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Leveraging agrobiodiversity to create sustainable food systems for healthier diets

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ABSTRACT

The current ways that planetary resources are used to produce and consume food are raising significant concerns about the impact on nutrition, health and sustainability. A major reorientation of our food systems is needed in terms of both activities and governance. This paper describes the important contributions agricultural biodiversity makes achieving healthy diets and sustainable food systems and highlights a number of key actions needed to maximize those contributions.

Dietary factors are the number one risk factor in the global burden of disease. At the same time, many of the ways in which food systems operate, from production to sales and consumption, are causing significant environmental damage, including loss of biodiversity and of the beneficial services that biodiversity in ecosystems provides to humanity.

This paper argues that focusing on increasing agricultural biodiversity in landscapes, food systems and diets is an important part of the solution to creating healthier diets from sustainable food systems. For instance, a healthy diet should be based on whole grains, fruit, vegetables, legumes, nuts and seeds, and be limited in added sugar and sodium. Agrobiodiversity can ensure these essential ingredients are present in our food system, and so support healthy diets. In terms of increased sustainability of food systems, agricultural biodiversity can boost yields, provide pollination services and pest and disease control, reduce the need for inorganic fertilizers and synthetic pesticides, and provide protection to natural habitats. Agrobiodiversity can also contribute to breeding of crops and animals that are more capable of coping with climate change. Good governance is key to achieving positive outcomes from promotion of agrobiodiversity. Food systems arise from complex agronomic, economic, political,

institutional and social interrelationships. Good governance must drive the enabling environment that influences multiple actors operating in these systems and the actions they can take that will impact on the sustainability of food systems and the creation of healthy diets. Promoting agricultural biodiversity can be a practical investment for healthier diets through four main avenues: local and more nutritious value chains; public or institutional procurement; increased availability of fruits and vegetables; and appropriate policy incentives and coherence for diversification of production and consumption. We use examples from a number of contexts to illustrate potential actions that other countries may follow.

INTRODUCTION

Sustainable food systems and healthy diets, a pillar of the Second International Conference on Nutrition (ICN2) Framework for Action, are key to delivering on most of the Sustainable Development Goals (SDGs), not just SDG 2 (Bioversity International, 2016). The UN Decade of Action on Nutrition (2016-2025) offers an important opportunity to strengthen implementation and commitment to achieving improved nutrition outcomes. Similarly, the overlap with the UN Decade on Biodiversity (2011-2020) provides a unique opportunity to break silo thinking and bring together biodiversity with nutrition.

The ways in which food is produced, distributed and consumed are causing huge environmental damages, likely pushing beyond certain planetary boundaries needed for sustainable development (Rockström et al. 2009; Steffen et al. 2015), which then undermines the capacity for future food production (Garnett 2014). It is estimated that food systems today contribute between 20 and 30 per cent of

anthropogenic green-house gas emissions (Vermeulen, Campbell and Ingram 2012) and agriculture accounts for 70 per cent of all water utilization (UN Water 2013). Deleterious effects of food systems include land degradation, deterioration of natural habitats, and losses of biodiversity and of the beneficial services that ecosystems provide to humanity. They can also contribute to considerable production and use of chemical fertilizers, pollution and contamination of soil and water (Parris 2011), all of which have significant impacts on human health (Hodgkin et al. 2015). In addition, the increasing uniformity and reduction of agricultural biodiversity in global food systems poses one of the greatest, but often overlooked, challenges to achievement of sustainable food systems and healthy diets (IPES-Food 2016).

In this paper, the proposal to increase agricultural biodiversity in landscapes, food systems and diets is used as an important part of the solution to the challenges to agriculture, the environment, and nutrition faced in the era of the 2030 Sustainable Development Agenda. Mainstreaming biodiversity in food systems offers multiple benefits, not just for diets and nutrition. While not the only component of a sustainable food system, a sustainable food system cannot exist without agricultural biodiversity.

THE ROLE OF AGROBIODIVERSITY IN SUSTAINABLE FOOD SYSTEMS AND HEALTHIER DIETS

Agrobiodiversity is defined as the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems (FAO and Bioversity International, 2017). A sustainable food system is defined as a food system that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised (HLPE, 2014). Greater utilization of agrobiodiversity within food systems is a promising approach to help achieve complex, inter-connected goals that span nutrition, environment and health (Romanelli et al., 2015).

Although over 5,500 species have been counted as food used by humans (Royal Botanic Gardens Kew 2016), three species – rice, wheat and maize – dominate our global diet and provide the majority of the world's plant-derived calories. Relying so heavily on such a narrow resource base is a risky strategy for the sustainability of the planet, for individual livelihoods and for achieving a healthy diet (Bioversity International, 2016). Expert opinions on the components of healthy diets consistently agree on the need for dietary diversity of healthy foods and for diets to be based upon whole grains, fruit, vegetables, legumes, nuts and seeds, and limited in added sugar and sodium (WHO, 2015; USDHHS, 2015; Imamura et al., 2015; Gallup and Swiss Agency for Development Cooperation, 2016). Considering the global burden of disease and the global needs for minimum diet-related risks to address them, our global food system reflects gaps in food availability of 44 per cent for fruits, 11 per cent for vegetables, and 58 per cent for nuts and seeds (Murray, 2014).

The evidence base for the role of biodiversity in food and nutrition security is growing. For example, Wittman and colleagues demonstrate the linkages between food security and biodiversity across a range of socio-ecological properties and across global, regional, landscape and household scales, and document the evidence base for the biophysical as well as social connections between the two (Wittman et al., 2016). In relation to nutrition security, significant and positive relationships between crop diversity and dietary diversity were found for a majority of contexts (Powell et al., 2015), and the diversification of agricultural production towards fruit, vegetables and aquaculture was seen to improve diet diversity and intake of specific nutrients (Pandey, Dev and Jayachandran, 2016). The role of the provision of food and essential micronutrients year-round is another well-documented association between greater use of biodiversity and food and nutrition security (Powell et al., 2015).

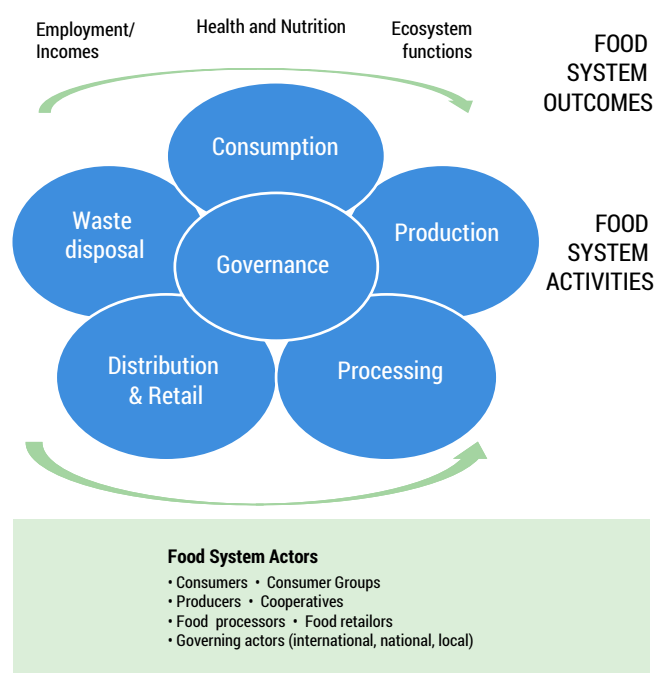
In terms of greater environmental sustainability, we know that agricultural biodiversity in production systems can boost yields, provide pollination services and pest and disease control, improve soil function and reduce the need for inorganic fertilizers and synthetic pesticides (Bioversity International 2016). Biodiversity also provides the base for traits for breeding stress-tolerant, nutritious crops and animal breeds that can help improve farmers' resilience in coping with climate change. Biodiversity is also essential to securing sustainable agricultural production through the provisioning of diverse raw material to markets and industry, supporting diversification of value chains, self-reliance of local economies and the empowerment of marginalized groups (Padulosi et al. 2015; IPES-Food 2016).

ACTIONS WITHIN A FOOD SYSTEM FRAMEWORK TO CREATE HEALTHIER DIETS FROM MORE SUSTAINABLE FOOD SYSTEMS

Food system activities encapsulate consumption, production, processing, distribution and retail, waste management and governance (Figure 1). The central role of governance within the framework is important because it drives the enabling environment that can in turn influence all other food system activities. Good governance is key to positive outcomes in this complex system of agronomic, economic, political, institutional and social interrelationships. Food system actors are individuals or bodies that play a specific role within specific food system activities. Food system actors include consumers, consumer groups, farmers, farmer co-operatives, food distributors, food manufacturers and food retailers. Food system activities and the actors that carry them out operate at different levels, i.e. international, national and local. The potential spheres of influence are highly complex and linked. As research on food systems has shown, the outcomes of food systems can be either positive or negative (IPES-Food 2016); the aim of a sustainable food system would clearly be to draw out the greatest number of positive outcomes for the system as a whole.

The most critical aspect related to making food systems more sustainable and diets healthier is to translate theory into practical, feasible actions. In order to work toward healthier

Figure 1. FOOD SYSTEM OUTCOMES, ACTIVITIES, ACTORS AND DRIVERS



Source: Adapted from Eakin et al. (2016).

diets and food systems to achieve the desired positive dual outcomes of improved nutrition and environmental outcomes, actions need to be taken by key food system actors. Table 1 provides suggestions for different groups of food systems actors by food system activity for moving toward both healthier and more sustainable diets.

Table 1. FOOD SYSTEM ACTORS AND POSSIBLE ACTIONS/CHOICES THAT CAN BE TAKEN FOR HEALTHY DIETS AND THE SUSTAINABILITY OF FOOD SYSTEMS

Food system activity	Actors	Healthy diet actions/choices	Sustainability actions
Governance	Governance bodies	<p>Ensure coherence of policies across line Ministries (eg. Health, Agriculture and Education) and across jurisdictions (national to local).</p> <p>Form multi-sectoral bodies that have a mandate to review and discuss implications of current and new policies on healthy diets.</p> <p>Promote consumption of agrobiodiversity that can contribute to healthier diets.</p>	<p>Ensure coherence of policies across line Ministries (eg. Agriculture, Natural Resource Management, Energy) and across jurisdictions (national to local).</p> <p>Form multi-sectoral bodies that have a mandate to review and discuss implications of current and new policies on environmental sustainability.</p>
	Consumers, producers and consumer/producer groups	Lobby for legislation that increases access, availability, affordability and convenience of healthy food choices.	Lobby for legislation that increases sustainable agriculture and natural resource management.

(Continued...)

Food system activity	Actors	Healthy diet actions/choices	Sustainability actions
Consumption	Consumers	Daily decisions on the types of foods (whole cereals, fruit, vegetables, legumes, seeds/nuts, processed foods, sugar and red meat) consumed and level of processing (raw, minimally processed or ultra-processed) to consume.	Decisions on what food to consume/purchase and the level of processed and packaged food to purchase. Decisions on where to purchase (from which type of retail and level of certification). Homestead fruit and vegetable production.
	Consumer awareness groups	Advocacy on healthy food choices.	Advocacy on sustainable food choices.
	Governance bodies	Legislation to ensure healthy food in social programmes that supply food (food aid, school feeding). Disincentives (e.g. taxes) for unhealthy food. Incentives for healthier food. Develop food-based dietary guidelines that valorize native agrobiodiversity.	Legislation to ensure sustainability of food in social programmes. Development of food-based dietary guidelines that include sustainable consumption practices.
Production	Farmers	Decisions on the level of crop diversity planted (species and cultivars) planted and balance between own consumption for dietary diversity and sale for income. Increase fruit and vegetable production.	Decisions about crop production diversity that also consider nutritional properties. Sustainable production practices such as mixed and rotational cropping (modify soil pH to make nutrients better available to plants).
	Farmers' cooperatives	Influence types of foods and cultivation practices managed collectively.	Influence crop diversity and sustainable production practices; selling of diverse nutrient-dense food in markets close to consumers; stewardship of community natural resources.
	Governance bodies	Policies in support of producing the types of food needed for healthier diets.	Policies to reduce unsustainable production practices (e.g. mono-crop/mono-variety cultivations; excessive use of pesticides); incentives to promote sustainable practices (e.g. greater use of diverse nutritious-dense and resilient crops).
Processing, storage and packaging	Food industry (small- and large-scale)	Use of nutrient-saving processing methods; use of whole cereals and diversity-rich food mixtures; use of neglected and under-utilized crops as main/secondary ingredients; adequate storage and packaging for safeguarding nutrients in raw/processed food; decisions on quantity and quality of ingredients used in processed foods.	Decisions on nutrient-sparing processing technologies, new products that leverage nutritious-dense crops, environmentally friendly packaging (also to relate to reduced food waste below); strengthen local procurement of raw ingredients and reduce reliance on ingredients that require long transportation routes.

(...Continued)

Food system activity	Actors	Healthy diet actions/choices	Sustainability actions
Processing, storage and packaging	Governance bodies	Legislation related to food labels and guidelines on promotion of healthy foods.	Legislation related to sustainability standards and incentives for use of environment friendly food processing, storage and packaging methods.
Distribution and retail	Food retailers (small- and large-scale)	Decisions on types, amount and price of healthier and less health foods for sale in retail outlets.	Location of stores. Distance between origin of production and retail.
Waste	Consumers	Decisions on amount of food to purchase and actions to reduce food waste after purchase.	Decisions on household food and waste management (recycling). Decisions on how much packaged food to purchase.
	Consumer awareness groups	Awareness raising among consumers on food waste.	Awareness raising among consumers about recycling and composting.
	Governance bodies	Establishment of programmes (e.g. food bank/food pantry) to redistribute surplus healthy food efficiently.	Provide access and manage recycling and composting programmes.

Consumers, numbering over seven billion and rising, are undoubtedly the most influential actors with regards to sustainable food systems and can also be proactive rather than only reactive to their food environment. The United Nations website for the Sustainable Development Goals provides some very practical actions for an everyday citizen (mostly applicable to a high-income country) to enable them to become more proactive in making more sustainable dietary choices.

RECOMMENDATIONS TO LEVERAGE AGROBIODIVERSITY FOR MORE SUSTAINABLE FOOD SYSTEMS AND HEALTHIER DIETS

Four actions are recommended in several recent reports (FAO and WHO, 2014; UNSCN, 2016a; IPES-Food, 2016; Global Panel on Agriculture for Food Systems and Nutrition, 2016) for more sustainable food systems and healthier diets: support of shorter supply chains for local produce; public and private procurement programmes for agrobiodiversity; promotion of fruits and vegetables; and

policy incentives and coherence for diversified production and consumption. Examples of how these actions can be used to promote agrobiodiversity and create healthier diets from more sustainable food systems are provided below.

1. Short supply chains; linking local farmers to consumers

Relevant recommendations:

- Strengthen local food production and processing, especially by smallholder and family farmers, giving special attention to women's empowerment, while recognizing that efficient and effective trade is key to achieving nutrition objectives (FAO and WHO, 2014).
- Invest specifically in nutrition-sensitive value chains and opportunities for crop diversity (UNSCN 2016a).
- Create demand and improve access to locally produced food as an investment for improving nutrition through consumption (UNSCN 2016a).
- Support short supply chains and alternative retail infrastructures (IPES-Food 2016).

The existence of many intermediaries in food supply chains is a recurrent theme that challenges efficient and nutrition-sensitive food systems, especially for nutrient-dense products such as fruit and vegetables. The shortening of food supply chains has a positive impact for both farmers and consumers in economic, social and cultural terms

(UNSCN, 2016b). Positive effects are also recorded in terms of growth in trust and equality and increase in sustainability in all its dimensions, including environmental, health and wellbeing, social and economic (Marsden, Banks and Bristow, 2000; Galli and Brunori, 2013). While helping to strengthen rural-urban linkages and contributing to sustainable development of rural areas, such interventions contribute as well to the provisioning of local fresh produce at lower prices from nearby farms with less environmental impact due to reduced transportation. Furthermore, farmers have opportunities for higher economic returns and for bringing to clients potentially neglected or underutilized crops that are usually excluded from marketing channels dominated by mainstream commodities. Examples of such crops include: cleome, baobab or corchorus leaves and moringa fruits in sub-Saharan Africa; chaya leaves in Central America; peach palm in South America; taro flowers, amaranth leaves, jackfruit and garcinia in Asia; chicory, beet leaves or figs in Europe. Short food supply chains (SFSCs), which have emerged as alternatives to the increasingly dominating global value chains, can be developed in different ways (e.g. farmers' markets, on-farm selling, consumer cooperatives, community-supported agriculture, solidarity purchase groups, Internet sales, mail order, home delivery, box schemes, etc.) and are seen as mechanisms to strengthen resilience of family farms (Galli and Brunori 2013). With regard to the development of local markets or farmers' markets in particular, SFSC can be established with the support of farmers' and consumers' associations. Active groups for short supply chains in Europe include: Associations pour le maintien de l'agriculture paysanne (France), Groupes d'achat solidaire de l'agriculture paysanne (Belgium) and Gruppi di acquisto solidaire (Italy). In developing countries, SFSCs require interventions to build capacities of farmers in delivering produce of high quality, in regular supply and in respect of safety standards. Lack of infrastructure and poorly organized farmers or consumers associations are often recurrent barriers in these countries (FAO, 2015b). Successful examples, however, do exist, as in the case of "Harvest of Hope" project from South Africa. This initiative is run by Abalimi Bezekhaya (Farmers of the Home), a non-profit organization that connects home and community gardens throughout the townships of Cape Town City.¹ This project aims at strengthening food and nutrition security by encouraging residents of townships to grow their own vegetables, which are then sold to markets. This produce is planned to match the market's demand for locally grown vegetables, free of chemicals and pesticides. Support to growers in accessing seeds, production planning, soil preparation, harvest, transportation, and financial services is also provided by the organization.

2. Public procurement, institutional markets and sustainable sourcing for healthy diets

Relevant recommendations:

- Establish food or nutrient-based standards to make healthy diets and safe drinking water accessible in public facilities such as hospitals, childcare facilities, workplaces, universities, schools, food and catering services, government offices and prisons, and encourage the establishment of facilities for breastfeeding (FAO and WHO, 2014).
- Use public procurement to support local agroecological produce (IPES-Food, 2016).
- Institutionalize high-quality diets through public sector purchasing power, including food provision in schools and hospitals (Global Panel on Agriculture and Food Systems for Nutrition, 2016).

In Brazil, strategic lobbying and advocacy by key actors involved in the implementation of the Food Acquisition Programme (PAA) and the National School Feeding Programme (PNAE) as well as strengthening the knowledge base to demonstrate the nutritional value of native food biodiversity has established a strong platform for mainstreaming underutilized nutrient-rich food biodiversity into both programs (Beltrame et al., 2016). Both the PAA and PNAE provide incentives for linking local farmers and agricultural biodiversity including a law passed in 2009, which states that 30 per cent of food procured for school feeding under the PNAE must be sourced from local family farmers while the PAA pays a premium of 30 per cent for agro-ecological and organic products.

Home-grown school feeding programmes also seek to link to local food procurement, though efforts to date to encourage the integration of underutilized, nutrient-dense food biodiversity have been limited. Pilot interventions in Kenya have demonstrated that underutilized, nutrient-rich African leafy vegetables can play a role in helping link local farmer groups to school markets at the county and district level in Kenya (Wasike et al., 2016), while it has been demonstrated that underutilized minor millets incorporated in school feeding programmes can enhance the nutritional status of school children in certain areas of Karnataka state, India (Bergamini et al., 2013). Although small in scale and scope, these examples do demonstrate the potential for agricultural biodiversity to diversify procurement and school feeding.

¹ For more details on this project, see www.harvestofhope.org.za/home [last access 26 April 2017].

3. Promoting fruits and vegetables

Relevant recommendations:

- Promote the diversification of crops including underutilized traditional crops and apply sustainable food production and natural resource management practices (FAO and WHO, 2014).
- Improve storage, preservation, transport and distribution technologies and infrastructure to reduce seasonal food insecurity, and food and nutrient loss and waste (FAO and WHO, 2014).
- Home gardening as a viable investment for improving nutrition for both production and consumption (UNSCN, 2016a).
- Focus more research investment on fruits and vegetables to increase their availability and affordability (Global Panel on Agriculture for Food Systems and Nutrition, 2016).

Increasing the consumption of fruit and vegetables has important positive health and environmental implications. This goal requires interlinked and interdisciplinary interventions along the value chain of target crops, together with measures addressing the food system. The departure point is a re-visitation of the pathways to nutrition in terms of production of more diverse, nutrient-dense foods. Local crops provide a reservoir of untapped diversity to pursue this goal. According to the Royal Botanic Gardens Kew (2016), there are more than 5,000 food crops, with Africa ranking as the most diverse region in the world (539 vegetables and 645 fruit indigenous species) (PROTA, 2010) in terms of wild or cultivated foods. An entry point to leverage this diversity is to better document the nutritional values and promote the conservation of these genetic resources, many of which are currently under threat due to marginalization from markets and environmental degradation. Fruits and vegetables for household consumption can be promoted through home gardens and family farms, whereas sustainable marketing may require efforts towards building better organized and efficient value chains (Padulosi et al., 2014). Value chains can be strengthened through more effective cold chains and enhanced processing methods; marketing strategies, including nutrition labelling or the provision of nutrition information for fresh produce; the introduction of Protected Designation of Origin (PDO) or Geographic Indication (GI); and the establishment of multi-stakeholder collaborative platforms (Polar et al., 2010). Education also plays a fundamental role in changing food habits of consumers starting at early ages, hence schools can serve as platforms to support parallel nutrition awareness campaigns targeting other members

of the family, especially women, or the community at large. School meals programmes also represent an excellent entry point for awareness raising and sensitization of youth to nutritious foods and diverse, balanced and healthy meals. Public awareness campaigns targeting consumers at large are also needed for the promotion of healthy diets and sustainable food systems. However, a robust and wide impact can only be achieved with the involvement of the multitude of private sector actors who participate in activities throughout the food system, from production to consumption.

4. Policy incentives and policy coherence for diversification

Relevant recommendations:

- Integrate nutrition objectives into food and agriculture policies, programme designs and implementation at multiple levels to ensure coherent food policies from production to consumption, enhance nutrition sensitive agriculture, ensure food security and enable healthy diets (FAO and WHO, 2014; IPES-Food, 2016).
- Create policy incentives for diversification and agroecology (IPES-Food, 2016).

One of the key actions a country can take to make underutilized, nutrient-rich fruits, vegetables, nuts and pulses more widely available is to develop policies that support and mainstream agricultural biodiversity. Brazil is one country that has made good progress in promoting agricultural biodiversity by taking advantage of the multisectoral governance mechanisms already in place under the Fome Zero (Zero Hunger) strategy. Brazilian policies and programmes such as the Food Acquisition Programme (PAA), the National School Meals Programme, the Minimum Price Guarantee Policy for Biodiversity Products (PGPM-Bio) and the National Plan for Organic Production and Agroecology (PLANAPO) all provide suitable opportunities and entry points for potentially improving nutrition by linking food systems with native agricultural biodiversity (CGIAR Research Program on Agriculture for Nutrition and Health, 2015). Further steps to better utilize Brazilian biodiversity for nutrition and livelihoods continue to be made, such as with the new policy (Ordinance N° 163) signed jointly between the Ministry of the Environment and Ministry of Social Development and Fight Against Hunger in 2016. The ordinance ensures that 64 “Brazilian Sociobiodiversity Native Food Species of Nutritional Value” are officially defined and recognized. Most of the species in the ordinance are nutrient-rich fruits.

CONCLUSIONS

The overlap of the UN Decade of Action on Nutrition with the UN Decade on Biodiversity provides a unique opportunity to break silo thinking and better leverage the benefits of agricultural biodiversity for healthier diets and more resilient and sustainable food systems. Current food systems dominated by few and highly uniform crops are undermining our nutrition, our health and the environment, as well people's cultural identity, self-reliance and options for economic empowerment of agriculturally engaged communities and vulnerable groups, including women. Though complex, when broken down into smaller sets of food system activities and food system actors, several actions can be identified along the food-system continuum to promote both healthier diets and more sustainable food systems. In this paper, concrete suggestions are provided for consumers, consumer awareness groups, farmers, farmers' cooperatives, food industries, food retailers and governance bodies that relate to actions they

can take to foster healthier diets as well as sustainable food systems. Several entry points for leveraging agricultural biodiversity to improve nutrition outcomes and increase the sustainability of food systems have been highlighted here. The highly strategic entry points to address shortcomings of current food systems include: (i) shorter supply chains, particularly for fresh produce, with fewer intermediaries between producers and consumers; (ii) public procurement schemes that link institutions such as schools and other social programs with producers that contribute to agrobiodiversity; (iii) increased fruit and vegetable production and consumption; and (iv) increased policy incentives and policy coherence through inter-sectoral participation (e.g. involving Ministries of Agriculture, Health, Environment and Education) to attain long-lasting and synergistic solutions for food and nutrition security as well as environmental promotion and preservation. Encouraging steps are being taken by some governments, such as Brazil, to embed agrobiodiversity into food-related policies. They should be widely shared, celebrated and replicated in other countries.

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