from a narrow focus on maximizing cereal production – can overcome the negative environmental and nutritional impacts of current agricultural systems.** Through knowledge-intensive agriculture, farmers should be able to have access to, and make decisions on the basis of, multiple and timely sources of knowledge and information on market conditions, agroecology and climate-related risks. That will foster productivity gains through sustainable production systems and greater resilience to climate change and the other shocks and stresses that threaten food and nutrition security.

3. **Many small-scale agricultural producers need diversified incomes for decent and resilient livelihoods, since relatively few will be able to achieve this through farming alone.** Improving agricultural production systems requires narrowing the yield gaps[5] for greater agricultural productivity and enabling smallholders to diversify production into high-value and diversified crops. But such an approach cannot work for all of them because of the constraints of quality standards, capital requirements and market arrangements. So diversifying beyond farming by developing off-farm opportunities becomes critical.

4. **Transforming agricultural production must be inclusive and equitable, focused on opportunities for women, youth and indigenous people.** Production of nutrient-dense foods through sustainable intensification does not necessarily lead to inclusive food systems. So special efforts will be needed to ensure that the needs of women, youth and indigenous people are accounted for in the development of strategies and investments.

Following these four sections, a final section translates these messages into policy priorities for transforming agricultural systems in ways that will be inclusive and support the rural poor.

5 Yield gaps are the difference between potential (Yp – irrigated conditions) or water-limited potential yields (Yw – rainfed conditions) and actual farmers' yields – Ya (van Ittersum et al., 2013).

Agriculture to shift towards more nutrient-dense foods through diversified production systems and market support

Agriculture's main challenge for the coming decades is to produce enough healthy and affordable food for a growing global population at an acceptable environmental cost. Meeting this challenge will require a shift from producing calories to producing nutrient-dense foods and making diverse and nutritious foods more available and affordable.

Higher diversity in diets is associated with better health outcomes (Brouwer et al., 2021). For low-income countries, the diversity of agricultural goods produced by a country is a good indicator of the diversity of the food supply – and higher levels of such diversity are associated with lower national stunting, wasting and underweight among children (Remans et al., 2014).

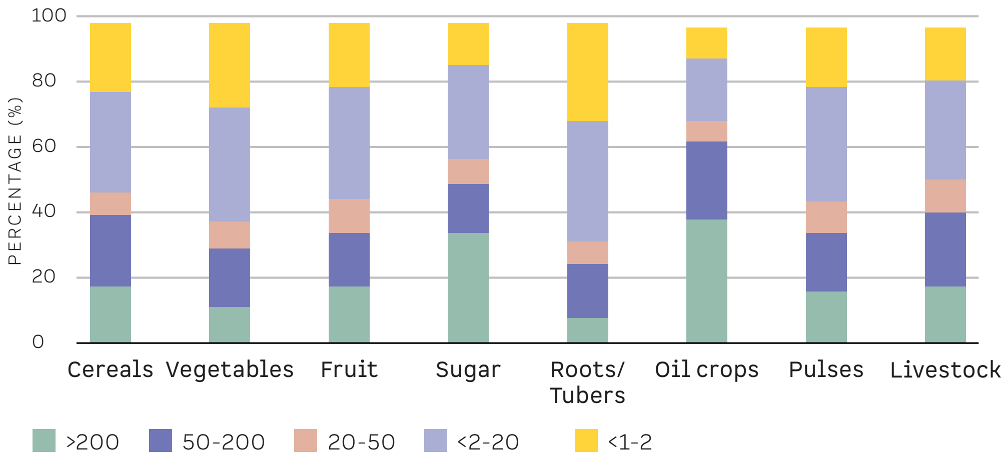
Since 1960, however, the global diversity of national food supplies has been declining: major cereals and oil crops have become increasingly dominant (Herrero et al., 2017). While more than 6,000 plant species have been cultivated for food, fewer than 200 make substantial contributions to global food output – and just nine accounted for 66 per cent of total crop production in 2014. Evidence suggests that the diversity present in farmers' fields has declined overall, and that the threats to diversity are getting stronger (FAO, 2019).

Small-scale farmers produce a large share (61 per cent) of global fruits and vegetables and a dominant share (67 per cent) of the roots and tubers. In contrast, medium-sized and large farms dominate in sugar and oil crops. Smallholders with less than two hectares produce 30-34 per cent of the global food supply on 24 per cent of global cropland area (Ricciardi et al., 2018). Across 83 countries, 44 million small farms in Africa and 338 million in Asia are responsible for 41 per cent of total global calorie production and for 53 per cent of the global production of food calories for human consumption (Samberg et al., 2016).

Globally, small and medium-sized farms (less than 50 hectares) produce 51-77 per cent of nearly all commodities and nutrients (Herrero et al., 2017). Many farms are very small (less than 2 hectares) and have local significance in sub-Saharan Africa, South-East Asia and South Asia, where they contribute about 30 per cent of agricultural commodities.

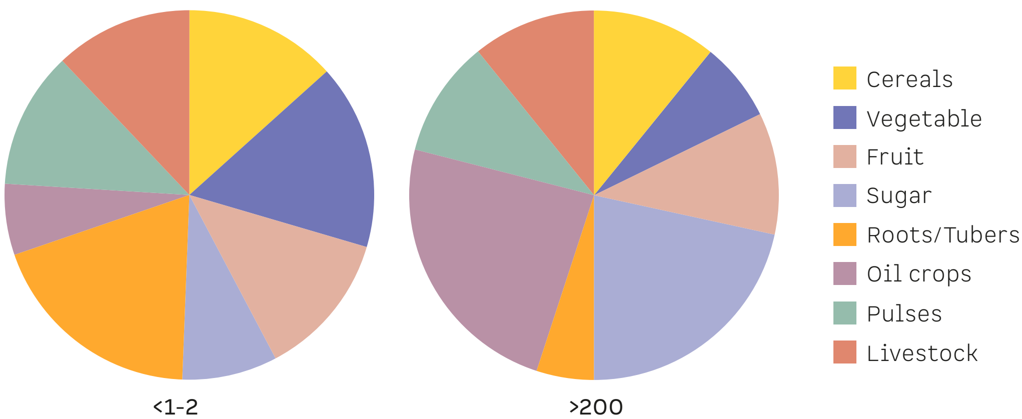
FIGURE 3.1 DISTRIBUTION OF FOODS PRODUCED BY FARM SIZE (IN HECTARES)

PER CENT OF TOTAL GLOBAL PRODUCTION



Source: Woodhill et al., 2021.

FIGURE 3.2 DIVERSITY OF FOODS PRODUCED: COMPARISON OF LARGEST AND SMALLEST FARM SIZES



Source: Based on Woodhill et al., 2021.

Agricultural intensification and increasing farm size are reducing the diversity of food production (**FIGURE 3.2**). Nutrient-rich species that are suitable for smaller plots, such as vegetables, fruits, and some roots and tubers, are reduced – while species that can be easily produced with mechanized systems, such as cereals, sugar and oil crops, are maintained (Herrero et al., 2017). This raises the risk of losing important nutrient diversity in the food supply system unless specific measures are taken to ensure it is conserved. Similarly disappearing at an alarming rate are nutrient-rich neglected and underutilized plant species, which could provide high nutrient potential if science and policy were better connected and if more coordinated policies and regulations pushed for their production and use (**BOX 3.1**).

BOX 3.1 NEGLECTED AND UNDERUTILIZED PLANTS – DISAPPEARING FAST

Nutrient-rich neglected and underutilized plant species (NUS) are crops, plants and species neglected or ignored by agricultural researchers, plant breeders and policymakers. They are generally not traded as commodities. They can be wild or semi-domesticated varieties and non-timber forest species creolized or adapted to specific, local contexts. These species, together with the knowledge about their cultivation and use, are being lost at a very alarming rate (Padulosi et al., 2013).

Many of them hold good potential for improving diets and nutrition, while protecting biodiversity and food systems (Bioversity International, 2017; Fanzo, 2019). There is uncertainly around the exact number of them that we can rely on to support biodiversity-enhancing and nutritious food production systems, going from a conservative estimate of 5,538 by the Royal Botanic Gardens, Kew (2016) to 12,500 reported in Kunkel's checklist of edible species (1984) and up to 75,000 in Wilson (1988) (in Hunter et al., 2019).

In the report on the *State of the World's Biodiversity for Food and Agriculture* (FAO, 2019), 15 of the 91 reporting countries (16 per cent) reported on the regular use of wild foods in their national diets. A recent review and research by Hunter et al. (2019) confirm their great potential for food and nutrition security, as well as the possibility of combating the "hidden hunger" caused by micronutrient deficiencies (Padulosi, 2013; Kobori and Rodriguez-Amaya, 2008; Bharucha and Pretty, 2010).

Since the Second World War, and especially in recent decades, the overarching rationale of agricultural and food trade policy has been that trade – by making agriculture more productive and its markets more efficient – will drive down food prices and drive up food availability and choice (CHAPTER 5). This expansion of food supply indeed contributed to reducing food insecurity (Pingali, 2012), and global food security increased thanks to cheaper and more widely available food (Benton and Bailey, 2019). But, as policies focused on increasing agricultural yields and crop efficiency, their negative unintended consequences have spilled over into the environment and health. Efficiency has come at the cost of quality. The scale of total food system costs is becoming clear only now, as the data revolution enables more transparent and more comprehensive analyses of the local and global impacts from the drive for cheaper calories.

Today, global agriculture is more productive than ever. Since the 1960s, global agricultural output has almost doubled (Alexandratos and Bruinsma, 2012). While the global population rose by 142 per cent between 1961 and 2016, average cereal yields increased by 193 per cent and calorie production by 217 per cent (Benton and Bailey, 2019). Yet at the heart of this remarkable achievement lies a paradox: as the efficiency of production increased, the capacity of the food system as a whole – to deliver nutritious food sustainably and with little waste – declined. Yield growth and falling food prices have been accompanied by increasing food waste, a growing malnutrition and obesity burden, and unsustainable environmental degradation. A recent study on the environmental impacts of food systems reports that failure to apply mitigation approaches in agricultural production would lead to a 50-90 per cent increase in global environmental pressures and a destabilization of key ecosystem processes (Springmann et al., 2018). These externalities and unwanted food system outcomes have emerged and increased over time as consequences of unbalanced food system governance, supporting the need for a transformed food system that moves from producing more food towards finding ways "to nourish everyone in ways that can be sustained environmentally, economically and culturally" (Haddad et al., 2016: 32).

Diversification of agricultural systems is a prominent means of enhancing resilience, since different crops and livestock production systems have varied levels and types of vulnerability. Diversifying the vulnerability of production systems reduces the risk of total production loss. Such resilience can be defined as the system's capacity to manage and respond to challenges, both foreseeable trends and unexpected events, while maintaining its essential functions of providing private and public goods. Robustness, adaptability and transformability are key to farming system resilience – and each of these three elements is positively affected when farming practices become more diverse (**BOX 3.2**).

The need to reinforce the resilience of farming systems has also been highlighted by the current COVID-19 pandemic. Although responses have varied greatly between farming systems, many have been affected, and vulnerabilities have been exposed. These range from farmers facing agricultural input shortages because of logistical restrictions, through limitations in market access because of restrictions in human mobility, to losing employment and income from remittances. But the effects have been limited as a result of the widely acknowledged need to keep food supply chains and trade functioning.

The real impact of COVID-19 on the rural poor and small-scale farmers is not yet clear, but there is an emerging consensus that there will be an increase in food insecurity, mostly through impacts on loss of income and employment among poor people (Béné et al., 2021). The crisis has also showed the disproportionate risk faced by small-scale producers, who have limited assets and savings to cope with disruptions to incomes and who, on average, are net purchasers of food. Higher food prices hit them as purchasers but do not flow back to them to any significant degree as sellers (Woodhill, 2020).

BOX 3.2 DIVERSIFICATION CAN CONTRIBUTE TO HEALTHIER DIETS AND FOOD SYSTEM RESILIENCE

A key topic brought to the fore in our regional consultations among food system experts across IFAD regions is the role of agricultural diversification in creating healthier diets and improving food system resilience. Experts stress the need to invest more knowledge and resources in nutritious foods beyond cereals. One from the Latin America and the Caribbean region put it thus:

"The main crops, maize and rice, have had a lot of investments, and so there's been a lot of production. Many of the diets across the region are based on maize and rice, and wheat to a lesser extent. So a lot of investment has been put on those, and not so much on the more nutritious foods: fruits, vegetables, other kinds of small livestock."

Source: Regional consultations.

A shift towards producing more nutrient-dense foods and reducing the yield gaps requires analysis of production requirements and opportunities for an expanded portfolio of agricultural products based on agroecological conditions as well as market opportunities. A main reason for smallholder farming systems to be dominated by staple crop production – even when farms produce a surplus – is that markets always exist for staple crops, even if they are not especially profitable. The highly perishable nature of many fruits and vegetables calls for more intensive post-harvest management and, in some cases, cold storage. Post-harvest infrastructure needs and local agroecological conditions are key determinants of feasible and profitable diversification into nutrient-dense foods.

Adaptive, knowledge-based and sustainable agriculture

Maximizing food production can no longer be the exclusive focus of policies – what is needed is a more adaptive, knowledge-based, sustainable agriculture, fostering resilience to climate change and other shocks and stresses that affect food and nutrition security. Historically, increasing agricultural productivity has had significant negative impacts on ecosystems and the services they provide to farmers and broader communities (Tilman, 1999; Foley et al., 2005, 2011; Lipper et al., 2020). Agriculture now needs to shift from production systems that deplete and degrade natural resources to ones that utilize ecosystem services to enhance resource use efficiency in production – while also enhancing the systems' resilience. This implies a shift from monocropping to more integrated production systems, and from agricultural systems reliant on indiscriminately high external input use to ones that are knowledge-intensive.

Knowledge-based agriculture

Knowledge-intensive agriculture has many interpretations and synonyms, such as "smart agriculture", "e-agriculture", "precision agriculture" and "data-driven agriculture". What these connotations have in common is that farmers have access to and make use of multiple sources of knowledge and information on agroecological and market conditions in their decision-making on important aspects of their farm operations. These sources include traditional knowledge developed over and transferred by generations but also scientific knowledge and data-driven information. Information and communication technologies (ICTs) can facilitate an information- and knowledge-based approach and be possible game changers in a radical transformation of food and agricultural production systems. In a nutshell, the options would include:

- Advisory and information services, such as relevant agronomic, environmental data to smallholder farmers: early warning weather, agro-advisory.
- Market linkages, such as price information.

- Supply chain management, such as market access and traceability by better connecting buyers, sellers and producers, for example through digital marketplaces and end-to-end supply chain management solutions.
- Financial services.
- Macroagricultural intelligence.
- Bundled solutions use case (Ceccarelli et al., 2021).

As a result, agriculture becomes more networked, with a variety of information sources and decision-making to achieve more efficient resource use. But there are obstacles to ensuring that digital technologies can support the food system transformation towards desirable pathways, starting first with the connectivity, diffusion and infrastructure required. For example, although mobile penetration and network connectivity are high in all countries, the adoption of internet and more sophisticated technologies has lagged in developing and least-developed countries.

To avoid information imbalances with buyers, smallholders need their own information networks, implying that more traditional connections will operate in parallel with more modern technologies for some years to come. Although COVID-19 has pushed forward an ICT revolution and digitalization of agriculture and food markets, there is still considerable need to build an enabling governance and regulatory environment as well as the infrastructure and institutions (IFAD, 2019; Ceccarelli, 2020). Communities in low- and middle-income countries will continue to rely on traditional means of communication delivery and telecommunications infrastructure (the limited network of landline telephone connections, radio, emails, simple feature phones) for a number of years. So multiple delivery channels and platforms will have to coexist. And strategies combining traditional and advanced delivery channels as well as intermediaries with mobile-based solutions on the ground (extension services, loan officers, street-level agents) will still be needed in view of the slow penetration of broadband connectivity and related services.

Sustainable agriculture

In addition to a knowledge transformation, agriculture requires a sustainability transformation to make production more efficient and tailored to the agroecological context and a changing climate. As food production inevitably increases, it must do so without expanding agricultural lands, implying that existing agricultural lands need to be farmed more efficiently (**BOX 3.3**). The best places to improve crop yields may be on underperforming landscapes, where yields are well below their potential. In other words, increasing production could focus on food systems where yield gaps are greatest.

BOX 3.3 MORE SUSTAINABLE PRODUCTION TO GUARANTEE THE FUTURE OF FARMING

Many food system experts consulted for this report indicated the need to move to more sustainable forms of production – to protect the environment and prevent degradation of key resources. As one government official put it: "The intensification generates money, but generates a lot of sustainability problems. This way, it is not possible to continue. The soybean sector, livestock, rice sector, they are all very intensive and generate problems with methane, with soil erosion, water contamination. Now the trade-off is: perhaps we need to obtain less money, but in a more sustainable way. We need to implement a more sustainable agrifood system."

Source: Regional consultations.

Sustainable intensification is one approach to address this need. In essence, it is a production process or system that increases yields without adverse environmental impact or the cultivation of more land. What this concept means in practice is much debated. Sustainable intensification is about not just reducing environmental damage while increasing productivity, but also about taking sustainable principles as a point of departure for productivity enhancements. In this view, sustainable intensification implies using ecosystem services to enhance productivity (Rockström et al., 2017). Note that sustainable intensification does not explicitly address equity and food access – focusing instead on environmental sustainability in production.

The transition to sustainable intensification in agriculture is a knowledge-intensive process that should not be perceived as simply the promotion of traditional or low-input practices. Sustainable resource management requires knowledge about the ecological functions of agroecosystems and their relation to management and agronomic practices. Best practices vary for different microclimates and for households with different resources.

A key feature of sustainable intensification is increasing input use efficiencies, which can be grouped under three main types: those related to resources (underuse of inputs), technology (type of technology used), and efficiency (inefficient use of inputs – including overuse) (Giller, 2021). Closing efficiency and resource yield gaps by improving the timing and amount of inputs applied for cereals on currently cultivated land in Ethiopia could deliver the added production needed to achieve national self-sufficiency and reduce cereal import dependency by 2050 (Assefa et al., 2020; van Dijk et al., 2020; Silva et al., 2021). Half of the technology yield gaps in Ethiopia are explained by suboptimal seed and fertilizer application rates in the highest-yielding fields, pointing to farmers' economic and capital constraints (Assefa et al., 2020; Silva et al., 2021). These insights are also relevant to other parts of East Africa (Tittonell and Giller, 2013).

Sustainable agricultural intensification also involves more efficient management of water. In rainfed systems, which account for 95 per cent of farmland in sub-Saharan Africa, better management of rainwater and soil moisture is the key to raising productivity and reducing yield losses during dry spells and periods of variable rainfall. Supplemental irrigation – using water harvesting or shallow groundwater resources – is underused for increasing water productivity in rainfed agriculture (HLPE, 2015; Oweis, 2014).

Increased organic and inorganic fertilizer use of appropriate quantity and timing is crucial for sustainable intensification in areas of currently low productivity. It raises food output per hectare and therefore relieves the pace of converting natural habitats to cropland (van Ittersum et al., 2016). And it augments the production of biomass and other sources of organic matter that can improve soil quality. But it must be part of integrated soil fertility management, which includes the use of quality seeds and timely planting. And to make investments in farm inputs profitable to producers, market information is needed to support decisions about the allocation of these inputs.

Small-scale agricultural producers are constrained in adopting sustainable intensification techniques (Arslan et al., 2020). Many practices require up-front investments of capital inputs and substantial labour, while the benefits may not materialize until several years after the practices are adopted. Other key constraints include a lack of access to land, water rights, finance, information and new technologies – all constraints that tend to be greater for women, limiting their productivity. While better-resourced farmers may be willing to make such investments, poor farmers tend to prioritize immediate food security needs and face serious labour constraints, since they depend on wage labour for their income. Women farmers in particular cannot adopt practices that demand labour and involve long-term investments (Jayne et al., 2019). Weak land tenure security also impedes the adoption of integrated soil fertility management, especially for women.

One example of a project to help smallholder farmers overcome these constraints is described in **BOX 3.4**.

BOX 3.4 INCREASING INCOMES AND FOOD SECURITY IN MADAGASCAR

Most of Madagascar's population lives in rural areas (78 per cent), and a dry climate troubles smallholder farmers. Investments in irrigation are required to support farming activities and ensure efficient land use.

To improve incomes and food security among smallholder farmers in the Menabe and Melaky regions, the project built upon instruments of rural infrastructure development to primarily benefit rice producers through secure land tenure and infrastructure development.

The estimated total number of beneficiaries is 156,000, or 26,000 households. Water user associations were established to ensure sustainable use of irrigation infrastructure, with a total of 34 being set up or strengthened through the course of the project. Irrigation allowed two and in some cases even three production cycles a year. Annual rice yields increased by 27 per cent and the value of crop production per hectare increased by 24 per cent. Durable assets and food security also increased because of the higher incomes. The project continues to build the capacities of water user associations through financial and educational support.

Source: IFAD project completion reports and impact assessments.

Adapting to climate change also drives the adoption of agricultural techniques that enhance resilience as well as productivity. Maintaining ecosystem services that regulate soil and water quality – while also supporting resistance to disease and pests – plays a key role in adaptation.

Agroforestry, which involves growing woody perennials in association with food crops and pasture, is a climate-smart agricultural practice: it contributes to climate change mitigation and adaptation, as well as to food security. Across the Sahel and at the southern edge of the Sahara, farmer-managed natural regeneration programmes based on agroforestry have bolstered farmer resilience to climate change, boosted their productivity and increased CO_2 sequestration and storage. A review of agroforestry's impact on crop yields (Kuyah et al., 2019) shows that agroforestry increases yields in both humid and semi-arid conditions. The most effective agroforestry practices are alley cropping, biomass transfer and planted fallows.

Significant barriers stand in the way of smallholder adoption of agroforestry practices. In Africa, the most prominent barrier to agroforestry adoption was a lack of access to information, chiefly from extension services. Also needed was targeting those with lower endowments, especially women farmers and woman-headed households (Arslan et al., 2016).

An alternative and much broader approach to sustainable agriculture is agroecology, which embraces science, a set of practices and a social movement. It has expanded from a focus on fields and farm practices to encompass entire agriculture and food systems (HLPE, 2019). It aims to build resilient farming and food systems that are inclusive of small-scale producers and low-income consumers, provide a diversity of safe and healthy food, and regenerate and improve biodiversity and ecosystem services. It is based on applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment, while considering the social aspects of a sustainable and fair food system. Its three core elements are recycling; resource use efficiency; and integration of a diversity of different crops and/or animals into a system. Agroecology changes the cost structures in small-scale farming systems by substituting capital-demanding inputs with labour and innovative technologies and practices to produce diverse farm outputs (**BOX 3.5**).

Sustainable intensification and agroecology have strong links to the circular economy through their emphasis on resource use efficiency and use of ecosystem services as well as encouraging the use of regenerative resources and preventing leakages of natural resources from the food system.

BOX 3.5 AGROECOLOGY AT IFAD

IFAD is part of the FAO-led multiagency initiative to scale up agroecology. All agencies have as a first task agreed to do an agroecology stocktaking of their portfolios. IFAD has developed an agroecology framework, based on the 10 agroecology elements approved by the FAO Council in 2019, and completed its stocktaking in 2020, analysing 207 projects (completed or to be completed between 2018 and 2023).

Of IFAD's projects, 13 per cent fully support the three core elements in agroecology in their activities, while another 47 per cent partially support agroecology approaches (two of the three or all three but not with all beneficiaries).

Projects supporting agroecology also score higher in supporting IFAD's mainstreaming priorities for nutrition, youth and climate change, while gender is doing well in all projects. They also give more support to indigenous peoples, confirming agroecology's social elements. Climate adaptation-focused funding, such as the Adaptation for Smallholder Agriculture Programme (ASAP), significantly contributed to enabling agroecology approaches in half of the projects fully supporting agroecology in the sample.

Source: Internal IFAD report.

Diversified incomes for decent and resilient livelihoods – not from farming alone

Within small-scale agriculture, a basic dualism exists between very large numbers of very small-scale farmers with less than 2 hectares of land – who derive only part of their income, and their food, from their own production – and a less numerous group whose larger farming operations (up to 20 hectares) produce most of the commercial food supply. The food produced by very small-scale farmers is vital to their income, food and nutrition security, and to local markets, but is unlikely to help meet the growing demands of urban populations (Woodhill et al., 2021).

Because of this dualism, policymakers must be careful not to conflate the challenge of tackling poverty and malnutrition among small-scale farming families with the different challenge of meeting growing urban food demand. The interventions that work best for larger producers – those aiming at commercialization – will differ from those focused on the very small-scale farmers. Generally, farmers' own production is a major component of food security and income, but cash-cropping and off-farm income are also critical (Frelat et al., 2016) (**BOX 3.6**).

Off-farm opportunities and diversification options

The prospects for improving poor smallholder well-being in sub-Saharan Africa through agricultural transformation alone are explored in a study by Giller et al. (2021), which focuses on six zones and uses two indicators: food self-sufficiency (threshold of 2,500 kcal/mean absolute error/day), and food security (measured against the same threshold using the food availability indicator, which converts all income into calories). In all six zones, households vary widely, yet the shape of the current distribution is very similar: few households are above the poverty line, obtaining a living

BOX 3.6 HIGH-VALUE AGRICULTURE IN NEPAL

Nepal's agricultural sector dominates the labour market, employing roughly two thirds of the working population, and contributes substantially to GDP. But food shortages remain a chronic issue for 4-9 months of the year, when half the districts are food-deficient and producers cannot earn wages to achieve self-sufficiency. The government has prioritized strengthening the agricultural sector, with empowering smallholder farmers as a first step.

The High-Value Agriculture Project sought to reduce rural poverty and improve food security in the rural mountainous areas by establishing producer organizations and forming farmer cooperatives. The producer services improved access to input, output and service markets – by streamlining value chains – and technical awareness training.

The project supported 15,745 direct beneficiaries and 107,860 beneficiaries in total; women constituted 47 per cent and ethnic minorities 25 per cent of all beneficiaries. It established or supported 456 producer organizations and built or rehabilitated 13 market processing facilities. Beneficiaries saw a 37 per cent increase in annual income (US$500), a 7-9 per cent increase in productive and livestock assets, a 5-6 per cent increase in market access in the dry and wet seasons, and a slight increase in dietary diversity. Technological adoption rates were high: 67 per cent of trained farmers adopted 50 per cent of the technologies introduced. Climate resilience was increased through polytunnels, allowing two or three crop cycles per year. Storage facilities reduced post-harvest losses, benefiting producers, market operators and the environment. And planting timur trees helped with soil conservation.

Source: High-Value Agriculture Project impact assessment technical report and policy brief.

income from agriculture, while the vast majority are among the region's poorest households. In four of the six zones, none of the households is food self-sufficient – producing enough food to feed the family – and in all six zones the highest rate of food self-sufficiency is half of households. The share of food-secure households is higher than the share of food self-sufficient households: even so, in none of the six locations are all households food-secure (Giller et al., 2021).

Narrowing yield gaps considerably increases the share of households that are food self-sufficient or food-secure across all six zones. Yet, even with the largest possible increases in yield, in only three of the six zones do a majority of households achieve food security or food self-sufficiency. For example, in Ethiopia, land is so constrained that, by narrowing yield gaps as much as is likely to be feasible, only 42 per cent of households would be food self-sufficient. By contrast, in Tanzania, closing yield gaps would lift 90 per cent of households above the food self-sufficiency threshold. Food security is not much different: in all cases, narrowing yield gaps makes the share of food-secure households only slightly higher than that of food self-sufficient households (Giller et al., 2021).

Enabling smallholder farmers to diversify production into high-value markets: some options

Two approaches that have shown some promise for raising smallholder farmers' incomes and improving their well-being are sustainability certification (Meemken, 2020) and linking small-scale producers to emerging high-value markets in fruits and vegetables (Ogutu, Ochieng and Qaim, 2020). It is clear that demand will soon grow for more nutritious diets and more diverse food – and even for high-value perishable foods, which offer ample economic opportunities for farming households. According to the Global Panel on Agriculture and Food Systems for Nutrition (2020), small-scale producers can play an important role as specialized producers of nutrient-rich foods, particularly through horticulture. Small-scale producers may even have a comparative advantage in certain types of fruit and vegetable production, particularly those that rely on high labour use with low capital requirements.

However, the degree to which future food demand will be inclusive and translate into viable futures for large numbers of more marginal, small-scale producers is questionable (Woodhill et al., 2020). It will depend largely on implementing measures that allow small-scale producers to overcome the barriers to producing and marketing their production.

Making food systems inclusive and equitable

A transformation of food systems that enables the production of sufficient nutrient-dense foods for consumers, achieved by sustainable agricultural intensification, does not automatically lead to inclusive and equitable food systems or better livelihoods for all. Without deliberate actions to ensure the inclusiveness of transforming to more sustainable production systems, poor people could be left behind or even harmed (Davis et al., 2021).

Without deliberate actions to ensure the inclusiveness of transforming to more sustainable production systems, poor people could be left behind or even harmed.

The fate of poor and marginalized rural people, especially women, youth and indigenous people, tends to be inadequately addressed in the process of agricultural transformation (Davis et al., 2021). Women are deeply involved in all phases of agricultural production, and at the plot level account for about 40 per cent of the total field work in crop agriculture in Africa (Palacios-Lopez et al., 2017). There is widespread consensus that women devote more time than men to many agricultural production-related activities such as seed selection, input purchasing and livestock care, and they certainly spend more time than men on household labour. Some suggest a potential gain in overall productivity by targeting women on specific objectives and actions, but there is not enough evidence to show what results this would entail (Doss, 2018). Even so, explicitly integrating gender considerations into strategies and targeting can help avoid missing some opportunities for productivity gains.

Food system interventions that take gender seriously and make the effort to transform and change existing gender norms and barriers may be more successful (Quisumbing et al., 2020).

Indigenous people are also often marginalized and left behind in strategies to improve agricultural livelihoods – even though they manage, or have tenure rights over, a quarter of the world's land surface, including about 40 per cent of all terrestrial protected areas and ecologically intact landscapes (Garnett et al., 2018). In rural areas, indigenous peoples are more than twice as likely as their non-indigenous counterparts to be living in extreme poverty (ILO, 2020). They are likely to be left behind by food system transformation as well – unless their knowledge, experience and desires are explicitly included in developing strategies and investments.

Developing off-farm opportunities

Given the importance of diversifying incomes for improving livelihoods, inclusive agricultural productivity growth has to proceed hand in hand with off-farm employment creation. In Asia and in Europe, agricultural intensification has always been accompanied by strong development of the non-agricultural economy (Giller et al., 2021). It has also been supported by trade policies – including protecting domestic markets, input subsidies and social protection. So far, Africa is following a different pathway, and employment opportunities outside the agricultural economy are insufficient to accommodate the huge rural labour force seeking economic opportunities. In many cases, people continue farming for lack of alternatives: a default strategy that further aggravates the fragmentation of land available for making a living from agriculture.

The emerging consumer markets for nutrient-dense foods afford opportunities for the production of more lucrative crops and animal protein sources on less land. Relevant areas include horticulture, pulses, chicken, fish and novel food such as insects (as outlined in CHAPTER 1). These trends all require the further development of midstream operations, which enhances opportunities to invest in agribusiness beyond the farm and create rural employment within the food system (Giller et al., 2021).

Even as farms become too small to provide a living wage from primary production, they remain critical for household income, as well as a key means of securing household access to nutritious foods. For smallholders' nutritional status to improve, a sharper focus is needed on producing diverse, nutritious foods that are – as far as possible – available year-round. This implies a production strategy different from that of maximizing commercial potential, with greater emphasis on diversified products whose labour requirements can be coordinated with non-farm employment needs.

Such integrated production systems differ greatly from the monoculture, high-input and grain-oriented food systems often promoted by government policies. Integrated systems are quite knowledge-intensive, based on circular resource use and, in many cases, on indigenous and local knowledge.

Better financing is essential to support needed transitions

Today's agricultural financing focuses mostly on the short term, excludes consideration of environmental and health values, and supports "perverse subsidies" that generate negative social and environmental outcomes. It fails to account for the increased risks associated with climate change, and is generally inaccessible to poor people and smallholders (Blended Finance, 2019; Lipper et al., 2021).

Financing is key to enabling change and creating incentives for change. This is a question not merely of increasing financing, but also of improving the enabling characteristics of financing to support transformation. Redirecting capital into circular, environmentally sustainable models of food production should generate higher-quality, lower-risk economic growth by opening new business opportunities. The Business and Sustainable Development Commission estimated the value of investments in more knowledge-intensive, resource-efficient and nature-based systems at up to US$2.3 trillion/year (Blended Finance, 2019).

To make agricultural financing work for food system transformation, action can be taken on four fronts:

- **Much greater coordination is needed in public sector financing.** In 2018, bilateral Development Assistance Committee donors reported 13,649 aid activities for agriculture, with average funding of US$0.5 million per activity, while multilaterals accounted for 2,275 aid activities, with average funding of US$1.2 million. At the country level, an abundance of small uncoordinated projects causes high transaction costs for recipient countries. The international financial institutions and the United Nations system at large often individually pursue country assistance strategies that are parallel exercises that struggle to converge on a common framework (Bharali, 2020).
- **More innovation is needed in the use of blended finance and private sector involvement.** Blended finance involves the use of different financing sources and instruments to finance investments that have both commercial and social returns. One of the most promising for agricultural transformation is blending with climate finance. For example, an investment may involve promotion of sustainable, diversified food production systems with climate-resilient crop varieties, and "climate-proof" infrastructure along a value chain. This may result in reduced losses, more consistent market access, improved local and national food security, and increased incomes for stakeholders along the value chain. In such a context, a combination of grants, concessional loans and equity resources may be justifiable to provide adequate incentives to achieve a desired result. The climate finance flows to small-scale agriculture in developing countries were estimated to average US$10 billion annually in 2017/2018. This was a very small share (1.7 per cent) of total climate finance, but it still represents a significant potential source for blended finance options in the future (Lipper et al., 2021).

- **Partnerships between public sector financing organizations and civil society organizations need to be expanded and deepened.** This is the case especially at the grass-roots level – and the role of these partnerships throughout the full project cycle (including monitoring and evaluation) needs to be expanded for sustainable impact. But in-depth consultation with groups on the ground at potential project sites takes time, it takes extra funds and capacity, and it takes the slow building of relationships and trust.
- **Instruments are needed that allow for the integration of environmental values into agricultural systems.** These could range from supply chain innovations that create sustainability performance incentives through labelling, to payment for ecosystem service programmes linked to agricultural investments, to sustainability-linked debt – including loans and bonds with environmental conditions attached – and to nature-linked insurance, based on adaptation and improved resilience driven by better environmental management (Blended Finance, 2019).

Policy priorities for nutrient-dense, knowledge-intensive, circular and equitable agricultural systems

Transforming the food system creates an opportunity to rethink small-scale farming within a wider vision, oriented towards improved livelihoods, better nutrition and environmental sustainability (Woodhill et al., 2020). To include rural smallholders in this new vision, such incentives must target livelihood opportunities to specific rural smallholder groups – both on and off the farm – beginning with women and youth.

Policymakers and other food system stakeholders should:

- **Create opportunities for smallholder farmers to diversify, both for income and for improved on-farm food supplies.** Smallholders should be offered extension support for a wider range of crops – along with market access, in cases where diversification is beneficial for income growth. Approaches should vary with a food system's type and stage of development: interventions for a traditional food system need to differ from those for an emerging food system. Increasing the access that small-scale producers have to productive assets, including knowledge and market linkages, cuts across all food system types. In creating opportunities to diversify, attention to women and youth is important. This implies the promotion of more equal access to productive assets between generations and between men and women.

- **Enhance a transformation towards sustainable production based on principles of circularity to move away from maximizing agricultural output to optimizing natural resource use.** The current set of policies and institutions governing agricultural production systems generally do not enable or incentivize sustainable production, and instead encourage practices that generate environmental damage and waste. A fundamental reframing of the policy and institutional system will involve changes in institutions/policies to incentivize conservation and sustainable use of ecosystem services in agricultural production systems – including regulations and taxes to reduce degradation/depletion and payments for ecosystem services. This transformation will require a significant transition period because of the time required to build and restore ecosystem services and for farmers to adopt new knowledge-intensive techniques. Planning and budgeting for a transition stage is essential to obtaining long-term success. There are good opportunities to combine agricultural development and climate financing to support transitions and multiple objectives (Lipper et al., 2021). This is an important lever of change for moving to sustainable and resilient production systems.

- **Inform this shift in production with a research and development (R&D) agenda that focuses on providing evidence and advice – and support a major expansion of public and private agricultural extension services to accelerate the use of digital technologies by smallholders.** Because sustainable resource management best practices are highly localized and knowledge-intensive, massively increased investment in local adaptive farm-level research and extension systems will be required to catalyse sustainable intensification in Africa (Jayne et al., 2019). With public expenditure on R&D lagging in many low- and middle-income countries, this will require higher national budgets for R&D. Different stakeholders will be implementing locally specific processes based on various sources of knowledge, including farmer-led and scientific knowledge and innovation. Non-research partners, extension services, NGOs, and producer associations and organizations – as well as large agricultural companies upstream and downstream – will have to be involved (Caron, 2014). This challenges the divide between public and private research and farmer-led indigenous knowledge and innovation. It will also be necessary to synchronize the promotion of more pluriform and digital outreach through extension services and midstream service providers. Efforts to reach the enormous and diverse community of smallholders must be intensified, and all available instruments deployed. Scaling up current outreach will require the massive application of digital technologies, because the human resources in public and private extension services will not be adequate to reach the masses of smallholders. And, drawing lessons from recent experiences with service delivery dominated by men, attention must be given to including women and youth.

Simulation 3 in annex 1 illustrates how halving yield gaps in cereals and fruits and vegetables, against a business-as-usual baseline, has an impact on inclusiveness, nutrition and the economy.

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