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Knowledge networks to support youth engagement in sustainable food systems

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Young people are on the front lines of transforming agriculture and food systems, coping with the social and economic impacts of COVID-19 as well as environmental and climate change effects which are likely to accelerate and intensify during their lifetimes. At the same time, young people across global contexts are increasingly emerging as visible agents of change in food systems, especially through networks that create, transform, and distribute food systems knowledge. This policy and practice review examines the role of youth as actors through food systems knowledge networks. Increasing youth participation in creating sustainable food systems for the future requires policies and practices that support food systems-related knowledge in two ways: (1) democratizing formal education systems; and (2) strengthening horizontal networks of grassroots research and innovation, including through traditional, ecological, local and community knowledge (TELCK). Food systems policies should be developed through dialogue with diverse knowledge systems, experiences, place-based needs, and aspirations of young people to maximize their participation in food systems policy development and evaluation.

KEYWORDS

sustainable food systems education, traditional ecological knowledge, cultural knowledge, knowledge networks, youth engagement, food systems policy

Introduction

Globally, youth have the potential to play a more active role in sustainable food systems than they currently do. Yet, today's youth live in a world facing a confluence of crisis, including climate and environmental change, and growing global inequalities in food security, nutrition, employment, and human wellbeing. These existing trends have been highlighted and exacerbated by the COVID-19 pandemic, adding urgency to the need for a radical transformation of global and local food systems. To control

and mitigate the impacts of the current crises unfolding across food systems, global institutions and policy frameworks urge actions that advance simultaneously, at global, national, and local levels, context-specific solutions that place young people at the forefront (HLPE, 2020a,b; IPES-Food, 2020). We build on the recent efforts by the High-Level Panel of Experts on Food Security and Nutrition (HLPE) to examine the role of youth as actors in diverse food systems knowledge networks and to identify pathways toward a food system in which all young people can engage with meaning and dignity (HLPE, 2021). We review global interdisciplinary food systems literature and case studies particularly in (1) formal sustainable food systems education (SFSE) programs, and (2) place-based and grassroots horizontal learning drawn from diverse regions of the world. We argue that to prepare and enable youth to exercise agency in the future of food systems requires investment and support for inter- and intragenerational learning across diverse knowledge systems.

Across globally diverse contexts, it is urgent to make agri-food systems engagement both more appealing and more accessible to young people to secure the future of global food security and nutrition. According to a definition provided by the Food and Agriculture Organization of the United Nations (FAO):

a sustainable food system (SFS) is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (FAO, 2016, 1).

The definition postulates the aim of a food system that is economically viable; that provides broad-based benefits for all members of society; and that does not deplete the natural environment. However, food systems livelihoods continue to remain precarious for many of the world's food providers, and food production is the single largest cause of, and is profoundly impacted by, global environmental change (Willett et al., 2019; HLPE, 2020a). Youth are particularly vulnerable to these challenges. Prior to the COVID-19 pandemic, young people were growing up in a world not on track to achieve the targets of the Sustainable Development Goals (SDG) related to food security; currently, a third of the global population is affected by at least one form of malnutrition (Amiot, 2020; SOFI, 2021). The social and economic impacts of the COVID-19 pandemic have put lives, jobs, and livelihoods at risk and continues to affect both food supply and demand worldwide (HLPE, 2020b; ILO, 2021). This is especially concerning for youth. Youth unemployment is itself a crisis (HLPE, 2020a; ILO, 2020), which globally is almost three times higher than adults, and youth face significant inequities in access

to resources and support for sustainable livelihoods across regions, gender, ethnicity, class, and other markers of difference and diversity (ILO, 2020).

Nevertheless, youth, as agents of change, are mobilizing to lead and participate in local, sub-national, national, regional, and international initiatives to address pressing global concerns such as the climate and employment crises. Youth agency is increasingly visible in alterative food politics; for example, youth participants from across the globe engaged in consultation processes responding to the United Nations Food Systems Summit in September 2021. At the Summit, youth made it clear that the top priority for them is for everyone globally to have access to healthy and sustainable diets. Many young people are already acting upon this priority in their own lives and communities. For example, they are reviving traditional agricultural practices, engaging in activism for socio-ecological justice and advocating for the democratization of knowledge production to recognize Indigenous/local knowledge on an equal footing as western knowledge (Battiste, 2013; Pimbert, 2017). These efforts are complemented by the creation of grassroots health and sustainability-oriented organizations, and the preservation of Indigenous and local knowledge and biocultural heritage through grassroots and youth-led start-ups (UN, 2021).

In this paper, we focus on a topic of increasing relevance to supporting youth engagement in sustainable food systems: the democratization and extension of knowledge networks (Battiste, 2013; Pimbert, 2017). Local knowledge is defined as “knowledge held by a defined group of people” and “embraces traditional knowledge (passed down from one generation to the next) and Indigenous knowledge that is culturally bound and locally derived knowledge from contemporary learning based on local observation and experimentation” (Sinclair and Walker, 1999, and Sinclair and Joshi, 2004, cited in HLPE, 2019, p. 47). Native science or Indigenous traditional ecological knowledge (TEK) is a knowledge–practice–belief complex that connects living beings with each other and the environment. It is adaptive, constantly evolving and culturally transmitted through generations, although naturally, certain practices could become maladaptive over time (Berkes et al., 2000; McGregor, 2004). To emphasize the legitimacy of these diverse forms of knowledge, and to democratize other forms of local knowledge that are often marginalized by formal scientific disciplines, in this policy paper we adopt the term “traditional ecological and local community knowledge” (TELCK). It should be underlined here that traditional does not, in any way, mean static, as the concept of “traditional” embodies ways of creating new local knowledge as well as passing on existing knowledge. For example, empirical studies of TELCK related to sustainable food systems highlight the wealth of ancestral TELCK in agrobiodiversity as the foundation of our food systems (Pierotti and Wildcat, 2000; McGregor, 2004; Berkes,

2012; Huambachano, 2018; The Intergovernmental Science-Policy Platform on Biodiversity Ecosystem Services (IPBES), 2019). Thus, TELCK can play an essential role in the continuity of ancestral wisdom of agrobiodiversity, culinary practices, and leadership in preserving healthy food systems as youth engage in transforming food systems (McGregor, 2004; Whyte, 2017; Huambachano, 2019).

Understanding the relationality aspect of knowledge production and transfer is key, because each cultural group has context-specific knowledge. Speaking from an Indigenous standpoint, Opaskwayak Cree Scholar Sean Wilson argues that “relationships do not merely shape reality; they are a reality” (Wilson, 2008, p. 7) alluding to the importance of a relationality or kinship-centric approach centered on being interconnected to land and in relationship with nature and to each other (human and non-human) to live in a harmonious life. Also, a generation’s identity is shaped by its relationships with older and younger generations, and these relationships are central to the process of socialization and social reproduction. Cultural norms, as well as negotiations, struggles, and outright conflict between generations, define the mutual rights and obligations of each generation in relation to others—an “inter-generational contract”—as its members progress through their life course (Huijsmans, 2016).

The cultivation of food not only provides us with food security but also represents a suite of practices and stories carrying seeds of knowledge, sovereignty, and self-determination (Huambachano, 2020). For example, the practice of agroecology and Indigenous biocultural heritage demonstrate how knowledge of ancestral practices and traditions related to agricultural biodiversity are held and transferred from one generation to the other. Indigenous biocultural heritage conveys not only agrobiodiversity knowledge and techniques concerning the plant species and animals found within Indigenous peoples’ territories, but also a rich cultural component embodied in stories, rituals, songs, recipes, and ceremonies (UNESCO, 2008). Some Indigenous peoples and local communities in North America, Africa and South America have also embraced the notion of “biocultural heritage” to revitalize and preserve their crops, knowledge, practices and ancestral territories for future generations (UNESCO, 2008).

The relational aspect of intergenerational learning is important to analyze in terms of addressing mutual expectations of older generations and youth; access to and transfer of resources such as land and finance as well as wisdom, practices, and experiences that can be passed on across generations (Osano and Adam, 2014). In the context of food systems knowledge networks, young people are both “active” recipients of knowledge and part of a continuum of learning built from intimate relationships with nature, other humans and nonhuman (mountains, rivers and deities), and institutions, making up a reservoir of local knowledge or traditional ecological knowledge (TEK) (McGregor, 2004; Huambachano,

2019). For example, in farming, youth learn agricultural skills by participating in multi-generational families or farming networks. While actively working the land together with older members of the community, youth can obtain skills and knowledge, which have been adapted to the local environmental and socioeconomic conditions over centuries. This knowledge that elderly farmers have collected from their ancestors is an invaluable heritage of the peasantry and the base of sustainable agri-food systems. The multi-generational setting on the farms provides an opportunity to harmonize in-and outflow of generation-specific knowledge (Neumeier, 2012), allowing for innovative, still locally rooted agricultural solutions. In this context of intergenerational learning, youth are given the opportunity to test their novel ideas in a protected environment, guided by more experienced farmers (Korzenszky, 2019). While youth and children experience firsthand the complex dynamics of farming systems, they acquire diverse traditions, knowledge, beliefs, and practices (both practical and technical skills) in the field. This intimate learning experience allows them to value and better understand their surroundings and environments as they move forward in roles as producers, recipients, or keepers of knowledge (Setalaphruk and Price, 2007).

Innovation is often understood simply as referring to new technologies. Instead, we define innovation as developing assemblages of old and new practices, recognizing technological and social innovations in diverse intergenerational knowledge systems, including Indigenous/local knowledge systems. Complexity arises when innovation is put into contemporary socio-economic contexts to improve agriculture in the absence of an understanding of how Indigenous peoples and local communities define it and their knowledge-based practices related to it. For example, Indigenous peoples’ innovation (technologies) of, for example, crop rotation and agricultural moon and solar calendars emerge from knowledge obtained from their intimately connected relationship with the land and the environment. They are heavily dependent on intergenerational learning, passed down mostly through oral history from one generation to the next, and are rooted in family and community labor (McGregor, 2004; Whyte, 2017; Huambachano, 2019; Nemogá, 2019). Innovation is thus not something that happens suddenly, but rather is a continual process; in this case, we focus on how youth apply agency to extend intergenerational knowledge networks and/or adopt new ways of doing things, such novel digital networks and platforms.

How should we judge innovations, to decide whether they play a worthwhile role in the transition to inclusive and sustainable food systems and to better opportunities for young men and women to engage productively with them? As Anderson argues, “if the rationale for an innovation is only increasing yields, productivity, profits or economic growth, it is likely to aggravate rather than ameliorate existing problems” (Anderson, 2020, p. 34). Although we usually refer to technological innovation, we need to also

recognize the importance of “social” innovations such as in institutions, ownership regimes, networks, organizations, knowledge production, which encourage people to act in ways that promote conviviality and collaborative problem solving (Haxeltine et al., 2018; Anderson, 2020, p. 31) as well as more equitable access to resources. In this regard, understanding of innovation should draw from the vast array of knowledge and practices from all stakeholders involved in food systems to foster social innovation, that is — progress for the benefit of humanity and not for profit-making solely (HLPE, 2012, 2019). In summary, providing equitable foundations for intergenerational knowledge transmission, dynamic learning, and sustainable innovation, or what Michel Pimbert calls “expanding knowledge democracy” (Pimbert, 2017), is critical for supporting youth employment and engagement in the future of food systems.

What follows is a review of opportunities and challenges for policy and guidelines to support investment in (1) inclusive food systems knowledge and training in formal educational systems, including technical and vocational training, new curriculum developments in sustainable food systems education and (2) supportive horizontal knowledge sharing based on regional and intergenerational grassroots and intergenerational knowledge networks. The policy and practice review is based on a systematic review of policy and practice literature related to the role of youth in food systems and intergenerational knowledge networks (cf. HLPE, 2021). We include illustrative examples from regional case studies with the aim to represent regional and global diversity of food systems practices and policies.

Formal food systems education

Formal modes of education can be defined as institutionalized, chronologically graded and hierarchically structured (La Belle, 1982, cited in McCarter and Gavin, 2011). Formal education is widely associated with many benefits, including the potential to unlock human capabilities, improve individual freedoms as well as enhance human health, social capital and institutions that promote inclusion (World Bank, 2018). For countries, it is associated with the potential to enhance human capital, productivity, incomes, employability, and economic growth (World Bank, 2018).

Inequalities in access to formal education are determined by location, gender and poverty, among other factors. In low-income countries, only about a quarter of the poorest children are able to complete primary school, in comparison to three-quarters in the richest countries of the world (World Bank, 2018). In 2018, nearly 31% of children, adolescents and youth of primary, lower secondary and upper secondary age from Sub-Saharan Africa were considered to be out of school, which in Southern Asia was 21%. In comparison, only 3% of the same demographic was considered out of school in Europe and North America (UNESCO (United Nations Educational,

Scientific, and Cultural Organization) and UIS (UNESCO Institute for Statistics), 2019). Similar disparities are visible in higher education enrollment. In 2018, the gross enrollment ratio in higher education (defined as the percentage of the population who are in the 5-year age group span immediately following secondary school graduation, typically ages 19–23), was nearly 9% in Sub-Saharan Africa and 77% in Europe and North America (UNESCO (United Nations Educational, Scientific, and Cultural Organization) and IESALC (International Institute for Higher Education in Latin America and the Caribbean), 2020).

Schooling enrolment and schooling to work transitions are also shaped by other intersectionalities; for example, gender plays a role in shaping educational enrolment and occupational aspirations, with girls often doing better in school but stopping school earlier, than boys (Elias et al., 2018). The declining trend in youth labor force participation worldwide reflects the longer time that young people are spending in school but also the growing number who are not in education, employment or training, among whom are disproportionate numbers of young women, increasingly discouraged by the grim job prospects (ILO, 2020). This should not be thought to imply that all or most youth with non-education, employment, or training status are “idle,” as many are engaged in forms of work or other activities, such as unpaid work within the household, that may not be captured in conventional employment statistics.

The assumption that investment in formal education will provide lifelong economic benefits in the form of secure employment and higher incomes is thrown increasingly into question in the light of current trends in education and youth employment, which show both increasing educational attainment and increasing precarity of youth employment. While many young people aspire to acquire an education and move into formal sector blue-collar and white-collar jobs, these aspirations are not matched by labor market realities. Young people may find difficulty in obtaining formal sector jobs without the relevant diplomas, but in today’s overcrowded labor markets, having these diplomas does not in any way guarantee access to such jobs (Bessant et al., 2017). Thus, it is important not to interpret young people’s difficulties in finding employment as being due to individual inabilities or endowment deficits with regard to education, as opposed to political economic shifts or neglect (Naafs and Skelton, 2018). For example, rates of “return to education,” the standard metric employed in the context of human capital theory – the proportional increase in an individual’s labor market earnings from each additional year of schooling completed – were decreasing over the past decade prior to COVID-19, and this has particularly affected young or early-career workers worldwide (ILO, 2020, p. 119).

Rather than focusing primarily on preparation for jobs in formal sectors, formal education systems can provide an opportunity to develop critical life skills that enable students to pursue a range of livelihood options, including within and beyond food systems. Along these lines, the UNESCO Delors

Commission Report calls for education to be structured around the four pillars of “learning to know, learning to do, learning to live together, and learning to be” (Delors, 1996, cited in McCarter and Gavin, 2011). This approach considers education important not – or not only – as job preparation but as a human right of children and young people for the role it can play in preparedness for active citizenship and potentially as an important stimulus to enhancing their active role in promoting sustainable food systems.

Our review of formal food systems education programs (HLPE, 2021) found that these programs often follow linear cause and effect models that focus on a limited range of objectives; for instance, agricultural yield, micronutrient intake or return on investment (Jordan et al., 2014). However, in preparing young people for food-related engagement and careers, educators must address complex issues of ecological sustainability, food safety and security, food sovereignty, food consumption and health, and emerging changes to food systems such as digitalization, in addition to entrepreneurship, profitability and livelihoods. This requires training programs to address new capacities, dispositions and skills needed to take integrated action to address complex and interconnected problems in food systems (Hamm, 2009), with learning outcomes including systems thinking, critical reflection, practical skills, and collaboration and communication skills (Ebel et al., 2020).

In response, within the last decade, formal food systems education programs in many countries, including in Europe, Latin America and North America, have begun to take a “food systems approach”, starting with primary and secondary school and leading into the university sector (Valley et al., 2018). New sustainable food systems education programs that help students understand processes of the whole food system and support the development of agronomists, nutritionists, crop breeders, policy advocates and food entrepreneurs who are capable of “systems thinking” (Jacobsen et al., 2012; Jordan et al., 2014; Valley et al., 2018). Critical food systems education programs also engage with broader themes of food justice, food sovereignty, and agroecology (Gliessman, 2014; Meek and Tarlau, 2016) as well as other forms of resilient, climate-smart agriculture, data-driven and digital technology and other forms of sustainable agriculture (Rose and Chilvers, 2018). One can observe the growing prominence of training programs in food technology, food processing and cellular agriculture in university curricula, for instance, as well as nutrition, dietetics and public health-related programs that take an integrated systems approach through a focus on functional nutrition. The recently released United Nations Environment Programme (UNEP) publication “GEO 6 for Youth” suggests there will be an increased demand for people skilled in conservation agriculture, climate-smart agriculture, organic farming, precision agriculture and urban farming, in the context of a green economy (UNEP, 2021).

Increasingly, formal education programs involve experiential learning formats, as part of training on a spectrum of sustainable agricultural practices, from conventional to ecological, to organic, to agroecological. Both formal and experiential technical training in agroecology is offered through the Latin American Institutes of Agroecology (IALAs) and in over 50 different locations globally in a network affiliated with La Via Campesina (LVC, 2021). These programs are designed to aid young people who aim for careers not just in farming but also in agricultural extension, environmental monitoring, and other food systems professions, to support transitions in agricultural systems that are more knowledge-intensive, rather than capital-intensive (HLPE, 2019), as a way of reducing barriers to youth participation in food production. In France, the action plan “Teaching to Produce Differently” (Ministère, d. e. l’Agriculture et de l’Alimentation, 2019; Laventure du Vivant, 2020) encourages agricultural education institutions to promote agroecological transitions by undergoing curricula and pedagogical reform in agricultural education institutions, as well as tools for demonstration and experimentation. The plan also includes actions to train the trainers needed for a transition toward more sustainable production systems.

As it has been shown in the growing field of food literacy, schools are important agents of socialization – often competing with the different messages coming from advertising media – in shaping children’s food habits and other forms of engagement with food systems, including aspirations related to their future employment (Rojas et al., 2011). Food literacy and food citizenship programs in primary and secondary schools aim to reconnect students with the source of their food, to use food to teach other curricular goals (e.g. school gardens are used as experiential methods to teach biology, mathematics, culture, botany, ecology, nutrition and climate change), and to “support school and community connectedness” through sharing knowledge between children, parents, teachers and community members (Powell and Wittman, 2018).

One example of such a program is the School Plus Home Gardens Project (S + HGP) of the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), in collaboration with the University of the Philippines Los Baños (UPLB) and the Laguna district of the Philippines’ Department of Education. In this project, school gardens support school-based feeding programs and are used for demonstration and training gardens to scale the gardening–feeding model to student homes. The program aims to increase both students’ and their parents’ understanding of nutrition in household diets while reducing food expenses (Calub et al., 2019). The project’s conceptual framework puts into context how the school and home gardens can contribute to the goals of food security and nutrition and, similarly, to the economies of wellbeing. In Kyrgyzstan, a project jointly implemented by FAO, the World Association of Girl Guides and Girl Scouts (WAGGGS) and the Youth and United Nations Global

Alliance (YUNGA) works to increase children's awareness of and participation in biodiversity conservation. Teachers across Kyrgyzstan use playful and creative individual and group methods, such as singing, drawing and writing poems, to achieve these objectives (FAO, 2011). As a result, Kyrgyz school children, like in the AKBeketov secondary school in the Kemin rayon of Chui province, involved members of their community in establishing a school garden, plant trees and collect waste paper (FAO, 2019).

However, formal food systems education programs, particularly at the tertiary level, often are characterized by disciplinary silos evident in traditional agriculture, food science, plant science, animal biology, economics and nutrition programs (Jordan et al., 2014). They are also not always inclusive of all social groups. Garibay and Vincent (2018) show that in the United States of America students of color remain underrepresented in environmental and sustainability degree programs and in environmental careers. Despite the expansion of these programs in US colleges and universities, many are yet to fully integrate environmental justice perspectives, which focus on the disproportionate distribution of environmental harms experienced by low-income communities and communities of color (Garibay et al., 2016). Garibay and Vincent (2018) suggest that greater inclusion of environmental justice and community engagement in environmental and sustainability curricula, as well as greater student compositional diversity, are likely to lead to a greater number of students of color enrolling in these programs (Garibay et al., 2016; Garibay and Vincent, 2018).

Recent data shows that women's participation in formal agricultural studies at the tertiary level is also significantly lower than that of men (Mukembo et al., 2017). This holds true even in regions where women participate in tertiary education in nearly equal numbers as men. In addition, there are considerably fewer women than men enrolled in science and engineering, which also has a bearing on agricultural planning and policy in all regions (GO-SPIN, 2019). This gap has been connected to a diversity of factors, including the lack of female role models, gender stereotyping, and gender bias (Enns and Martin, 2015). For example, in sub-Saharan Africa, the shortage of female professional agriculturists (Kanté et al., 2013; Beintema and Marcantonio, 2019) has been attributed to low enrollment and high attrition rates (Beintema, 2006), as well as social norms.

Efforts to encourage girls to enroll in science-based subjects such as agriculture at the elementary and high school levels may facilitate greater diversity in science-based programs of study at college and university, including courses related to food production (World Bank, 2009). Muñoz Sastre and Mullet (1992) posited adolescents begin to become aware of their career aspirations and interests as early as 14 years of age, and this is a particularly important period to explore a wide range of skills development (Super, 1990). As such, some studies suggest that systemic changes in agricultural policy, governance and education systems will be required

to support the effective participation of women and girls in agriculture and food systems globally (Glazebrook et al., 2020). Gender training for instructors themselves would facilitate early career awareness about the diverse opportunities available in agriculture, which may in turn also support increase female participation (Mukembo et al., 2017). Female students' interactions with same-sex role models and peers can also influence their career aspirations (Kracke, 2002; World Bank, 2009). Mukembo and others note that field trips to agricultural research organizations, trade fairs and universities as part of students' training programs can provide opportunities to interact and network with professionals and peers who share similar interests (Mukembo et al., 2014; Mukembo and Edwards, 2016). The development of horizontal social networks among youth and adults with similar career aspirations is another way to create more inclusive pathways for careers in agriculture and food systems (Kruijssen, 2009).

Technical and vocational education and training

Technical and vocational education and training (TVET) has, since WWII, provided an applied and experiential approach to education and job training in both developed and developing countries. TVET is defined as "those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life" (UNESCO, 2001, p. 1). With consistent emphasis on education for occupational skills, TVET programs in developed countries have been largely situated as either an addendum to secondary education or within the postsecondary education context, as an alternative to university training. In developing countries, the siting of TVET has historically been less clearly defined, with programs and institutions ranging from alternatives to general primary and secondary education (including nonformal educational settings like field-based training), to job-specific skills training, to more traditional vocational colleges and certification programs (King, 2011). According to the (UNESCO-UNEVOC, 2022) International Center, TVET has the potential to promote the productive participation of women in the labor market, equipping them with the necessary skills to undertake the jobs of the future. However, this potential remains challenged in certain occupational sectors, particularly those requiring training in science, technology, engineering, and mathematics (STEM).

The perception that TVET programs remain overly theoretical and "academic" (Chea and Huijsmans, 2018) has led some employers to develop the required skills "in house" or actively create private or commercial TVET institutions, according to Richard Hawkins, a senior adviser for the

BOX 1 Access to resources and knowledge for livestock shepherding

In Spain, as in several other European countries, there has been an increase in both the supply and demand for training for young (prospective) shepherds. Catalonia's Shepherding School and similar initiatives are shaping what is considered "the first generational renewal seen in the world of shepherding in the last 40 years." For some, the return to agriculture is seen as an alternative to unemployment. But for most, it is about living their lives in accordance with their principles and their interest in producing healthier and locally grown foods. The students (around 20 in each course) receive 2 months of theoretical training and 4 months of hands-on training on livestock farms in Catalonia and the French Pyrenees. Students come from Catalonia and other parts of Spain, as well as other countries. Many are young, in their late 20s and early 30s. In addition to training, the school offers the students access to a land bank, a job pool, advice on new agricultural products and artisanal-product marketing. The proportion of female students has recently reached 41%, thus breaking the mold in what is otherwise a highly masculinized sector. With close to 80% of students turning to livestock farming after completing the course, the school plays a vital role in reviving the rural sector. Former students may set up their own farms or projects from scratch or work as salaried mountain shepherds during the summer transhumance period (Alvado, 2018).

International Center for Development-Oriented Research in Agriculture at a plenary session on skilling African youth (Ligami, 2018). Other experiential learning programs have been developed to increase training and participation in food sector activities facing challenges to generational renewal (see Box 1).

The state can also be a key player in supporting applied and experiential learning. In Andhra Pradesh in India, the state-led community-based Natural Farming Programme develops institutional partnerships, hiring young agricultural graduates and placing them for a period of 3 years in communities to work jointly with farmers on developing context-sensitive methodologies and practices which are at the same time economically profitable. Such hiring subsidies are central to collaboration and partnership across formal and informal knowledge systems (HLPE, 2019, p. 42). Morocco's national strategy for youth (2015–2030), which includes a strong education and training axis, is another example of state-led interventions. In the agricultural sector, training and knowledge acquisition are part of the "Green Morocco Plan" which aims to develop technical, vocational and managerial skills for the integration of young people into working life. Technical and vocational training in the food sciences and food manufacturing sector is also increasingly offered by the private sector, which faces an aging workforce and the ongoing perception of food industrialization as providing poor quality employment. Some large companies have placed food ambassadors on university campuses in Europe and North America to "build a more positive image," while others have created technical apprenticeship schemes leading to postsecondary employment in food manufacturing companies (West, 2016). While young people as a demographic are widely considered to be active participants in and consumers of the internet and online media, these opportunities are not equally accessible to all young people, and therefore a digital divide can further exacerbate inequalities (Rotz et al., 2019). Addressing the practical digital divide given the emerging trend of digitization is also crucial, where the inclusion of technical tools for digital learning in curricula from early years of schooling to higher education is key to narrowing the gap. The necessity for more inclusive and equitable youth access to these digital technologies could facilitate not only greater participation in education but also could strengthen

the role youth play in democratically shaping formal education systems from the ground up.

Horizontal networks for intergenerational learning

Knowledge and innovation in food systems happens through both formal and horizontal knowledge networks in a dynamic process through which farmers, pastoralists, fishers, food workers, retailers, and other stakeholders involved in food systems improve the way food is grown, processed, distributed, and consumed. This may include planting new crop varieties, combining traditional methods with modern scientific knowledge, applying new integrated production and post-harvest practices, or engaging with markets in new, more efficient, and sustainable ways. This has created an opportunity for increased participation of young people in food systems networks especially given the increase in innovative approaches and tools. Furthermore, if these learning networks, both formal and horizontal, increase youth engagement in food systems, this provides a potential positive feedback loop whereby the increased engagement can further strengthen the knowledge networks, although further research on this possible feedback loop is needed. However, since formal education is increasingly perceived as an important accomplishment for young people, as they spend more time and focus on schooling, their daily interactions with the environment and in helping with household livelihoods decline. This transition has the potential to weaken traditional livelihood and ecological skills and knowledge these experiences help transfer (Punch and Sugden, 2013). Outmigration is another phenomenon widely discussed in relation to weakening intergenerational cycles of TELCK transmission (Robson, 2009; Punch and Sugden, 2013; Iniesta-Arandia et al., 2015). At the same time, not all young people have access to formal education, despite its designation as a human right. Thus, informal knowledge networks remain a vital tool for youth engaging in agriculture and food systems, in particular for the maintenance and transmission of place-based agroecological production methods for climate resilience (e.g., Heckelman et al., 2018).

BOX 2 Participatory education and agroecology in Malawi

Using participatory education and agroecology in Malawi, thousands of rural families have seen dramatic improvements in maternal and child nutrition, food security, crop diversity, land management practices and gender equality. Central to the success of this long-term program has been iterative, participatory and transdisciplinary research methods that have used multiple measures to assess and improve farming and social change with participating farmers (Bezner Kerr and Chirwa, 2004; Nyantakyi-Frimpong, 2017). Agroecology education has been integrated with nutrition and social equity issues through interactive, dialogue-based methods, such as recipe days, discussion groups and theater (Satzinger et al., 2009; Bezner Kerr et al., 2016, 2018), (quoted from HLPE, 2019, p. 43). As a pedagogical tool that aimed to draw out indigenous farmer knowledge, generate discussion and foster transformational change toward food sovereignty, there was some evidence of success. Around half of the farmers interviewed felt that the drama, story-telling and small group discussions gave them an opportunity to share their own experiences and innovations around curriculum topics, and for others to do the same, increasing overall knowledge sharing. Many of the participants reported sharing information from the training with other farmers through the use of drama, with some having traveled to up to 12 villages, and others reported being invited to come to neighboring villages that had learned about the teaching and dramas (Bezner Kerr et al., 2018).

Grassroots training programs

In addition to other forms of intergenerational knowledge transfer, some training programs offer alternative modes of knowledge exchange to those delivered through formal education systems. These include grassroots training programs such as farmer-to-farmer field schools across a number of contexts. An example of this is “Education of the Countryside” curriculum developed by the Brazilian Landless Rural Workers Movement (MST), which offers place-based education as a counterpoint to the neoliberal model that generates inequality and social exclusion. This model of education aims to train a critical citizenry capable of understanding the social, economic, and political contexts of their home community and its relation to the state, contributing to family subsistence, community life and regional sustainability (cited in Meek and Tarlau, 2016). Another example of the important potential of agroecology training, education and information is the successful agroecology program in Malawi (Box 2).

Other social movements globally have been pursuing a wide range of critical food systems education projects, programs and initiatives – in both urban and rural contexts – to raise awareness of the challenges to sustainability in current food systems and to advocate for agroecology, food sovereignty and food equity (Gliessman, 2014; Meek et al., 2019). Examples of such models that encompass agroecology as a science, a practice and as a social movement include farmer-to-farmer training initiatives (Holt-Giménez, 2006; Rosset and Martínez-Torres, 2012; Martínez-Torres and Rosset, 2014; Bezner Kerr et al., 2018), training on local solidarity partnerships between producer and consumer networks (Urgenci, 2020), the Slow Food movement, internships, volunteer programs, intergenerational mentorships (and critical views thereof) (Ekers et al., 2016; Weiler et al., 2016; Levkoe and Offeh-Gyimah, 2020), and learning journeys that connect producers and consumers (Nyasimi et al., 2017; Sustainable Food Lab, 2019). Another application of the farmer-to-farmer learning approach is the Climate Change Agriculture and Food Security (CCFA) Consultative Group on International Agricultural Research (CGIAR) “Farms of the Future”, which aims to provide experiential learning to face climate change (see Box 3).

Apprenticeship and mentorship

Apprenticeships can act as a hybrid training tool that allows young people to learn directly from the experience of others by working in a company or a farm while simultaneously enrolled in academic training. In Europe, the Erasmus+ program promotes international apprenticeship training to foster an exchange of pedagogical practices, the development of social and learning networks and other innovations (European Commission, n.d). Youth participate in such movements not only as recipients of knowledge transfer but also as generators and facilitators of horizontal transfers of knowledge between traditions and communities and with other groups of young people. The rapid development of ICT online/virtual platforms has created new opportunities for young people to learn and pass on knowledge, especially evident in the face of COVID-19. The ability to access asynchronous learning platforms can also help bridge gender gaps in access to knowledge (OECD, 2018). However, barriers such as inadequate infrastructure needed for access to online systems remain a challenge. Many global locations still lack sufficient levels of electricity and Internet connectivity infrastructure. Improving this digital divide requires financial and political commitments (Mehrabani et al., 2020).

Intentional mentoring programs can also serve as knowledge exchange spaces as explored by face-to-face, online, in-conference and peer-to-peer models. A review of the Young Professionals for Agricultural Development (YPARD) mentoring program found that some young people were able to “unlock life skills that they never thought they had” as they explored personal development trajectories with their mentors and peers (YPARD, 2017). The Purpose Road Map is an example of a tool which mentees develop with their mentors’ guidance; it plots a trajectory from where they are to where they want to be, while identifying what they need to develop to reach their goals, all in their respective fields of agriculture and food systems such as agribusiness, research, extension. As a result, positive outcomes in terms of employment were reported by mentees due to their engagement through the mentoring program. It was noted, however, that such programs could deliver more impact if barriers in policies or in accessing finance, land

BOX 3 Farms of the future: a CCAFS-CGIAR approach

The CCAFS “Farms of the Future” project uses the climate analog tool to connect farmers to their possible climate futures via farm visits. Through this novel anthropological approach of farmer-to-farmer exchanges between spatial analogs, CCAFS aims to establish, test and validate a methodology enabling identification of social, cultural and gender-specific barriers to improving adaptive capacity. The visits provide an opportunity for farmers to learn about the practices and technologies that other farmers use in areas that are similar to the climates they will soon face. Farmers can then go home and start to implement them on their site and improve their adaptability. This approach has been implemented in West Africa: Burkina Faso, Ghana, Mali, Niger and Senegal. In East Africa the visits were carried out in Kenya and Tanzania. The exchanges showed that while the “farms of the future” approach enables farmers to learn adaptation practices and technologies from people on similar sites, the hosting farmers can also learn lessons from their visitors. Notably, there are limits to what can be achieved by a study tour. To achieve adaptation may require structural and broader policy and institutional changes beyond the local. However, as a learning process a study tour can enable farmers to learn to begin to read the world differently. It can help them to think critically about their future and encourage them to act (Gonsalves, 2013).

BOX 4 Agriculture and arts

A Filipino YPARD mentee wrote a musical play that explored how theater can communicate the need for youth in agriculture. In 2017, YPARD Philippines partnered with UP Broadway Company and received funding from the Office for Initiatives in the Culture and the Arts of the University of the Philippines Los Baños (UPLB) to produce “Agra: A New Musical” (Cano, 2017). Filipino youth from different fields of study (agriculture, engineering, biology, environmental science, communication arts, theater, development communication) came together to produce the musical. Around 2,000 high school students watched the play. As a result of the mentoring program in 2018, the mentee has pursued graduate studies in theater arts, a distinct turn from her background of genetics, to further develop the skills that would allow her to better communicate through the arts her advocacy for youth in agriculture.

and education were removed. Several recommendations on how to better implement mentoring programs for youth in agriculture were provided (YPARD, 2017, p. 45–46). These include ensuring clarity in mentoring-pair goals; creating a conducive environment where mentees can freely ask for help; bridging mentees to funding and practical opportunities, for example, partnerships, internships, and scholarships; long-term monitoring and evaluation to assess the real impact of mentoring which is not observed in the short term. The assessment of the mentoring programs led to a subsequent pilot of a YPARD country chapter-led mentoring program in the Philippines (del Valle, 2018) (Box 4).

Some of the recommendations addressed were the need to (1) source mentors locally for the mentees that had a better chance of meeting them regularly, and (2) provide some travel and communications stipends to facilitate face-to-face mentoring sessions. Mentors were selected based on the needs and aspirations of the selected mentees. Mentoring pairs represented various fields in agriculture (agricultural extension, agribusiness, entomology, research in general) and, most notably, included a pair that focused on developing the agriculture-arts interface. The lessons learned from the different iterations of mentoring helped YPARD shape the YPARD Mentoring Toolkit (Kovacevic, 2018) along with its organizational partners – the International Forestry Students’ Association (IFSA) and African Women in Agricultural Research and Development (AWARD). Funded by the Global Forum on Agricultural Research and Innovation (GFAR) and the European Union, the toolkit helps organizations develop mentoring programs from planning and designing them to implementing and sustaining them.

Young people engage in learning about food systems through their roles in inter-generational and other forms of knowledge transfer, as generators of knowledge themselves and as knowledge brokers and intermediaries within social networks and institutions. Food systems in which all young people can engage with meaning and dignity require an inclusive and participatory knowledge paradigm, one that respects and legitimates diverse forms of knowledge systems and recognizes young people as important actors in these systems. Young people’s roles in food knowledge systems, including place-based and Indigenous knowledge networks, should be understood in the context of increasing access to both formal and grassroots horizontal and experiential education and skills and knowledge sharing networks, including through novel digital networks and platforms. Formal education systems should equip young people with the systems thinking, critical reflection, and theoretical and practical knowledge to engage with a range of livelihood options in food systems and more broadly as actors in driving the transformation of sustainable food systems.

Policy recommendations

The following policy recommendations provide avenues for both state and non-state actors and institutions to strengthen knowledge generation and transmission pathways so that youth can be better prepared to shape future food systems in a context of complexity and uncertainty.

- Revitalize inter- and intra-generational knowledge networks for biocultural heritage in sustainable food systems. This requires an understanding that knowledge is context-based and unique to specific societies and geographic areas. Knowledge is vital in assessing the needs, for example, upskilling/training young people and aspirations such as revitalizing intergenerational agricultural learning of young people when developing policies concerning youth in agriculture and food systems. We can achieve this by engaging youth in research, promoted by formal, accredited research and academic institutions, related to sustainable food systems and resource conservation. Equally important is strengthening opportunities for youth to participate in community-based research partnerships through developing methodologies that integrate diverse ways of knowing. Thus, the development and implementation of policies that include the myriad of knowledge systems, innovation, and practices of sustainable food systems emerging from Indigenous and local communities will enable young people from these societies to be active actors in developing more resilient and holistic food systems. Therefore, national and sub-national government agencies and public institutions should construct an enabling policy environment with supportive legal and financial measures, such as appropriate financing for the operation of horizontal and intergenerational learning networks and programs by grassroots movements and formal institutions such as schools, gardens, and study tours. Working in collaboration and in partnership with the state, NGOs and other civil society organizations such as farmers' and Indigenous people's organizations play an essential role in shaping these enabling policy measures, ensuring the access of relevant actors from different generations to these programs. In addition, the private sector can provide complementary services for the operation of food systems training programs and networks, for example, by designing digital platforms enhancing more comprehensive connectivity and inclusivity.
- Promote the recognition and application of agroecological knowledge and practices in food systems by young people in both rural and urban settings. Using agroecological methods in food production systems involves continuous experimentation and adaptation, in which young people can take a more active approach to develop alternative strategies for sustainable agriculture. This requires that governments value and prioritize sustainable agricultural methods and practices when designing public policies shaping the future of their food systems, including establishing or providing extension services promoting agroecological practices for the next generation of food producers. In addition, as described above, states must again ensure that already existing agroecology schools run by farmers' movements can flourish.
- Strengthen food literacy educational programs, experiential learning (e.g., immersion agricultural, land-based, an incubator farm, and practicum programs), and grassroots initiatives to democratize education for young people. Research and academic institutions should support educational curriculum (co-)development and reform in primary and secondary schools, including agroecology, food literacy, food systems, and health. Reform vocational training curricula to develop community education business partnerships developed in collaboration with local community members, focusing on the topics of interest to youth, such as agroecological production, nutrition and dietetics, food value chains, marketing, innovation, ICT, and food systems education.
- Implement curriculum reform to develop close community-education-business partnerships based on collaborative assessments of local community needs through mobilizing resources for communities and youth. Educational reform by the state also requires strengthening community-based research partnerships through the development of methodologies that are more culturally sensitive and tuned into the ways of how knowledge is acquired, shared and disseminated within different contexts. In turn, the active engagement of well-organized communities and their pro-active dialogue with the state educational institutions are essential, so they can meaningfully shape those curricula co-constructed based on local needs and knowledge.
- Promote the recognition of knowledge acquired through informal, local and Indigenous exchange processes in labor markets to facilitate job entry for youth and to facilitate uptake of traditional ecological and local community knowledge (TELCK) in food systems. This could occur through expanded considerations within accreditation and regulatory bodies and formal training programs.

Conclusions

Food systems in which all young people can engage with meaning and dignity require an inclusive and participatory knowledge paradigm, one that respects and legitimates diverse forms of knowledge systems and recognizes young people as important actors in these systems. This would require recognizing the value of developing knowledge networks where context- and location-specific knowledge and diverse epistemologies, including Western science and TELCK, provide youth opportunities to transform food systems. Young people engage in learning about food systems through diverse forms of knowledge transfer, as generators of knowledge themselves and as knowledge brokers and intermediaries within social networks and institutions. Young people's roles as carriers

of knowledge and learning in food systems, including place-based and Indigenous knowledge networks, and their role in democratically shaping these networks, should be understood in the context of increasing access to both formal and grassroots horizontal knowledge sharing networks, including through novel digital networks and platforms. Governments and civil society must promote the intergenerational and intragenerational exchange of information, knowledge and practices through experiential learning, and encourage youth to practice agroecology and other sustainable innovations by connecting knowledge that is locally specific such as traditional and intergenerational with horizontal and formal training and education programs, as well as advisory and extension services, to improve the resilience of agriculture, farming systems and food systems to environmental and social crises.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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