Review Article

Comment [U1]:

Quantifying the Hidden Costs: A Review of True Cost Accounting in Agrifood Systems

Abstract

Agrifood systems provide food along with providing employment opportunities to a large number of people around the globe. While the positive aspects are well known to all, many negative costs also arise out of agrifood systems which when given a monetary value are known as hidden costs. Antimicrobial resistance, air pollution, soil erosion, unhealthy diet composition, unaffordability of healthy diets, and water contamination are a few such negative costs. Though the food producers are responsible for these, they are not held accountable for the same as these costs are not reflected in the market prices of the food.Hidden costs are measured and valued using a methodology called True cost accounting (TCA). An assessment by FAO (2023) using TCA revealed that the total hidden costs of agrifood systems stood at 12.7 trillion dollars, which is around 10 per cent of the global gross domestic product (GDP) in 2020.Hendricks et al., (2023) also used TCA for calculating the hidden costs of agrifood systems and reported total hidden costs of 29 trillion dollars per year, while the cost of the total food at market prices is only 9 trillion dollars per year.Though adding up these hidden costs to the total price of the product will result in the rise of prices of food, a shift to sustainable production, in the long term, would make prices relatively lower and also will improve the productivity of the population by providing healthy food and conserving the environment. Therefore, it is imperative to integrate such assessments at regional levels so that the respective governments can use specific levers to internalise the costs and move towards sustainability.

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Comment [U3]: Remember that this is abstract, summarise the main findings of your work, the method used and your recommendation. If possible, do away with referencing because you are not reviewing. In addition, your abstract lack the main ingredients. You started well but later focused on review and justifications of the study which are not essential here. Your abstract should include: brief problem statement, objectives, methodology used for review, results from the review literature, conclusions and recommendations

Keywords: agri-food systems, hidden costs, externalities, true cost accounting,sustainability

1. Introduction

Global agrifood systems provide the food that nourishes the population in tandem with providing employment to the majority of the population. On the other side, certain negative costs such as natural resource degradation, climate change, carbon sequestration, and biodiversity conservation, etc., are also inherent in the food systems.Agrifood systems are reported as one of the major contributors to greenhouse gas (GHG) emissions (Pachauri, 2014). They are also the single largest consumer of freshwater, totalling around 70% of total water usage (World Bank, 2023). They are also leading to antimicrobial resistance, air pollution, soil erosion, unhealthy diet composition, unaffordability of healthy diets, water contamination etc. The prevailing market prices of the food do not account for all such negative costs. Such negative effects, along with certain benefits that arise out of the production or consumption of goods and services while not getting reflected in the product market prices are termed as externalities (OECD, 2003). These unaccounted costs, which are termed hidden costs, often lead to distorted information arising out of market prices (Gemmill-Herren et al., 2021), indirectly rewarding unsustainable food production and consumption practices. Overall, these externalities hinder our progress towards ensuring sustainable consumption and production practices as envisaged in goal number 12 of the United Nations Sustainable Development Goals.

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2. Agrifood systems and their capital flows

Agrifood systems comprise various actors with multiple connections between them. Generally, theyinvolve three players: the players in the agricultural industry, the actions these players do, and the broader supportive environment. From farmers and agricultural companies to processors and distributors, the actors represent the entire spectrum. The laws, regulations, and financial commitments that impact market accessibility and sustainable production are all part of the enabling environment. It involves all the actors and their activities from the production, aggregation, processing, distribution and consumption stages.
From their multi-layered structure to their interactions with the resources that support both people and the natural world, agrifood systems are dynamic. They are also affected by actions made by businesses, consumers, and legislation. The underlying workings of agrifood systems, their effects on resources (and vice versa), and the levers available to modify them are depicted in Figure 1. The framework facilitates the understanding of the multiple effects and interdependencies of agrifood systems, as well as the chances for improvement that exist for decision-makers.

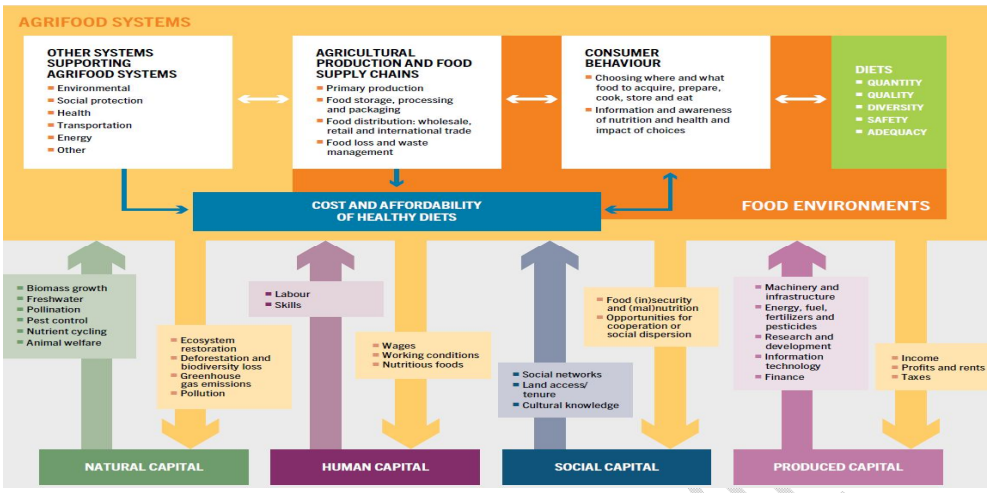

Figure 1: Capital flows in agrifood systems

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Agrifood systems are shown by the yellow rectangle in Figure 1, which demonstrates how they are made up of consumer behaviour, diets, agricultural production and food supply chains, and interactions with other systems including the environmental and health systems. Aquaculture, fisheries, forestry, and crop and livestock production are all included in agricultural production. Food environments, or the physical, economic, sociocultural, and policy variables that influence access, cost, safety, and food preferences, overlap with food supply chains, consumer behaviours, and diets. The arrows that flow into and out of agrifood systems show how the natural, human, social, and produced capitals are both dependent on and impacted by the activities of these systems. These are characterised as follows and serve as the cornerstones of environmental sustainability, economic prosperity, and human well-being:

Natural capital: the stock of renewable and non-renewable natural resources that combine to yield a flow of benefits to people

Human capital: the knowledge, skills, competencies and attributes embodied in individuals that contribute to improved performance and well-being,,

Social capital: the networks, together with shared norms, values and understanding, that facilitate cooperation within and among groups,,

Produced capital: the human-made goods and financial assets that are used to produce goods and services consumed by society.

While all four capitals are key to the agrifood systems, there is discrimination in measurement and valuation among them. Produced capital and to some extent, human capital are the only capitals that are measured regularly and are considered in the process of decision-making. Whereas, social capital and natural capital are seldom measured making them economically invisible. And thereby, any decisions taken in the arena of agrifood systems are inherently biased and are taken based on incomplete reality.

3. Externalities in agrifood systems

3.1.Classification of externalities

Externalities can be classified based on their effects and also based on their place of origin. Under the basis of effect, they are classified as positive and negative externalities. A positive externality is any benefit that arises out of the production or consumption of goods or services. For example, biodiversity conservation arising because of organic farming is a positive externality as it promotes and enhances biodiversity. Whereas, in the case of a negative externality, costs will arise out of production or consumption. For instance, monocropping leads to soil degradation which is a negative externality.

Externalities can also be termed production-based and consumption-based, based on their place of origin. Positive benefits to neighbouring farms because of bee rearing in a particular farm is a production-based externality. Theemission of greenhouse gases because of food waste is a consumption-related externality.

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3.2.Effects of externalities on societies

Externalities cause certain vital issues for food systems, globally. The first issue is that by warping the message about the worth of food that market prices transmit, externalities impede society from realising its full potential. Products' genuine costs and advantages are not reflected in their market pricing. Also, a company's earnings do not represent its contributions to climate change, underpayment of employees, or provision of reasonably priced, healthful food (Serafeim et al. 2019). The food industry's economic worth is determined by its GDP contribution, which is calculated as the total added value of all businesses, or the value of output less the value of intermediate consumption calculated at market prices. Therefore, critical economic indicators for policymakers such as GDP, do not account for the extent to which food systems contribute to deforestation, climate change, or poor health. As a result,

externalities cause countries to have lower average living standards than would otherwise be possible.

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Social injustice is a second issue with negative externalities. Damage from the environment, such as air and water pollution, is frequently concentrated in areas where marginalised communities live. Vulnerable groups, like children, are frequently the targets of heavy marketing campaigns for unhealthy items. The end result is a range of involuntary damages that violate the rights of those who grow our food and may involve grave rights violations such as forced labour, harassment of women, or underpayment in the agricultural sector.

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The third issue with externalities is that they unintentionally encourage the production and consumption of unhealthy, unsustainable, and expensive food. Food production that is harmful and unsustainable is more profitable because natural, health, and social costs are externalised. Cheap labour is represented by child labour, forced labour, and low-paid labour; cheap inputs are produced by depleting natural resources without replenishing them, and limiting pollution reduces expenses. However, despite the detrimental impacts on health, promoting and increasing calories, salt, bad fats, sugars, and unhealthy sugar substitutes to food items might boost sales (Stuckler et al. 2012). Also, the majority of capital will go to the businesses that are best at externalising expenses in order to maximise profit since capital is allocated on global markets based on financial returns (Serafeim et al. 2019).

3.3.Need for accounting the hidden costs

Accounting for hidden costs has several advantages to offer for producers, consumers and decision-makers. Firstly, it will reveal the true costs of the food that we are consuming. This will allow the consumers to make informed decisions regarding their consumption patterns. Accounting also provides the necessary data in all the capitals involved in agrifood systems, thereby evidence-based results can be used fordecision-making. As evidenceis available, legal actions can be taken by the relevant authorities in case of violations or deviations from the normal. This will also lead to fair and equitable food systems. Finally, they also help in identifying the origin of the externality and the community which is being affected. This will help in punishing the person or organisation responsible for the negative externalities.

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4. True cost accounting (TCA)

TCA is a holistic and systemic approach to measure and value the positive and negative environmental, social, health and economic costs and benefits to facilitate policy, business, farmer, investor and consumer decisions (Soil & More Impacts & TMG, 2020)

Breakdown of the definition

Holistic and systemic - TCA examines entire systems, taking into consideration how their constituent parts are interrelated, even through higher-order effects. It considers several capitals and stakeholders, constantly examining the connections between them.

Measuring and valuing - The primary instruments in the TCA toolbox are effects measurement and valuation. In this sense, valuation is defined as stating an effect's value to its stakeholders. This is required in order for it to be considered when making decisions. There are other ways of valuing, such as monetary, quantitative, and qualitative.

Positive and negative; costs and benefits - The concept of TCA appears to contradict the inclusion of benefits, or positive outcomes. In fact, TCA reveals both favourable and unfavourable (external) consequences that are insufficiently considered in conventional decision-making. Making wise decisions requires knowledge of both.

Environmental, social, health and economic - Although this is not a binding segmentation, these four dimensions capture the broad perspective that TCA has on scope effects. Additionally, the four capitals—natural, social, human, and produced—reflect this expansive viewpoint.

To facilitate decisions - In TCA, the use of decision-making is crucial. Despite the term "accounting" being in the name, the focus is on using accounting information appropriately.

Decisions by policymakers, businesses, farmers, investors and consumers - TCA's information can be used by a broad range of audiences to make decisions. Although all other audiences can be viewed as secondary (for instance, companies are targeted if policymakers utilise fiscal incentives based on a TCA analysis), policymakers are the primary audience in this paper.

4.1.Steps involved in TCA

Broadly TCA involves steps such as framing, scoping, measuring, valuing and application. The steps are briefly described in the following subheads:

4.1.1.Framing stage

Describing the policy: Using TCA, decision-makers can incorporate aspects of hidden costs that they would not have otherwise had access to. The issues of livelihoods and rural development, resource usage and climate change, and food security and nutrition must all be balanced by policymakers. Depending on the dominant natural state and socioeconomic situation of their nation, policymakers usually have distinct areas of interest. In addition to demonstrating who pays what and who benefits, a TCA research can help make decisions by holding stakeholders responsible for their contributions (Reinhardt et al., 2021). The financial picture is usually altered by policy initiatives (as some of those directly involved benefit and others suffer). It is important to evaluate the justifiability of a change in externalities, including spillover effects, from an integrated perspective. Policy decisions should be evaluated for a variety of stakeholders and current costs, but they should also take transboundary and intergenerational consequences into account.

Choosing an assessment design: A TCA study's design is determined by the user and how they want to use TCA (Sandhu et al., 2019). TCA can be used at several points in the policy cycle, from defining the problem to analysing potential policy designs to monitoring and assessing the results. During the policy design phase, the TCA research needs to be employed to provide insights and guidance, rather than serving as justification for a pre-drafted proposal (Merrigan, 2021). Asking what the most pertinent beginning and ending points are is essential when the study is monitoring or looking backwards. The three design categories i.e. baseline assessments, repeated measurements and scenario analysis are frequently seen.

Baseline assessments: In most cases, baseline evaluations use historical data as a point of comparison to estimate the hidden costs of the current state of affairs. Thus, they can assist policymakers in determining areas of emphasis. Comparing the effectiveness of two or more alternatives—such as different manufacturing techniques, goods, companies, nations, cities, and so forth—is a common use. This can then be utilised to encourage the alternative to perform better or to incorporate some of its features into the others.

Repeated measurements: Baseline evaluations gauge a system's condition at a specific moment in time. It's critical to monitor any actions done in response to the baseline assessment to see if they actually result in progress. Studies using TCA that repeat measurements over time are rather rare.

Scenario analysis: There is always a forward-looking or predictive element to scenario analysis. Two or more future scenarios are forecast based on policy choices, one of these is usually a "business-as-usual" scenario, when no additional policy is enacted. Every scenario's advantages and disadvantages are calculated, along with the investments needed to get there. The best-performing scenario can be spread using the findings of scenario analysis.

4.1.2.Scoping stage

Choosing functional unit: TCA can assist in determining possible paths for an agrifood systems transition and indicates regions that require modification in areas including supply networks, domestic production, and agricultural methods (TMG Think Tank and WWF, 2021). Similar to this, a TCA study's policy purpose inherently identifies the best unit of analysis. Such a functional unit establishes the parameters of a TCA study by defining what is tested and judged by it. Choosing the functional unit to use to address the policy question is one of the most important decisions made during the scoping stage. Commonly used functional units are agrifood systems, diet, investment, organisation and product. Choosing a small functional unit will help in detailed analysis which cannot be done when the whole agrifood system is studied.

Setting boundaries: Boundaries allow a TCA study to achieve its objectives while maintaining a manageable scope. The fact that "the true cost... will inevitably be only an approximation, or an incomplete snapshot, limited by a given set of boundaries over a given period of time" must thus be kept in mind. Geographical borders restrict the selected functional unit to a certain geographic area. For instance, examining the various diets of only the people in Latin America, examining meat produced in Germany, or researching rice production in Thailand are examples of geographical boundaries. Selecting the system as a functional unit and then drawing geographic limits based on their sphere of influence and capacity to act on the findings is a very popular and helpful use for policymakers. In this manner, a TCA can take into consideration the agrifood systems as a whole while concentrating on the sector that policymakers find most significant.When data are reported in their functional units, the time period they span is referred to as the temporal limits in a TCA study. These limits are intimately related to the evaluation design that was selected.

Choosing of indicators: The essential components of a TCA investigation are indicators. The consequences on consumer health, food security, and climate change are a few examples. A single study may have as many as twelve indicators. In the processes that follow, each

relevant indicator is measured and assigned a value after being chosen based on its materiality. Improving the comparability of various research findings is more important when trying to expand the use of TCA. The TCA community coming to a consensus on standardised indicators and the underlying techniques to quantify the impacts these indicators capture could be one step towards achieving this harmonisation. Table 1 provides indicators that are commonly used in assessing hidden costs under each capital.

Table 1 - Indicators used in TCA

Natural capital	Social capital	Human capital and health	Produced capital
Effect on climate change	Food security	Health effects from food consumption	Taxes and subsidies
Land occupation and land transformation	Effects on poverty	Employee compensations and earnings in the value chain	
Air, water, and soil quality and pollution	Effects on local communities	Employee health and safety	
Water scarcity	Diversity, equality and inclusion	Employee career and skill development	
Recycling and waste management	(Other) effects on human rights		

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TCA studies may contain a lot of data since they employ a multi-stakeholder and multi-capital approach. For example, they may include a significant number of indicators that need to be monitored and appraised. The materiality concept aids in narrowing the scope of a TCA study to the facts that are important, or the factors that have the potential to influence the final decision the study seeks to assist. Selecting indicators within the parameters of the TCA research is a crucial use of the materiality principle. Only a few number of indicators can usually be included due to time, resource, and data availability constraints. Included should be all the indicators that are relevant to the choice of the policy goal.

Indicator size (scale, scope), likelihood, simplicity of measurement, risk level, feasibility, availability of measures to affect the indicator, and expert feedback are a few criteria for choosing material indicators that are useful to policymakers, but they are not the only ones. Practitioners need to take care to make sure that every indication currently in use that has an impact on various stakeholders is fairly represented. Therefore, a key component of a materiality evaluation is stakeholder engagement in order to choose the most pertinent topics for examination (Capitals Coalition, 2022). This can be done in a variety of ways, depending on the circumstances facing the policymakers.

Choosing of valuation approach: Selecting the valuation strategy is still another crucial TCA step. Estimating an indicator's value or utility to individuals or society is part of the valuation process (TCA Accelerator and Impact Institute, 2023). The process of translating measured indicators into information that TCA study users can understand is known as valuation (Bandel et al., 2020b; TCA Accelerator and Impact Institute, 2023). Approaches use qualitative, quantitative or monetary valuation, as well as a combination of different approaches

Qualitative valuation: It is possible to value anything qualitatively as well as numerically (Natural Capital Coalition, 2016). Its application is particularly helpful when a wide range of viewpoints need to be taken into account, when there are conflicting moral or ethical convictions, or when insufficient data exist to support a quantitative assessment. However, quantitative valuation has inherent limitations with respect to replication and validation, as well as bias. Similarly, it is not as easy to compare as the other approaches of valuation. However qualitative valuation might provide an alternative or clarification if monetary values or quantities are hard to comprehend or dispute. Non-numerical examples of valuation include "increases in air pollution" and "decreases in social

Quantitative valuation: Values can be quantitatively assessed using both direct and proxy metrics. This approach can be helpful in situations where monetization is either unaccepted or too difficult and enables the assessment of whether progress has been made. However, it might be challenging to comprehend or draw comparisons, particularly in cases when the context and/or units are ambiguous. Stakeholders may have trouble accepting quantitative valuation when it comes to factors with an ethical component, including the importance of health (Social & Human Capital Coalition, 2019). Heilwell Happiness Index is one instance

of quantitative appraisal that policymakers find significant (TMG Think Tank and WWF, 2021).

Monetary valuation: The conversion of indicators evaluated in several units into a single comparable unit is one of the main advantages of monetary valuation (TCA Accelerator and Impact Institute, 2023). Therefore, non-financial capital can be integrated and compared with intrinsically monetized financial capital through the use of monetary valuation (United Nations, 2021). For instance, the price of unhealthy foods (human capital) and greenhouse gas emissions (natural capital) can be compared when results are expressed in a same monetary unit. Therefore, it allows for the evaluation of trade-offs between various capitals if done accurately and consistently (Social & Human Capital Coalition, 2019).

4.1.3. Applying stage

Interpretation and testing: Prior to interpreting the findings of a TCA study, it is important to test the results' sensitivity to changes in the underlying assumptions. For instance, how the results (and conclusions) change when an investment in more effective irrigation techniques only achieves half of the anticipated water savings? It is important to take into account how sensitive the results are to less precise assumptions, like altering the estimated discount rate or the number of individuals impacted. By supplying the appropriate margins of error, a sensitivity analysis indicates the degree of confidence that may be placed in the findings of a TCA study. When dealing in situations where there is a lack of data, a sensitivity analysis is probably more crucial because many of the conclusions would depend on estimates.

Following the evaluation of the results' sensitivity, the data must be presented in an aggregated manner that facilitates decision-making. The deliberate decision to combine several distinct indications into a single value as a result of the measuring and valuation process is known as aggregation. A TCA study's total number of outcomes can be lowered through aggregation to facilitate interpretation. In theory, aggregation can be simple if all indicators have the same value in a common (monetary) unit. Caution is still necessary, though, as advantages to some people do not always outweigh disadvantages to others. Policymakers have to decide which stakeholder groups' costs are acceptable in exchange for advantages to others, even when one stakeholder group's benefits outweigh the costs to another.

When aggregating TCA data, the most evident division is between costs and benefits. It makes clear whether, in comparison to other possibilities, some stakeholders or capitals are

"losing out." Stated differently, it is best to avoid netting costs and benefits. Stakeholder group or capital aggregate outcomes are further, non-exhaustive alternatives. Different methods of aggregating the information can give decision-makers varying perspectives on the desired policy objective. Based on the aggregation, policy decisions are taken.

Comparing various policy alternatives should takeinto account their consequences across borders and throughout generations. Encouraging agricultural output in area A instead of region B reduces overall pollution but raises it in region A. This is an example of a transboundary effect. To determine if something is just or not, there are no objective standards. The problem becomes considerably more complicated when it comes to intergenerational equity when there is an impact on the climate.

5. Hidden cost estimation

Various estimations of hidden costs of agrifood systems were conducted using TCA revealing the magnitude of costs involved. A few such estimations are discussed in the sub-sections below.

5.1. United Nations Food Systems Summit working group estimation of hidden costs (Hendriks*et al.*, 2023)

Table 2 - Indicators and its related costs estimated by UNFSS working group

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Type of externality	Externality	Costs (USD)
Environmental	GHG emission, nitrogen water pollution, phosphorous water pollution, scarce blue water use, land-use, air pollution	7 trillion
Health (human life)	Contribution to cardiovascular diseases, diabetes mellitus type 2 and neoplasms	11 trillion
Health (economic costs)	Contribution to cardiovascular diseases, diabetes mellitus type 2 and neoplasms	1 trillion

The assessment of hidden costs of agrifood systems by the UNFSS working group revealed that the total hidden costs are around 19 million USD while the market price of the food is much less at around 9 million USD. This reveals that the hidden costs are almost double the prevailing market prices. As explained earlier, market prices when added with the externality costs give us the true cost of the food we consume. By adding both of them we arrive at a price of 28 trillion USD. The true cost of food is around four times the prevailing market prices. This reflects the magnitude of hidden costs in the agrifood systems that are going unaccounted for. It can be seen from the table that health-related costs associated with human life were the major hidden costs followed by environmental and health-related economic costs.

5.2. Food and Land Use Coalition (FOLUC) estimation (Food and Land Use Coalition, 2019)

A similar estimation of the hidden costs of agri-food systems was done by FOLUC in the year 2019. Results are presented in Table 3.

Table 3 - Indicators and its related costs estimated by FOLUC

Type of externality	Externality	Costs (USD)
Health	Obesity, undernutrition, pollution, pesticides and anti-microbial resistance	6.6
Environment	GHG, natural capital costs	3.2
Economic	Rural welfare, food loss & waste and fertiliser leakage	2.1

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The analysis revealed that the total hidden costs were around 12 trillion USD while the market value of the food is around 10 trillion USD. This study also reflects that the hidden costs are higher than the prevailing market prices of the food. The study revealed that health-related costs are the major contributors to hidden costs followed by environmental and economic costs.

5.3. FAO assessment of hidden costs of agrifood systems (The State of Food and Agriculture 2023, 2023)

FAO estimated the hidden costs of agrifood systems to be around 12.7 trillion USD in the year 2020.

Table 4 - Indicators used in the estimation of hidden costs by FAO

Type of externality	Externality
Environmental	GHG and nitrogen emissions, water use, and land-use change
Social	Poverty and productivity losses associated with undernourishment
Health	Losses in productivity due to unhealthy dietary patterns

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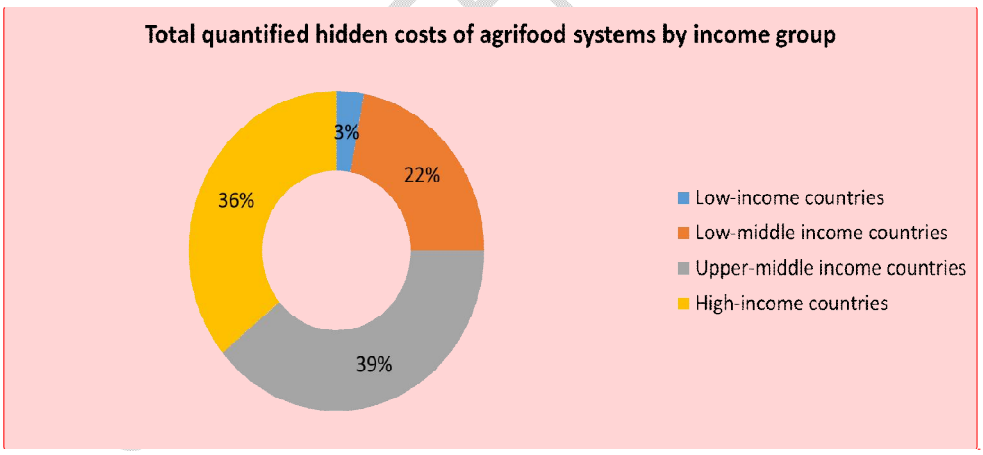

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Figure 2 - Total quantified hidden costs of agrifood systems by income group

It can be seen from Figure 2 that Upper middle-income countries contributed 39 per cent to the total hidden costs followed by High-income countries with 36 per cent, low-middle-income countries with 22 per cent and low-income countries with 3 per cent. The results reveal stark differences between developed and developing economies. High and upper

middle-income countries together contribute around 75 per cent of the total hidden costs while the other two contribute only 25 per cent.

5.3.1. Share of hidden costs to GDP

Table 5 - Countries wise share of hidden costs to GDP

Country	Share of hidden costs to GDP
Low-income countries (LICs)	27.00%
Low-middle income countries (LMICs)	12.00%
Upper-middle income countries (UMICs)	11.00%
High-income countries (HICs)	8.00%

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Table 5 reveals the share of hidden costs to GDP of respective countries. As seen above, LICs had 27 per cent share of hidden costs to GDP while LMICs had 12 per cent, UMICs had 11 per cent and HICs had 8 per cent. Though the share of LICs to the total hidden costs as seen in figure 3 is only 3 per cent, their effect is very severe as indicated by their share to GDP. HICs and UMICs though had higher shares to total hidden costs, their share to their respective GDPs are very low. This reflects that hidden costs have very severe effects on poor nations with majority of the population in such nations involved in food agri food systems. HICs and UMICs dependence on agricultural sector is low when compared to service and industrial sectors and thereby their shares of hidden costs to GDPs are low.

5.3.2. Hidden costs across different externalities

They revealed that in HICs, LMICs and UMICs, health related hidden costs are the major contributors to the hidden costs followed by environmental and social costs. So, dietary patterns are the major reasons impacting the agrifood systems of these nations. Whereas in case of LICs, social related hidden costs are the major ones. This reflects the dismal situation of the actors involved in the agrifood systems of these regions. Poverty and productivity losses are the factors impacting them.

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5.3.3. Intensity indicators of hidden costs

FAO study has also calculated certain metrics to indicate the intensity of the hidden costs on the economies as presented in Table 6. The indicators are namely, Agricultural externalities impact ratio (AEIR), Social distribution impact ratio (SDIR) and Dietary patterns impact ratio (DPIR).

AEIR – It is the ratio between a country's hidden costs from agricultural production and the national gross value added (GVA) of agriculture, forestry and fisheries.

SDIR – It is the ratio of the total income shortfall of agrifood workers below the moderate poverty line of 3.65 dollars per day over the annual total income of the moderately poor.

DPIR – It is the ratio of the average productivity losses per person from dietary intake in 2020 dollars to GDP per capita.

Table 6 - Intensity indicators of hidden costs across various countries

Countries	Agricultural externalities impact ratio	Social distribution impact ratio	Dietary patterns impact ratio
HICs	0.76	NA	0.06
UMICs	0.35	0.15	0.09
LMICs	0.17	0.27	0.07
LICs	0.36	0.57	0.04
India	0.13	0.24	0.07

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Globally, the AEIR is expected to be 0.31, which means that for every $1 of agricultural value added, there are 31 cents of hidden costs generated; that is, in 2020 dollars, hidden costs from agriculture will account for about one-third of agricultural value added. Disparities among different countries is also evident from Table 6 as HICs have the highest AEIR value which is also reflected in their share in contribution to global hidden costs. For India, the value is 0.13 which is relatively better. In SDIR, disparities are seen again, with LICs having high score of 0.57, indicating that the incomes of agrifood workers should be increased by 57 per cent than the prevailing incomes to make them reach the moderate poverty line. And

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finally in case of DPIR, almost all the countries are having values ranging from 0.04 to 0.09 indicating a maximum GDP loss of 9 per cent and a minimum of 4 per cent as a result of hidden costs.

5.4. TCA assessment of Public Distribution System of India

Comment [U19]: Are you now using India aa a case study, please provide justifications for this

Tata-Cornell Institute for Agriculture and Nutrition in the year 2022 have assessed costs associated with greenhouse gas emissions, water use, and pollution resulting from the burning of crop residues. The study revealed environmental costs at around 5.1 billion USD, while health-related costs are estimated to be 1 billion USD. The assessment revealed that the true cost of rice and wheat is 40% greater than the cost borne by the government and consumers. Majority of the environmental and health costs are borne by the people of Punjab and Haryana ((Tata–Cornell Institute for Agriculture and Nutrition, 2022).

6. Levers for agrifood systems transformation(The State of Food and Agriculture 2023,~~2023~~)

Trade and market interventions: Governments can support farmers by assisting them in receiving higher prices or by lowering the cost of food for the general public through trade and market interventions like import taxes and export prohibitions. The quantity of food produced, traded, and eaten is impacted by these policies. Some of these strategies are frequently used by low- and middle-income nations to shield their agriculture industries from import competition or to control domestic pricing so that consumers have access to enough food supply. These policy approaches, however, can result in a less than ideal distribution of domestic resources among various food items since they are frequently distorted. Tariffs aimed against particular goods or commodities, for instance, have the potential to increase their domestic pricing, which would be detrimental to consumers.

Laws and regulations: Laws and regulations are primarily intended to protect natural resources and human health from harm that could result from externalities associated with, for example, production and processing. Commonly cited examples in this regard are regulations on natural resource use, input and fertiliser applications, safe food handling, and food labelling and marketing. One example is the European Union regulation on deforestation-free products, which forbids companies from putting products on the EU market unless they are deforestation-free and legally produced and makes it illegal to export such products from the bloc. Authorities can use laws and regulations to influence

agricultural production and food supply chains by establishing standards and targets that affect both producers and intermediaries.

Subsidies: Tax breaks for farmers are yet another crucial instrument for affecting the productivity of agriculture. These are financial transfers made to individual farmers by the government (or, more precisely, the taxpayer) with the aim of achieving particular goals, such increasing productivity and output in agriculture or sustaining farm revenue by lowering production costs.

General services support: These services, when rendered by governments, come under the heading of general services support and primarily deal with market failures caused by public products, incomplete information, or absent markets. Their provision affects the operation of agrifood systems more widely. Governments hope to lower transaction costs and address market imperfections by providing this kind of assistance. They can increase output, support food availability and safety, and bring down the cost of food, especially nutrient-dense foods. Investing in infrastructure, for instance, can increase food availability by lowering transportation costs and food loss throughout food supply chains and maintaining the efficiency of corporate operations. It is now well acknowledged that research and development (R&D) is a key lever for the transformation of agrifood systems.

Behavioural policies: In this context, labelling and certification are essential. Consumer purchase behaviour can be influenced by front-of-pack labels and/or certifications that highlight sustainability features or other criteria. On the other hand, depending on how they are used and how well they can enforce adherence to sustainability standards, voluntary standard certifications can have varying degrees of efficacy. Additional instances include producer associations and agricultural cooperatives, which can boost farmers' earnings by satisfying consumer demand for niche goods like coffee produced in accordance with conservation agreements.

Public and private capital: Another important lever in agrifood systems is capital, both public and private. Up to $9 trillion USD is invested annually by private investors worldwide in agrifood systems.16 This represents over 14 times the level of public support for the food and agriculture industries, and it has an impact on consumer choice as well as how food is produced, processed, and distributed. Since agrifood companies and investors are at the forefront of supply-chain threats and have a strong interest in creating innovative initiatives to improve risk management and overall resilience, they are also important funders of

sustainability research, such as improving farming techniques and technologies. The creation of long-term development strategies depends critically on how government laws, rules, and policies interact to affect where and how private money is invested. Co-benefits of sustainable agriculture can be encouraged when policies are created to support sustainable production paths. Significant potential exists for public capital to enhance the sustainability of agrifood systems. For instance, insurance can encourage producers and investors in agrifood systems to increase their contributions to sustainability. Small-scale producers, who could get caught in vicious cycles of shocks, debt, and poverty, should pay special attention to this. It is imperative to reduce impediments in financial system components, such lending and savings institutions, in order to encourage investments in sustainable agrifood systems. Public-private collaborations may serve as tools for implementation.

7. Conclusion

In conclusion, externalities are a major obstacle to the shift to sustainable food systems. It is hard to see how policies that promote sustainable food systems will work in an economy that allows and heavily rewards the depletion of natural capital, violations of human rights, and consumption of unhealthy food. Hidden costs are also significantly more than the market prices of food. Estimations reveal and further,strengthen the principle of common but differentiated responsibilities as it was evident that the share of developed nations in the total hidden costs is higher than the developing countries. The above review provides a snapshot of the magnitude of hidden costs in our agrifood systems and calls for urgent interventions to decrease their burden on both the environment and the population.

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