Research Article

Accelerating Action towards Net Positive Agriculture and Food Systems

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Abstract: Sustainable food systems are essential to providing healthy and nutritious food while enhancing livelihoods and climate resilience for people and the planet. While there are many forms of agriculture that support food security, healthy diets, economic prosperity and the environment; unsustainable agricultural practices are also a key contributor to the triple planetary crisis of biodiversity loss, climate change, and pollution and waste. Responding to these challenges requires taking a systems-based approach that addresses these complexities in a holistic and sustainable manner. Building on the outcomes of the 2021 UN Food Systems Summit, which launched bold new actions for progress on all 17 SDGs through the development of national food systems pathways; in this paper we consider agricultural systems as an integral part of food systems and evaluate their contribution to sustainable development outcomes - specifically those that are biodiversity-friendly, climate-resilient, pollution-free and human-centered.

Introduction

Despite the long-lasting G20 experience in recognizing and providing the tools to tackle complex crises, the world continues to face a severe food security crisis. This has been exacerbated by the COVID-19 pandemic and the war in Ukraine, putting the world further off track in achieving the 2030 Agenda for Sustainable Development, including its goals of ending hunger, fighting against climate change and sustainably managing life on land and below water. Meanwhile, agriculture representing over 31 per cent of total anthropogenic GHG emissions (FAO, 2021) and over one-third per cent of the global land area (SCBD, 2020), accounts for 70 per cent of freshwater withdrawals (FAO, 2020), and drives 50 per cent of deforestation through conversion of forest into cropland (FAO, 2020). Ongoing global crises have increased the need for a more resilient and sustainable global food

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system, and the G20 plays a key role in achieving these objectives through a multilateral, systemic and inclusive approach. Since its inception, improving agriculture productivity and increasing access to technology and food have been key strategies to reduce global poverty and guarantee long-term food security (G20, 2009). Since then, G20 has widened its scope to recognize the role of, and take action on several global crises endangering and destabilizing the global economy including, food security and nutrition. As such, G20 has consistently reiterated its commitment and engagement to tackle *inter alia* climate change (first mentioned in UK, 2009), corruption (USA, 2009), ocean degradation (South Korea, 2010), threats to animal and human health (i.e. antimicrobial resistance and infectious diseases) (Turkey, 2015), food loss and waste (Turkey, 2015), migration (Turkey, 2015), environmental and land degradation (Saudi Arabia, 2020), childhood overweight and obesity (Argentina, 2018), biodiversity loss (Japan, 2019), pollution (i.e. land, fresh water, and marine) (Japan, 2019) and, water insecurity (Italy, 2021) through action. A food systems lens can help show how these disparate commitments are connected in a way that optimises outcomes for environment, livelihoods and health.

Unsustainable Agriculture: As Catalyst of Multiple Global Crises

As recently recognised by the UN Global Crisis Response Group, a complex set of factors, including disruptions in critical value chains, have increased food prices and decreased food availability (GCRG, 2022). The resilience of global food systems are under pressure, notably due to unsustainable agriculture production and its role in catalyzing and amplifying various other crises(Steffen *et al*., 2015; Lade et al., 202; Campbell *et al*., 2017). Despite unprecedented volumes of food being available for consumption globally, impacts on the environment, human health and farmer livelihoods are only getting worse. Food systems are facing climate instability and extreme weather events, stagnant yields, poor soils, polluted water, increased GHG emissions, massively reduced agricultural and wild biodiversity (important for pollination, pest control, soil fertility, and resilience), and widespread food and nutritional insecurity. The reality of our current food systems is that the most vulnerable and poor in developed and developing countries are disproportionately impacted. For example, current widespread food inflation is impacting poor communities and populations worldwide, notably by restricting their access to food, particularly fresh and nutritious foods. As such, a significant part of world population is facing serious health issues now (malnourishment, micronutrient deficiencies, obesity, diabetes) (FAO *et al*., 2022).

For these reasons, the UN Food Systems Summit in 2021 was a critical step in recognizing the urgent need for a food and agriculture system transformation. A transformation that has at its core a systems approach to foresee and actively pursue solutions that result in multiple co-benefits (synergies) and tackle the multiple crises while actively mitigating unavoidable tradeoffs. Interestingly, 14 of the G20 countries have developed National Pathways for sustainable food systems transformation through multi-stakeholders' dialogues. In the run up to the official Summit follow-up in 2023 (Stocktaking Moment), the challenge will be to accelerate action to further the resilience of food systems, enhance their capacity to adapt to climate change and improve management of biodiversity,

Table 1: G20 Summits and Related Commitments to Food Systems, Agriculture and the Environment

G20 Summit & Year	Commitments
G20 London Summit (UK, April 2009)	Committed to engageme to tackle *inter alia* climate change_
G20 Seoul Summit (South Korea, November 2010)	Addressed ocean degradation, food security, and strategies to improve agriculture productivity and ensure access to technology for food production.
G20 Cannes Summit (France, November 2011)	Emphasised the importance of addressing food price volatility and promoting sustainable agriculture to enhance food security.
G20 Los Cabos Summit (Mexico, June 2012)	Focused on fostering sustainable development, including issues related to food security, agriculture, and energy.
G20 St. Petersburg Summit (Russia, September 2013)	Continued discussions on addressing food security and promoting agricultural productivity.
G20 Brisbane Summit (Australia, November 2014)	Addressed food security, agricultural productivity, and the role of technology in boosting agricultural efficiency.
G20 Antalya Summit (Turkey, November 2015)	Renewed commitments to tackle food security issues and promote sustainable agriculture; Discussed threats to animal and human health (i.e. antimicrobial resistance and infectious diseases) food loss and waste, migration; Discussed diversification to mitigate risk
G20 Hangzhou Summit (China, September 2016)	Highlighted the importance of sustainable agriculture and food security; Discussed diversification to mitigate risk
G20 Hamburg Summit (Germany, July 2017)	Reiterated commitments to promote food security, sustainable agriculture, and environmentally-friendly practices.
G20 Buenos Aires Summit (Argentina, November 2018):	Discussed the importance of sustainable food systems; to increase productivity, production, incomes and employment ;and agricultural practices; as well as childhood overweight and obesity
G20 Osaka Summit (Japan, June 2019)	Discussed biodiversity loss, pollution (i.e. land, fresh water, and marine)
G20 Riyadh Summit (Saudi Arabia, November 2020)	Discussed environmental and land degradation
G20 Rome Summit (Italy, October 2021)	Highlighted the need for water insecurity through action; Discussed diversification to mitigate climate risk
G20 Bali Summit (Indonesia, November 2022)	Highlighted the importance of enhancing market predictability, minimizing distortions, increasing business confidence, and allowing agriculture and food trade to flow smoothly; highlighted the need for digital innovation in agriculture and food systems to enhance productivity and sustainability in harmony with nature, to diversify business opportunities and promote farmers and fishers' livelihoods and increase income, in particular smallholders by increasing efficiency, and equal access to food supply chains

Source: Authors' compilation.

while ensuring their contribution to communities' resilience to future shocks and crises.

How has the G20 Treated So Far

Diversification from mitigating risk and managing investment portfolios to increase health and resilience

Diversification is a strategy commonly mentioned in previous G20 ministerial declarations and summits to guarantee security (energy in USA, 2009, Turkey, 2015, China, 2016), to deliver co-benefits and multiple outcomes (agriculture in Indonesia, 2022), to increase resilience (water: Indonesia, 2022), to adapt to the changing climate (industry: Indonesia, 2022, Italy, 2021), to guarantee stability, security and affordability (value chains, markets and energy sources, in Indonesia, 2022), to diversify business opportunities (Micro, Small and Medium-sized Enterprises and financial instruments, Indonesia 2022, China, 2016), and to increase productivity, production, incomes and employment (agri-food, in Argentina 2018). Local level diversification is a strategy commonly deployed by small farmers for mitigating risk whereas scientific evidence demonstrates that countries with diversified production systems have more stable national food production systems(Renard & Tilman, 2019).

Despite the recognition of diversification as key strategy in the G20, current agriculture and food systems remain increasingly dependent on few crops. Previous G20 efforts to tackle some of the global challenges led to the creation of very important monitoring tools, initiatives, or programs, however these often lack a system-lens. For example, the GEO Global Agricultural Monitoring (GEOGLAM) Initiative monitors only four crops (all cereals), and the Agricultural Market Information System (AMIS) focuses on prices of three cereal crops and one legume. Likewise, half of the global harvested area in 2021 was allocated to only four crops (wheat, maize, rice, and soybeans) (FAOSTAT), in contrast with over >7,000 edible plants that exist (Ulian et al., 2020). This over-dependence on few crops reduces the resilience of our food production by increasing susceptibility to disease and extreme weather events as well as significantly weakening the gene pool. It is also a missed opportunity for developing new and diverse markets, strengthening ecosystems while increasing both agriculture and food systems' resilience and adaptability (Jones *et al*., 2021) .

Clarity and Consensus needs in International Frameworks

Multiple methodologies, movements and initiatives (several endorsed and mentioned already across G20 declarations) have been proposed to achieve better food systems outcomes. While embedded in agreed international frameworks and initiatives, clarity and consensus from development and research partners is needed to accelerate progress towards these comittments. Furthermore, government capacity to monitor and evaluate such progress needs to be strengthened. Despite widespread agreement worldwide regarding the necessity of transitioning agricultural systems into more sustainable forms, the specific methods and components of this transformation continue to be a source of disagreement and discussion among various interested parties and policymakers. Current methodologies and approaches to improve agricultural practices include

sustainable intensification (Pretty *et al*., 2011; Tilman *et al*., 2011), conservation agriculture (Hobbs *et al*., 2008), climate-smart agriculture (Harvey *et al*., 2014), agroecology (Wezel *et al*., 2014) , ecological intensification (Bommarco *et al*., 2013), diversified farming systems (Kremen & Miles, 2012) , circular economy (Barros *et al*., 2020), nature-based solutions (Nesshöver *et al*., 2017) , natural farming (Nesshöver *et al*., 2017) , nature positive agriculture, organic agriculture (Seufert *et al*., 2012), permaculture (Ferguson & Lovell, 2015) and regenerative agriculture (Lacanne & Lundgren, 2018). The politics behind these methodologies and approaches (Tittonell *et al*., 2022) (Loconto *et al*., 2020) , the contested scientific evidence supporting some of them (Perfecto & Vandermeer, 2010; van Etten, 2022) and their limited capacity to contribute to multiple priorities due to their sectoral focus (e.g. yields) (Loconto, 2020) reinforce entrenched positions and divergent efforts undermining urgently needed collective action.

Attaining the global goal of a healthy, sustainable, and inclusive economy requires therefore going beyond specific methodologies and evaluating agriculture and food systems with a systems lens where the overall aim is to have a net positive balance. For example, multiple agricultural practices promoted across methodologies contribute to multiple ecosystem services (Kremen & Miles, 2012) (weed control, nutrient cycling, soil fertility, soil health, water regulation, carbon sequestration) without compromising yields (Rosa-Schleich *et al*., 2019; Tamburini et al., 2020; German *et al*., 2017). Also, certain agricultural practices result in more nutritious foods, lower environmental impacts and higher profitability in tandem with more social and ecosystem benefits (Reganold and Wachter, 2016). The lower environmental impacts of alternative production systems mobilizing multiple agricultural practices, also results, on average, in larger gross income, and profits, even in the cases when these demand higher labour (often compensated by larger gross incomes) (Sanchez Bogado et al, 2022).

Yet, evidence remains scattered for multiple practices while the performance of certain practices is determined by contextual factors (e.g. climate, soil types, production system) (Dawson *et al*, 2019). Hence, the importance of condensing scientific evidence around the diversified agricultural practices and technologies promoted across methodologies that contribute to biodiversity friendly, climate resilient, pollution free, and human-centered agriculture and food systems (See Table 1).

In this context, multilateralism represents an effective tool for global coordination and for streamlining environmental governance. The recent adoption of the Kunming-Montreal Global Biodiversity Framework (GBF) is a powerful reminder of the importance of Multilateral Environmental Agreements (MEAs) to tackle multiple challenges that go beyond national borders. The parties in meeting in Montreal in December 2022 agreed among others to reduce the risk of pesticides and nutrients lost to the environment by at least 50 per cent by 2030, increase the sustainable management of biodiversity in agricultural areas, reduce global consumption footprint and cut food waste by half, and repurpose harmful agricultural subsidies. National implementation and enforcement will be key to ensure that these targets further promote healthy and resilient agriculture and food systems. Use of innovative climate financing, including blended finance, offers a promising avenue to expedite the adoption of climate-

Table 1: A net positive agriculture contributes to multiple outcomes often ignored in current economic models, policies, and investments. A systems-lens to agriculture and food systems will enable reducing the pervasive role of the current dominant agriculture production models while positively contributing to solve many of the intertwined global crises.

Net positive agriculture and food systems							
		Biodiversity friendly	**Climate resilient**	**Pollution free**	**Human centered**		
					Material	**Quality of life**	**Relational values**
Conceptual Framework	**Agricultural management, practices and technologies at the field and landscape levels can…**	• Increase wild and cultivated species diversity (i.e. richness, abundance and evenness) above and below ground. Improve biodiversity-mediated ecosystem services provision (i.e. pollination[37–39] pest or pathogen control[40–42], nutrient cycling[43,44], production value[45], yield stability[46], connectivity[47,48])	Reduce GHG emissions (i.e. CH4, CH2, N2O) Sequestrate GHG emissions (i.e. carbon) Improve soil physical and chemical conditions (i.e. structure, carbon, aggregation, density, pH, temperature, water content) Increase recovery after shocks (e.g. hurricanes, drought spells)[49]	Reduce nutrient runoff, leaching or infiltration in surface and ground water Reduce input dependency (i.e. increase N fixing) Reduce soil erosion[50] and sediment load in streams[51] Improve water infiltration and sediment retention Reduce microplastics in the system[52]	Provide income and production stability in the short and long term[35] Offer farmers safety nets for climatic or economic shocks	Provide year-round nutritious, safe, fresh and diverse food [53] Guarantee farmers enjoy mental, emotional, and physical health Reduce disease agents and infectious diseases[54]	Recognize and value farmers' knowledge and contributions as the stewards of terrestrial and aquatic systems Reinforces place-based connections and attachments [55,56]
	Why it matters	Agriculture production is often portrayed as separated from nature, however, agriculture **fully depends** on cultivated and wild biodiversity for ecosystems functioning and service provisioning. Both, wild and cultivated biodiversity are disappearing an alarming rate.	The agriculture from the 60s is **very different** from the agriculture in the Anthropocene. In present days, agriculture is a main contributor to GHGs[57], while facing water scarcity, poor and degraded soils, and more frequent and extreme events.	Soil, oceans, and freshwater systems are not only under **unprecedented pressure and exploitation levels**, these also experience **unprecedented pollution levels** threatening future human use and all the biodiversity using and living in those ecosystems.	Farmers are confronted with **volatile and globalized pric**ing Hence, regardless of the level of yield, other metrics will be more informative by capturing better farmers financial , stability and production systems viability. Yield, as a performance metric, has been heavily criticized due to its myopic and limited capacity to account for food systems performance [58].	**Farmers are leading suicide rates** worldwide and compared to other sectors, notably in countries where farmers have access to and use most up-to-date and advanced technologies and conventional agriculture dominates[59–63]	Vulnerable, degraded, and polluted agricultural landscapes **deprived humans** from vital cultural, environmental, and social dimensions of human wellbeing.

Enabling Frameworks	**Contributions to Kunming-Montreal Global Biodiversity Framework**[64]	Bringing wild and cultivated biodiversity in fields and agricultural landscapes to increase connectivity, viable and adaptable populations contribute to target 1, 2, 4, 10 and 12	Using traditional (also called neglected or underutilized) species adapted to harsh conditions contributes to target 4 Designing fields and agricultural landscapes to host wild and cultivated biodiversity to maintain viable populations and the ecosystem services these provide contributes to target 2 and 12 Mobilizing cultivated and wild biodiversity in tandem with sustainable practices contributes to target 8 and 10	Designing fields and agricultural landscapes to host wild and cultivated biodiversity for maintaining viable populations and the ecosystem services these provide contributes to target 2 Mobilizing cultivated and wild biodiversity in tandem with sustainable practices contributes to target 7 and 10	Measuring agriculture performance and contributions beyond yields (e.g. land use equivalent ratio, nutritional functional diversity) while accounting for massive food waste reductions will contribute to target 1	Ensuring farmers and local communities reach good quality of life and overall wellbeing is in line with the consideration for the implementation of the framework – different value systems.	Mobilizing local and traditional knowledge to diversify plates, markets, fields and agricultural landscapes contributes to target 21 and 22
	Enabling Kunming-Montreal Global Biodiversity Framework targets for a net positive agriculture and food systems[64]	Integrating cultivated and wild biodiversity in fields and agricultural landscapes for their contribution to farmers, production, food systems and other multiple values will be enabled by a close aligment of national and global policies, agreements, and financial flows (Target 14). This will also require repurpusing policies and phase out harmful subsidies and incentives for biodviersity, the environment and people (Target 18)[65] National policies and global programs fostering, supporting and enabling sustainable, healthy and diversified consumption choices is central to dinamize diversified local, national and international markets offering fresh, locally adapted and diversified foods (Target 16)						
	Contributions to SDGs						

Source: Authors' compilation.

friendly and pollution-free agricultural practices in G20 countries. By combining public and private sector resources, it can provide the necessary financial support and incentives to accelerate the widespread implementation of sustainable agricultural technologies and methods, driving positive environmental outcomes.

Box 1: From Global Crisis to Local Solutions: Andhra Pradesh Community Managed Natural Farming in India

Since 2016 the Government of Andhra Pradesh has undertaken the task of transitioning to a climate change resilient system of farming, called Natural farming (NF). It is a system that mimics nature, and utilises certain universal principles which include covering the ground with diverse crops all year round, minimizing disturbance of soil, using biostimulants for catalyzing soil biology, pest management through better practices and botanical pesticides and zero use of synthetic fertilizers, pesticides, weedicides. Natural Farming aims to restore degraded soils, support biodiversity, and in turn build resilience to weather and climate related shocks including drought and flood resistance. For farming communities, the practices can reduce costs, improve health and create better livelihoods. The land equivalent ratios are better in natural farming, enabling enhanced crop diversity and better food nutrition.

While NF is a paradigm shift, transfer of NF technology is challenging and calls for saturated transformation of a village rather than converting into a single farmer or single farm. The Implementation strategy is as follows-

The programme spends 7-10 years (3-5 years/farmer) in a Gram Panchayat (village). The programme plans to cover at least 85 per cent farm families in the GP.

The programme works through the vast network of the women Self-Help Groups (SHGs) and their federations, Village Organizations (VOs) and community cadres responsible to them ensuring continuous local handholding and thematic support.

Local natural farming champions farmers, who are identified, nurtured and counselled. These cutting-edge internal community resource persons (L3 CRPs) spearhead NF transformation on ground in each village/GP. They are accountable to Village Organization locally and take responsibility for converting around 100 farmers into NF over a period of 3-5 years by means of demonstration, training, nurturing, trouble shooting, handholding, etc. They also help SHGs and Village Organization in tracking progress of the farmers towards transformation on the entire land and in all practices.

These L3 CRPs supported by CRPs at L2 CRPs, responsible to a cluster of 3-5 GPs. Some of the L2 CRPs provide exclusive digital support. L2 CRPs, with better performance and leadership, are emerging from the L3 CRPs to take higher order/ thematic responsibility.

The CRPs at higher levels (L1) support and work with multiple clusters.

Capacity building and knowledge enhancement are crucial for the field functionaries; dedicated pool of **Master Trainers** have been created identified from

Box continued...

Box continued...

existing Community Resource Persons. They support Natural Farming, Institution Building, Health & Nutrition, Digital, and Marketing and Educated Young Practitioners engagements. They are responsible for covering all the units in their districts and deliver trainings to cadres (CRPs), lead farmers, SHG leaders etc.

Based on this, the programme has currently enrolled 630,000 farmers in 3730 villages across Andhra Pradesh and it aims to reach all the 6 million farmer households in the state, over an area of 6 million hectares by 2031.

Apart from working with women collectives and champion farmers for transformation, the programme engages with critical players of the food systems through convergence with the various Government departments of Agriculture, Rural Development, Education, Women and Child Development, along with involvement of civil society and national and international partnerships on aspects of science and research, communications, exchange of technologies etc., APCNF is working on long term system change. The success of APCNF is inspiring other States in India to replicate this transformative model at scale.

Notes: G20 Agriculture Ministers' Declaration, 2017.

Source: Authors' compilation.

Way Forward

G20 economies depend on 60 percent of all agricultural land and about 80 percent of world trade in agricultural products. Hence, G20 is uniquely positioned to accelerate and create the propelling conditions to transition to net-positive agriculture and food systems (i.e. biodiversity friendly, climate resilient, pollution free and people centered). This must also include elements around sustainable consumption, sustainable diets and include accelerating factors, such as enhanced public and private financial flows and better governance of food systems. In response to the interlinked multiple crises, the Triple Planetary Crisis, increases in global food insecurity, and as a follow up to the Food Systems Summit, the G20 can accelerate progress towards achieving net-positive food systems by taking the following key actions:

Support the application of net-positive food systems approaches integrate the 2030 Agenda, the Paris Agreement and the Kunming-Montreal Global Biodiversity Frameworks by strengthening enabling governance and financing mechanisms at the national level and through disbursements of overseas development aid.

Promote a systems approach for net-positive food systems through enabling food loss and waste prevention, for example, investments in human capital and technologies that promote a robust regulatory environment for sustainable food production; and provision of incentives to facilitate access to sufficient, nutritious and diversified diets.

Embed relevant indicators and metrics into current G20 monitoring and knowledge platforms, the National Pathways for sustainable food systems transformation developed as a process of the UN Food Systems Summit, and other international commitments(including under the Paris Agreement, and the Kunming-Montreal Global Biodiversity Framework). Metrics to encompass context-relevant innovations (e.g. diversification with local crop and agroforestry species, and identification of corelating agroecological zones)

and formalized pathways to integrate indigenous practices and land rights, as these net-positive contributions are commonly overlooked by governments and the private sector.

In the face of geopolitical and climate related shocks, G20 can explore policy and fiscal measures including blended finance mechanisms to incentivize agriculture towards greater resiliency and positive outcomes on nature, climate and pollution and human health/food security.

Through closer collaboration with the UN system - including the UN Food Systems Coordination Hub – the G20 can support the operationalisation and implementation of the transformational Food Systems Pathways, developed by countries in the run up to the 2021 UN Food Systems Summit. This will help to overcome multifaceted challenges blocking desirable collective transformation at the required pace. National food systems pathways can become learning sites for jointly tackling the multiple crises in an orchestrated fashion and outlining key pragmatic steps at the individual, public, and private sector levels to bring the desired and envisioned "integrated, inclusive, and equitable development" (G20 declaration Argentina, 2018).

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