

1 INTRODUCTION

This paper reviews different aspects related to the financing of the transformation of food systems based on work done by the author and colleagues at the International Food Policy Research Institute (IFPRI)^[1-5].

First, Section 2 discusses the meaning of such transformation, emphasizing the Sustainable Development Goals (SDGs) and the objectives of the Paris Agreement involved in that definition. This analysis determines the specific goals to be attained and their quantitative dimensions (Section 2).

Second, the objectives of the transformation then help define the public interventions (used in general to refer to policies, programs, investments, expenditures, taxes and subsidies, laws and regulations, and institutional aspects) or private activities necessary to achieve them, which in turn determine the costs involved in the desired transformation. Different cost estimates are mentioned in Section 3. Also, the nature of those interventions helps to determine whether the funding may be public or private (including philanthropic options) and come from domestic or international sources.

Third, it is also necessary to clarify the nature of financing. For some it is mainly international development money. Others focus only on private business investments, from value-chain operators, or from capital markets. Still other analyses look at the banking system, or even components of them, such as public banks. This paper follows a broader framework of six flows of funds^[1-5]. Section 4 explains those different flows and discusses some of the estimates of available funds.

Fourth, this paper analyzes different approaches to manage, reorient and increase those flows of funds to finance the needed activities to achieve the desired transformation of food systems (Section 5).

Fifth, there is a brief discussion of institutional aspects (Section 6), considering that financing is just an aspect of the implementation of comprehensive programs of food systems transformation.

2 FOOD SYSTEMS TRANSFORMATION: RATIONALE AND OBJECTIVES

Why is there a need to transform the operation of those food systems and what such transformation implies? After all, humanity has made tremendous progress in reducing hunger and increasing food security over the past 60 years or so. The

world moved from feeding 3 billion people in the 1960s to feeding almost 8 billion people today, with an availability of calories and proteins per capita that increased by 20%–30% in that period and using only a 6% more of agricultural land (2019 compared to 1960 according to data from FAOSTAT), while real prices of agricultural commodities in 2020 stood about 15% below the levels of the 1960s. Technological advances and economic growth have been crucial for those achievements. However, more modern and integrated food systems, from farmers and operators along the whole food value chains to consumers, supported by public policies and investments, have been important for the provision of a stable supply of food for billions of people.

However, lately, and even before the pandemic of COVID-19, there have been growing concerns about the operation of food systems. For example, it was estimated that about 620 million people were suffering from undernutrition (lack of enough calories or hunger) before the pandemic in 2019, number that was projected to increase from 740 million to 750 million in 2022, after the impact of COVID-19 and the war in Eastern Europe^[6]. In addition, about 675 million were affected by obesity, 570 million women between 15 and 49 years suffered from anemia and an estimated of 3 billion people could not afford a healthy diet^[6], leading to deficiencies in crucial nutrients, thus affecting physical and intellectual capacities and health in general. Also, food systems (from primary production to disposal of waste) represent about a third of global anthropogenic greenhouse (GHG) emissions^[7], with primary agriculture being a significant factor in, as well as being deeply affected by, climate change. Therefore, advancing the mitigation, adaptation and resilience objectives of the Paris Agreement are also linked to the operation of food systems.

Food systems also have important impacts on natural resources, biodiversity and the environment in general (by encroaching on forests and by inadequate use of land, water and ecosystems).

Concurrently, the whole agri-food system is the world's largest sector of employment probably generating close to half of all global jobs, once all the direct and indirect activities linked to growing, transporting, processing, commercializing, financing, regulating, storing, cooking and consuming food are considered^[8]. However, many farmers, workers and small firms operating in that vast system suffer from low and insecure incomes, and employment opportunities may be limited, particularly for women, youth and ethnic minorities. Finally, food systems also face the challenge of supplying adequate diets for a growing population, which by 2050 may

reach 10 billion people.

Food systems then must be strengthened, modernized and transformed in the coming decades to become nutrition- and health-driven, productive and efficient in the use of scarce resources, environmentally sustainable and climate-smart, socially inclusive, and based on a diverse, competitive, and dynamic private sector, which provides decent employment and income opportunities.

The list of those qualitative objectives implies that a variety of the SDGs are linked to the operation of agri-food systems. The most obvious case is SDG2, which commits all countries to “end hunger, achieve food security and improved nutrition and promote sustainable agriculture”. However, many other SDGs are also related to how food systems function such as, reducing poverty (SDG 1); leading to better health (SDG 3); facilitating gender equality (SDG 5); decent employment (SDG 8); reducing inequality in general (SDG 10); promoting sustainable production and consumption systems (SDG 12); helping with the mitigation of climate change (SDG 13); ensuring the sustainability of fisheries (SDG 14); and managing forests sustainably, combating desertification and land degradation and protecting biodiversity (SDG 15)^[9].

The question then is how broadly or narrowly the objectives of that transformation must be defined in the context of the Sustainable Development Agenda (i.e., how many SDGs are considered and the policy boundaries for the transformation).

Even concentrating only on SDG2, the policies and investments needed, and therefore, the costs involved in such transformation would differ if the focus is just on hunger (SDG 2.1); or if it expands to the consideration of all forms of malnutrition (SDG 2.2), which would include other problems such as deficiencies in proteins, vitamins, minerals and micronutrients, and excess consumption of calories (sugar, fats, and others), with the associated problems of obesity, diabetes and cardiovascular diseases. The type of interventions and costs will increase further if the other components SDG2 are also considered, such as 2.3 (doubling “agricultural productivity and incomes of small-scale food producers ...”); 2.4 (ensuring “sustainable food production systems and implement resilient agricultural practices ...”); and 2.5 (maintaining “the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species...”)^[3].

Further, it is necessary to consider the specific quantitative

objectives across SDGs, with their complementarities and trade-offs^[10].

Also, food systems have implications for the climate objectives of the UN Framework Convention for Climate Change (UNFCCC), which is related to the Sustainable Development Agenda but is a separate framework under the UN system. Further, while the SDGs (and the pledges made by countries during the recent UN Food System Summit (UNFSS)) are not legal obligations, the commitments in the climate change negotiations are more binding. Here, again, the costs of the interventions depend on the quantitative objectives defined. For example, in the case of climate change, costs are different depending on trying to stay well below 2 °C above preindustrial levels or to limit the temperature increase to 1.5 °C above preindustrial levels (Article 2, paragraph 1a of the Paris Agreement). Also, the objectives for adaptation and resilience of Article 2 paragraph 1b have been interpreted in different ways (given that the language of the article is broad referring to “the ability to adapt to the adverse impacts of climate change and foster climate resilience ... in a manner that does not threaten food production”).

Given the quantitative objectives of the transformation, the next question is what needs to be done for such transformation to happen, and, in particular, from the point of view of the public sector, what would be the policy instruments, investments, and other interventions needed. This definition determines the actions by the public and private sectors, and therefore the overall costs.

In summary, the discussion of financial strategies requires answering some key questions: what are the main problems related to the food systems that need to be addressed in the transformation, and what would be the metrics that indicate that the problem has been solved (the objectives of the transformation); and what type of interventions with its costs and operational approaches are needed to solve the problems identified^[3].

Certainly, achieving the SDGs and the Paris Agreement objectives needs a broader context of sustainable and inclusive economic growth and peace. However, the discussion about the policy and institutional requirements for countries to maintain some minimally adequate levels of economic growth, macroeconomic stability and peace largely exceeds the topic of this paper.

3 THE COSTS OF THE TRANSFORMATION

A confusing aspect of the discussion about financing of the transformation of food systems is the large variety of numerical estimates of those costs. A main source of differences was mentioned in the previous section: opinions may differ as to the objectives and policy boundaries for the needed interventions to be included in the transformation of food systems, and therefore the costs and the financial requirements for such undertaking would also vary. However, there are other differences related to methodological approaches such as the modeling frameworks utilized; the baseline scenarios (or socioeconomic and climate-change pathways) used to calculate the business-as-usual projections and therefore the incremental costs of the desired transformation; whether the focus is on the entire food system or only the agricultural sector; whether focus is global or just developing countries; and even units of measurement for valuing the costs (e.g., market prices, purchasing power parity values, etc.) and the starting year for the baseline.

Díaz-Bonilla^[1] summarizes the costs related to SDG2 and ending hunger following the work reported in von Braun et al.^[11], with the background of two other studies^[12,13]. The latter (part of the project called Ceres2030: Sustainable Solutions to End Hunger) considers 14 interventions and policy instruments to end hunger, increase agricultural incomes, and achieve some environmental outcomes, grouped in three main blocks related to social inclusion, farm development, and markets and infrastructure. It uses household survey data to better target food system transformation interventions, which helps to narrow the estimated additional costs and related financing needs; about 33 billion USD per year above the business-as-usual projections. This level of funding would be needed to end hunger for over 490 million people, double the incomes of about 545 million farms, and limit greenhouse gas emissions for agriculture to the commitments made under the Paris Agreement (as reported by 2020).

ZEF and FAO^[12] calculate the additional costs of lifting people out of hunger and malnutrition using a variety of interventions, selected by their favorable impacts on the elimination of hunger. It uses marginal abatement cost curves to quantify the cost-effectiveness of interventions, allowing ranking alternative actions toward the reduction of hunger and malnutrition. Those interventions also support other components of SDG2 and, in particular, given the technologies considered, they are aligned with the objectives of mitigation and adaptation to climate change (but without modeling whether the objectives of the Paris Agreement are achieved). The number of people who may be lifted from hunger depends on the range of interventions considered (which include agricultural R&D, extension and ICT, irrigation, agricultural Practices, infrastructure, gender and nutrition, social protection and trade^[12]). A summary of these estimates are shown in Table 1 (from Díaz-Bonilla^[1]).

As can be seen from Table 1, the costs of eliminating hunger are nonlinear, with each additional reduction in the number of people affected becoming costlier^[12].

These estimates, as noted above, focus on SDG2, and although they include interventions related to climate change, they do not determine whether they can help achieve the objectives of the Paris Agreement.

Díaz-Bonilla and Echeverría^[4] discuss costs estimates to meet climate-related goals in food systems: they range from an additional 15 billion to 350 billion USD per year to 2030, depending, among other things, on the components of food systems targeted (i.e., only primary agricultural or broader components); on whether they focus only on mitigation, only on adaptation, or both; and how the mitigation and adaptation objectives in food systems are defined^[12,14–19].

A broader estimate is in FOLU (2019), which calculates costs of 10 critical transitions in food systems for the whole world, including “Healthy Diets”, “Productive & Regenerative Agriculture”, “Protecting & Restoring Nature”, “A Healthy &

Table 1 Estimates of ending hunger and other SDG2 goals

Source	People lifted from hunger (million)	Additional cost per year (billion USD)
IFPRI, IISD, Cornell (Ceres2030)	490	33
ZEF and FAO (2020)	870	56
ZEF and FAO (2020)	1050	163

Note: Sourced from Díaz-Bonilla^[1] based on the studies cited there. For IFPRI, IISD, and Cornell, see Laborde et al.^[13].

Productive Ocean”, “Diversifying Protein Supply”, “Reducing Food Loss & Waste”, “Local Loops & Linkages”, “Harnessing the Digital Revolution”, “Stronger Rural Livelihoods”, and “Gender & Demography”. That estimate uses different methodologies (from model-based scenario analysis to partial-equilibrium estimates of the costs of food systems transformation) to define what the authors consider would help achieve not only SDG2, but also other objectives related to climate, employment, gender equality, health, land and ocean conservation, and biodiversity. FOLU estimates the total additional investment and intervention costs of those transitions at between 300 billion and 350 billion USD per year from 2020 to 2030 (which would be equivalent to about 0.3%–0.4% of global GDP at current prices in 2018–2019, when the estimates were produced).

All the cost estimates mentioned so far are aggregates, some for the planet and some others for developing countries in general. What is needed now is to conduct more detailed studies related to actionable programs for the transformation of food systems at the level of individual countries.

4 SOURCES AND FLOWS OF FUNDS

Following Díaz-Bonilla et al.^[2] a broad view of financing is taken here, considering six main flows of funds that need to be mobilized and scaled up toward financing the transformation of food systems (Fig. 1). Two are internal to food systems: food

and food-related expenditures by consumers, which constitute the sales/revenues of operators in food value chains (including the intra-flows between different subcomponents of the value chains). Four are external to food systems: international development flows (concessional and non-concessional loans, grants and donations); public budgets (expenditures and revenues); banking systems; and capital markets¹.

Each flow has different actors and therefore the policies and interventions needed to reorient and scale them up to finance the transformation of food systems would be different.

First a sense of the quantities involved is needed; how much money represents each flow. Based on that, it can be estimated how large is the gap (if any) between current financial flows and the expenditures needed for the desired food systems transformation. Also, looking at the different financial flows, it can be assessed whether they are currently supporting activities that help to achieve that transformation or are detrimental to the desired objectives.

4.1 Internal flows

Consumer food expenditures include those for the direct consumption in the house, but also the sales of food products to consumers by operators outside the house in a variety of settings (such as different types of cafes, bars, restaurants, cafeterias and street vendors). Consumer food expenditures

Fig. 1 Flow of funds for food systems. Sourced from Díaz-Bonilla et al.^[2].

¹ All figures are simplifications. Figure 1 is used to help organize the discussion of the estimates of financial flows and the discussion of what to do. Lines were added for the flows intra food value chains. The bidirectional lines are, for example, because the public sector offers subsidies but may also impose taxes, and banks lend to firms and then receive payments back. The figure may be more complex by also adding bidirectional lines across the four external flows.

of expenditure to AFF relative to its value to their economies; as a reference the AOI for developed countries is 0.41^[1]).

As noted, these numbers do not include other public expenditures relevant for agriculture, such as rural infrastructure, or for the food system as a whole.

Another important type of expenditure related to SDG2 and ending hunger is for programs of social assistance; they are linked to poverty and vulnerability and are financed by general revenues from the government and not by contributions from beneficiaries (i.e., non-contributory programs). They include conditional cash and unconditional cash transfers, social pensions, school feeding, public works, food programs, health fee waivers and other social assistance. They are part of the broader category of social protection, which includes as well programs financed by the beneficiaries (contributory). About 44% of the outlays for all developing countries (and 53% excluding China) have been for conditional and unconditional cash transfers and social pensions^[1].

For the countries in the ASPIRE database (sourced from the World Bank and the basis of Table 2), the median of social assistance expenditures is less than 1.2% of their GDP^[1].

The estimates for climate-change adaptation and mitigation show even smaller numbers (58.8 billion USD) particularly for AFOLU (only 4.1 billion USD).

However, public expenditure reviews should consider not only the funds related to the desired transformation of food systems but those that appear to work against it as well, for example, public budgets also include large subsidies to fossil fuels (expenditures and tax exemptions), which Díaz-Bonilla and Echeverría^[4] reported at over 800 billion USD (based on Parry

et al.^[24]). Eliminating those subsidies would reduce incentives for fossil-fuel use, and the funds could be reallocated to adaptation and mitigation in food systems and other sectors.

These considerations suggest the need to utilize a broader food-system focus to analyze, in each country, the level and composition of public expenditures (and taxes, for which there is far less information^[23]) that are relevant for achieving the desired transformation of food systems.

4.4 Banking system

Although, in the previous sections on international development aid and governmental budgets, the focus was mainly on public flows, the transformation of food systems will also require significant private investments from all operators in the food value chains. The internal cash flows from food operations (based on consumer food purchases) can be expanded by loans from the banking system (discussed here) or by operations in capital markets (analyzed in the next section).

Díaz-Bonilla^[1] presented data (from FAOSTAT) on the total amount of loans outstanding (a stock, while the data in the previous sections were flows; average of 2014–2019 in present value), which was provided by the banking sector to producers in AFF (including household producers, cooperatives and agribusinesses, but not other operators in food systems) and for all sectors.

There are no data on net disbursements (loans minus repayments of principal), but the change in stocks may be an indicator of net flows. For total credit, the average annual change in stocks for 2015–2019 was about 1.6 trillion USD globally; but the average for developing countries (excluding China) was only 87 billion USD. The average annual change in

Table 2 Public budgets

Category	Total government outlays (billion USD; average for 2014–2019)	Outlays for agriculture, forestry and fisheries (billion USD; average for 2014–2019)	Outlays for social assistance (billion USD; average for 2014–2018)	Outlays for climate-change adaptation and mitigation (billion USD; average for 2017–2018)	AFOLU (billion USD; average for 2017–2018)
Developing countries	8013.2	410.9	407.7	na	na
Developing countries (without China)	5026.2	125.1	260.9	na	na
Developed countries	19044.8	136.9	na	na	na
Total	27058	547.8	na	58.8	4.1

Note: Sourced from Díaz-Bonilla^[1] and Díaz-Bonilla and Echeverría^[4] with the databases and sources mentioned in those publications. These figures should be seen as approximations of the orders of magnitude and should not be added across categories, given that sources of the data and time periods vary, and that the categories of developed and developing countries also differ across data sets. AFOLU is agriculture, forestry, land use, and natural resource management.

have made pledges and formed coalitions such as the Glasgow Financial Alliance for Net Zero (GFANZ) and the Climate Finance Leadership Initiative. However, they refer to climate change in general and not food systems^[27].

Also, in discussing the financing of food system transformation plans it is necessary to consider overall constraints on the flows of funds, both at the global and country levels. A general constraint is defined by global aggregate savings; they amount to about 21.6 trillion USD (average of 2015–2019) but are distributed very unevenly across regions^[1]. Further, global savings are the counterpart to world investments. Therefore, any proposal to increase investments in certain activities would require adjustments in other investments and/or consumption, with economy-wide repercussions that must be considered.

There are budget constraints at the level of each individual flow of funds that need to be analyzed as well, such as international development flows or public budgets in individual countries. Therefore, there may be economy-wide repercussions that must be considered when funds are reallocated from some activities to different ones^[1].

5 HOW TO IMPROVE, REORIENT, AND SCALE UP FINANCIAL FLOWS FOR THE TRANSFORMATION OF FOOD SYSTEMS

In the previous sections the main questions analyzed were the objectives of the transformation of food systems, the estimated costs involved in such transformation, and what were the options for financing the interventions needed and their quantitative availability. This section (which follows mainly Díaz-Bonilla et al.^[5]) looks at how can those potential sources of finance be reallocated, mobilized and scaled up to achieve the desired transformation of food systems.

5.1 Better data on financial flows

The previous sections reviewed the available data on financial flows and although they cover some components of food systems (mainly primary agriculture, forestry and fisheries, some programs relevant for social protection and nutrition, and some aspects of climate-change adaptation and mitigation), an overall view of the funding of the whole food system is lacking.

The more systematic data-gathering work is done by the

Standing Committee on Finance on climate finance^[20], but it does not include other objectives of the desired food systems transformation (e.g., SDG2). Also, it only distinguishes climate-change adaptation and mitigation activities related to AFOLU, without including a review of financial flows to all segments of the food systems.

Therefore, a more thorough collection of information about financial flows it is needed for the whole food system, and across the different objectives of the desired transformation. Further, it is not enough to estimate the value of that funding but it is also relevant to consider the nature and impact of the activities financed; are they helping, hindering or are neutral regarding the desired transformation. That analysis should help answer several questions: what the amount of available financial resources is; whether some of them can be reallocated toward the desired objectives; and, if that is not enough, then where the additional money may come from, considering the overall availability of financial resources (budget constraints).

5.2 An adequate overall incentives framework

Adequate macroeconomic policies, a supportive business environment, and peace are basic requisites for the operation of food systems. Without those foundations, food systems, and indeed the whole economy and society, will not function properly.

Also, more specific policy and incentives frameworks will be needed to achieve the objectives of the desired transformation of food systems. For example, focusing only on climate change, it should be important to define net-zero emissions as policy targets, the pricing of externalities, development of carbon markets and implementing risk disclosures (as suggested by the Task Force on Climate-related Financial Disclosures (TCFD) of the Financial Stability Board).

It is also crucial to provide the adequate incentives framework for consumers. In principle, they want affordable, convenient, good-tasting and safe food, and also may profess to value healthy food and environmental sustainability (although the latter preferences may not be reflected in their choices). This dissonance may be related to the costs of healthy and sustainably produced foods, lack of information, or other factors. Governments can influence the food environment (including the prices, incomes, preferences and the market structure that frame consumer decisions), by using taxes and subsidies, income support with a nutrition focus for the poor and vulnerable populations, nutritional information/education

and regulations (e.g., labeling requirements, advertisement standards, urban zoning and the like)^[1,2]. These interventions can also help to redirect demand from obesogenic consumption and toward healthier and more sustainable diets.

Another key policy and incentives framework is the one that frames the decisions of the operators in food value chains. Governments influence the decisions of those operators, using regulations and controls related to health, nutrition, food safety, labeling and advertising. Governments also tax and subsidy activities, but not necessarily they are aligned with the health and environmental objectives of well-functioning food systems. There are also regulations and controls related to labor conditions (to promote decent jobs) and to competition (to avoid market distortions from dominant positions by some operators). Other regulations and interventions will be needed to address climate and social objectives, such as stopping deforestation and displacement of vulnerable communities from their land, and for the reduction of food loss and waste^[1,2].

5.3 Scaling up, reallocating and using more strategically international development funds

As mentioned above when discussing better data on financial flows, there is information about agriculture in general, and what part of climate finance goes to AFOLU, but there is not enough information about how much goes to food systems and for what purposes.

Nevertheless, the existing information suggests that this type of financial flow is the smallest of all external ones, needs to be scaled up, in some cases reallocated, and in general used more strategically.

For example, regarding climate finances developed countries pledged in 2009 at COP15 to provide 100 billion USD annually for mitigation and adaptation by 2020; this pledge was renewed at COP26, but it is yet to be fulfilled (the latest figure for 2020 is about 83 billion USD, lower than the average for 2017–2018 mentioned before). Also, Díaz-Bonilla^[1] suggested that international development flows for food systems should be increased by about 15 billion USD above current levels (within the range suggested in Laborde, Parent, and Smaller^[13]) to achieve SDG2 and eliminate hunger (including funding to support a Zero Hunger Alliance & Fund to help countries design and implement national programs to eliminate hunger).

However, if total international development flows cannot be

increased (because of budgetary and political factors in donor countries, and the limitations of their capital base and restrictive financial policies in the case of MDBs), then it would be necessary to reallocate funds from other activities to the transformation of food systems. For example, some of development funds are still supporting investments with high GHG emissions^[20]. At COP26, several countries and public finance institutions committed to ending financing abroad of projects with unabated fossil-fuel energy by the end of 2022, and those funds, as well as other with low priority uses, can then be reallocated to the transformation of food systems.

International public resources should also be used more strategically to leverage and mobilize the large liquidity in global private capital markets. Blended and parallel finances, guarantees to de-risk specific projects and socially or environmentally themed bonds can support private investments that address larger humanitarian and development objectives. This potential for leverage is also relevant for the possible uses of the International Monetary Fund's newest issue of Special Drawing Rights (SDRs) (about 650 billion USD, of which about 60% has gone to developed countries that do not need these funds). Currently, the discussion has been about reallocating a share of them to developing countries to finance mitigation and adaptation activities. The approval of the Resilience and Sustainability Trust at the IMF has been a step in that direction. However, there are other options with larger multiplier impact that should be explored (such as the proposals in Díaz-Bonilla^[1,28] and von Braun and Díaz-Bonilla^[29] to use a percentage to SDRs to set up a fund to guarantee the issuing by developing countries of zero hunger bonds or pandemic recovery bonds as perpetual bonds).

In addition to using international development funds more strategically to leverage and mobilize private funds, multilateral and bilateral organizations should better coordinate their own operations to avoid the fragmentation of relatively isolated initiatives and competition across international agencies at the national level.

5.4 Improve the structure of expenditures and revenues in public budgets for the transformation of food systems

Indicators, such as the AOI for agricultural expenditures or the percentage of social assistance expenditures in total GDP, show that developing countries in general devote comparatively few resources to those crucial interventions needed to achieve SDG2 and other objectives related to the transformation of

food systems. In Díaz-Bonilla^[1] it was suggested that individual developing countries should try to increase the AOI for their public expenditures to about 0.5 and social assistance expenditures to at least 2% of the GDP to address SDG2 and ending hunger. Díaz-Bonilla and Echeverría^[4] also showed that the levels of public expenditures for climate-change adaptation and mitigation were low, particularly in relation to agriculture and related activities.

Of course, the level of public spending alone cannot determine agricultural performance, nor is there any formula to indicate whether a certain level of spending is more adequate than another. However, there are several studies showing that the type of expenditures matters^[30], particularly their orientation toward the provision of public goods, such as agricultural R&D, which is still low in most developing countries^[31]. Scaled-up investments in science and technology are also needed across the whole agrifood value chain and the consumer environment. A proposal recommends that national investments in these areas should reach at least 1% of food-system-related GDP^[32].

An option to increase and improve the expenditures in the case of agriculture is the repurposing the agricultural support measures (about 600 billion to 700 billion USD) that currently include a variety of expenditures and transfers to producers. Of this, about 35%–40% are subsidies (concentrated in Europe and China) that could be repurposed toward the provision of environmental public goods and support of healthier and more sustainable diets, instead of supporting products that damage health and the environment^[17]. The total amount of agricultural subsidies in developing countries (excluding China) is about 52 billion USD^[1]. Quantitative estimates of those potential reallocations show the possible complementarities across different SDGs, but also trade-offs, that must be considered in repurposing those expenditures.

In the case of social assistance as well not only the levels of expenditures matter but it is also necessary to improve the design of the programs using the evolving type of enhanced social safety nets^[33], while significantly improving the targeting^[1].

Public budgets also include large and direct fossil-fuel subsidies, amounting globally to over 800 billion USD (as noted before from Parry et al.^[24]). The Glasgow Climate Pact agreed at COP26 commits countries to “accelerating efforts towards the phase-down of unabated coal power and inefficient fossil-fuel subsidies...”, which if implemented would allow the

reallocation of those funds to finance adaptation and mitigation in food systems.

However, reallocating or repurposing, along with better targeting, even with improved instruments, may not be enough to reach the levels needed to achieve the desired transformation of food systems and, therefore, expenditures and revenues may have to be increased.

Different ways to achieve this include: improving tax administration to reduce tax evasion; reassessing the multiple exemptions to value-added and sales taxes (which in several countries, represent an important loss of revenue; are not targeted to the poor consumers; and do not address challenges of nutrition or environmental sustainability); implementing taxes on unhealthy and/or environmentally damaging food products; analyzing taxes on international trade considering the impact on production and consumption incentives for the transformation of food systems; using more progressive taxation of incomes and wealth; and pricing the externalities of fossil fuels, not only to shift incentives away from high GHG emissions, but as a source of revenue (Parry et al.^[24] estimate that if all the explicit and implicit support to fossil fuels were eliminated, then the revenues generated in 121 developing countries in 2025 would be about 3 trillion USD).

It is also important to note that many developing countries are already facing fiscal stress as a result of the coronavirus pandemic. These countries will require strong support from international financing agencies to design and fund their pandemic recovery programs in the short-term and a just climate transition in the medium term. More is needed as well regarding controls at the international and national levels on money laundering and tax havens that facilitate illegal financial outflows and tax evasion from developing countries, while the proposal for a more unified system of taxation of international corporations must also be implemented^[1].

Therefore, the fiscal analysis with a focus on the transformation of food systems should include not only expenditures but also revenues. Those fiscal reviews can help determine the adequacy of both the level and composition of public expenditures and taxes dedicated to food systems, as well as their efficiency, efficacy and equity, in regards to the desired transformation of food systems. Those analyses can help define the reallocation, better targeting and programmatic improvements for public expenditures within the existing budget limits, and design an improved tax systems.

5.5 Guide banking systems and capital markets to financing the desired transformation of food systems

The banking system and capital markets are significant sources of funds. However, the previous sections highlighted the insufficiency of information on the level of funding from the banking systems and capital markets for food systems, and the existing information suggests that financing for the transformation of food systems is limited. Concurrently, as noted banks and investors continue to finance fossil-fuel operations and activities linked to deforestation.

Expanding the current levels of funding from banks and investors for the transformation of food systems requires understanding and lifting the systemic barriers that limit the supply of financial sources and services, particularly for agriculture, small farming enterprises and SMEs in food systems, and the poor and vulnerable (women, disadvantaged ethnic groups, and youths).

A starting point was already mentioned: the need for an adequate macroeconomic, regulatory and incentives framework. Lending to the agricultural sector is affected by macroeconomic volatility, and by regulations that are designed for the urban sector and for activities with more regular cash flows than agriculture. Policies requiring disclosure of climate-related risks could make banks and investors steer away from operations leading to high GHG emissions. Also, legislating net-zero emissions targets, pricing externalities, and developing carbon markets, can guide the necessary financial flows.

In the banking systems some of the main constraints relate to the sources of funding, the types of institutions, and the lack of adequate instruments^[34]. Regarding sources of funding, central banks, framed by appropriate monetary programs that address inflationary objectives, can issue dedicated lines of credit to financial entities, which in turn can finance loans for the transformation of food systems, targeted to small farming enterprises and SMEs, including women and youth, in food value chains. Using central bank discounts to finance credit lines for agriculture was the norm in many developing countries until the policy changes of the 1980s and 1990s^[23].

With respect to institutions, well-managed public development banks^[23], which already are key contributors to agricultural and climate finance, can be important instruments for addressing market failures that affect financial markets in relation to those activities and sectors. They can also help to mobilize private sector funds from commercial banks and private investors by using blended finance and de-risking

arrangements with their own public capital. To accomplish that, public development banks need to operate with the adequate incentives, performance metrics and controls that would help to avoid the problems of the past in this type of institutions that led to their scaling down and even elimination in the 1980s and 1990s.

For financial instruments continuous innovation is needed, both on the lending side, and for savings and other financial services used by actors along the food value chain. A central instrument is credit, particularly longer-term operations, which face specific problems in the agricultural sector, such as the dispersion and small scale of customers, and weather and other risks. Innovative insurance schemes, technical assistance and better weather and market information can mitigate some of those risks. However, credit for long-term investment may require earmarked funding from public fiscal or monetary sources. Supply-chain and value-chain lending also offer a flexible form of financing that can include small farming enterprises and family farms. In any case, beyond the obstacles to credit, other financial products and services for small farming enterprises, rural populations, and SMEs in food systems are needed. This is true both on the financing side (such as leasing, warrants, and the discount of invoices, all of which require the adaptation of regulations and operational mechanisms) and on the payments and savings side (e.g., simplified payments and deposits). In general, digital technology can help to better reach small farming enterprises, SMEs and rural populations reduce transaction costs and generate more information about potential customers, lowering risk for financial institutions. Other instruments such as sustainability-linked loans and bonds (used to finance decarbonization transition plans, with interest rates that fluctuate depending on the attainment of emissions-reduction goals or supply-chain sustainability metrics) can also help (see a more detailed discussion in these references^[1,4,34]).

Regarding capital markets, in addition to the overall incentive framework mentioned above, a further requirement is the development of a robust pipeline of investable opportunities (including individual projects, impact investment funds, green bonds and other instruments), which can be helped by establishing a dedicated project preparation/incubation/acceleration facility^[35,36]. Another proposal to mobilize private funds in capital markets is the use of SDGs to guarantee zero hunger and pandemic recovery bonds to finance related public programs^[1,4].

In summary, many policy interventions and innovations are needed to mobilize funds from banks and capital markets on

Compliance with ethics guidelines

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