Unveiling the true costs of food production in Kenya and Viet Nam

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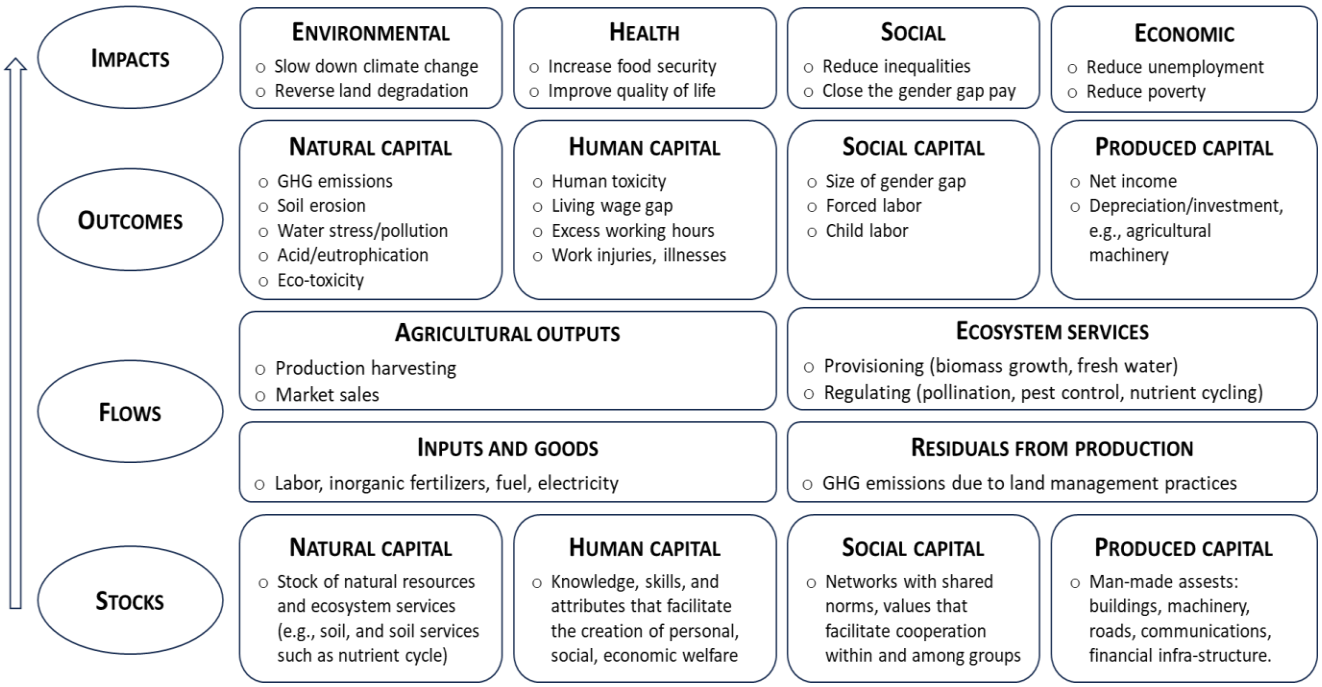
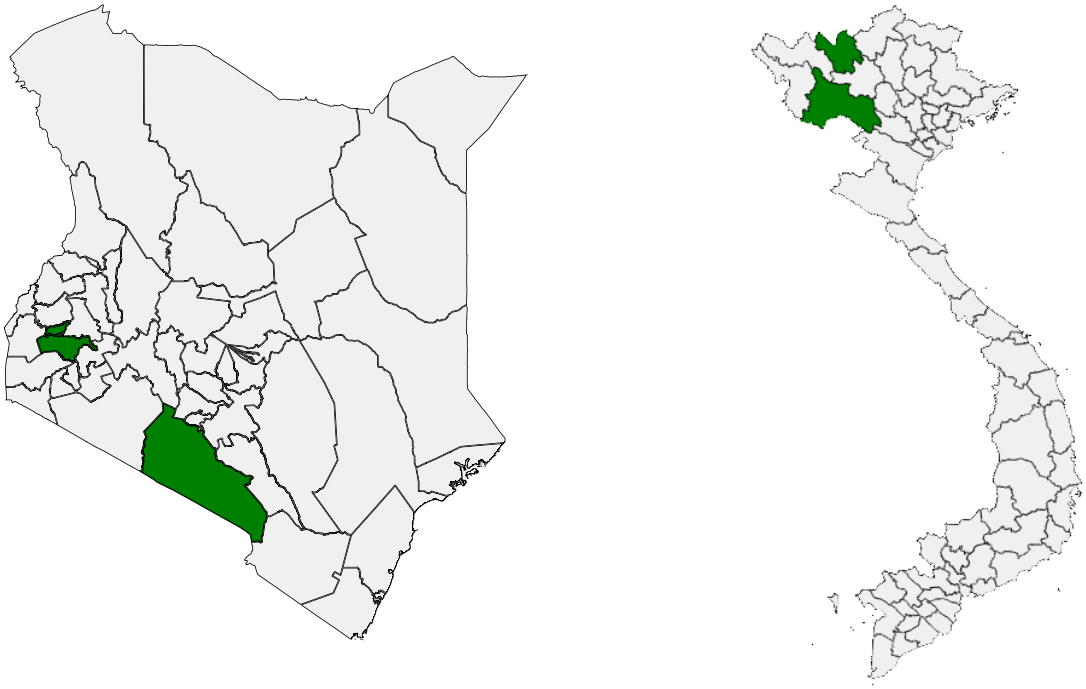


Figure A1. Elements of the TCA methodology.
Note: GHG = greenhouse gas.
Source: Adapted from Müller and Sukhdev (2018) and TCA Handbook (2022).



Kenya Viet Nam

Figure A2. Geographical locations of the surveys.
Source: Authors' elaboration.

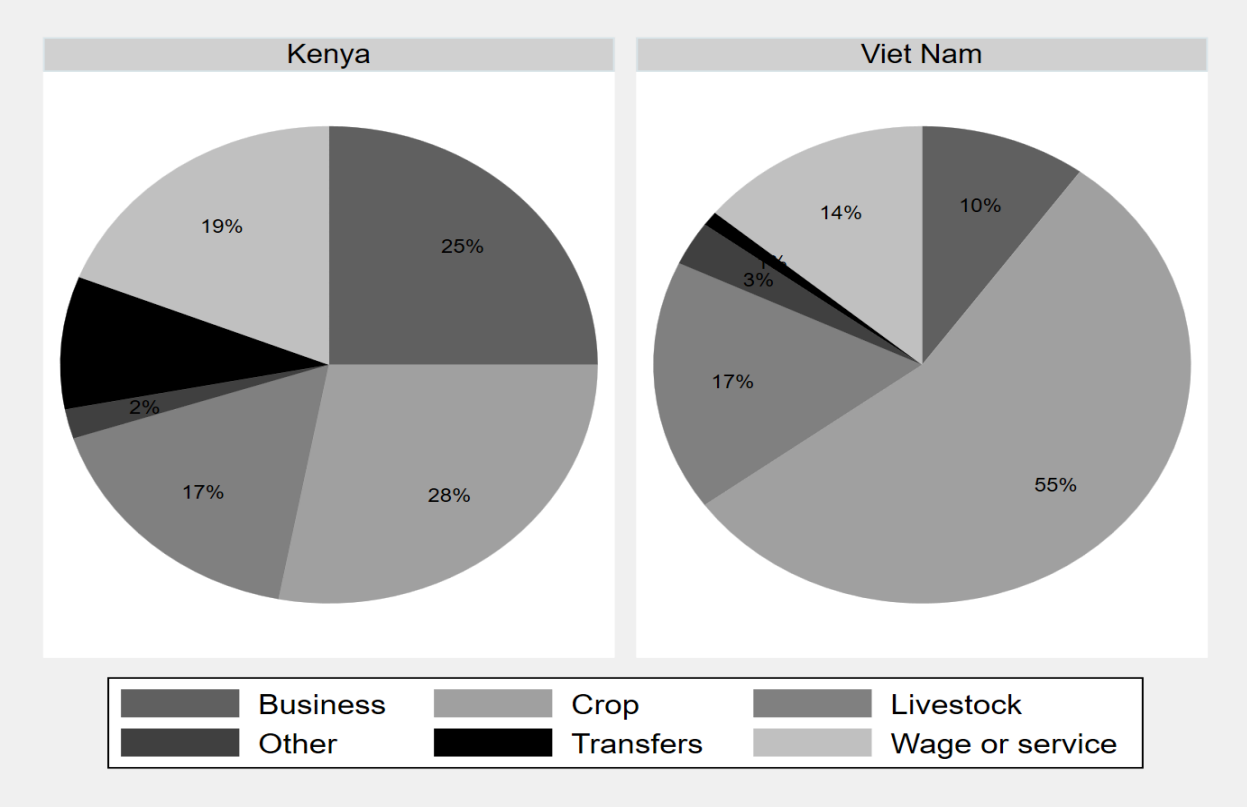


Figure A3. Composition of household income.

Notes: N = 1,502 in Kenya and 1,153 in Viet Nam. All the indicators are measured at the household level, reflecting the share of an individual income stream to the household's total income.

Source: Authors' own calculation using NATURE+ Kenya and Viet Nam household surveys.

Appendix Tables

Table A1. Capital and externality types, impact categories, and impact indicators

Type of capital	Type of externality	Impact category	Impact/footprint indicator
Natural	Environmental	1. Climate change	Greenhouse gas (GHG) emissions
Natural	Environmental	2. Air pollution	Toxic emissions to air*
Natural	Environmental	3. Water pollution	Toxic emissions to water*
Natural	Environmental	4. Soil pollution	Toxic emissions to soil*
Natural	Environmental	5. Land occupation	Land occupation**
Natural	Environmental	6. Land transformation	Land transformation**
Natural	Environmental	7. Soil degradation	Soil organic carbon loss
Natural	Environmental	8. Fossil fuel depletion	Fossil fuel depletion
Natural	Environmental	9. Other non-renewables depletion	Other nonrenewable material depletion
Natural	Environmental	10. Scarce water use	Scarce blue water use
Human	Social (working conditions)	11. Workplace health/safety incidents	Occupational health and safety
Human	Social (working conditions)	12. Workload	Excessive working hours
Human	Social	13. Underpayment/work pay	Living wage gap
Social	Social (human rights)	14. Child labor	Child labor (underage work/loss of education)
Social	Social (gender discrimination)	15. Gender wage gap	Gender wage gap
Social	Social (human rights)	16. Forced labor	Forced labor (low and medium severity)

Notes: * Human, terrestrial, fresh water, marine. ** Forest, woodland, grassland, inland, coastal.
Source: True Price (2021a).

Table A2. Definition of TCA indicators computed from the farm and workers surveys

Externality type	Impact type	Description indicator	Measurement	Indicator type
Environmental	Contribution to climate change	Contribution to climate change	Total CO2 emitted from the quantity of fertilizer used in production	Continuous
	Land occupation	Land occupation	Cultivated land in last 12 months (hectare)	Continuous
	Use of scarce water	Scarce blue water use	Total water used in production	Continuous
	Soil Degradation	Soil loss from water erosion	Total soil degraded for cultivated land due to water erosion	Continuous
		Soil loss from wind erosion	Total soil degraded for cultivated land due to wind erosion	Continuous
Social				
	Child labor	Underage workers who are not attending school	Children aged between 6 and 17 in Kenya (6 and 16 in Viet Nam) not attending school	Binary
		Underage workers below minimum age involved in hazardous work	Children aged between 6 and 13 involved in hazardous work (such as manual application of spraying and use of machete), with FTE estimated based on 40 hours of work per week	Continuous
		Workers above minimum age and below 18 involved in hazardous work	Children aged between 14 and 17 in Kenya (14 and 16 in Viet Nam) involved in hazardous work (such as manual application of spraying and use of machete), with FTE estimation based on 40 hours of work per week.	Continuous
		Underage workers below minimum age for light work involved in nonhazardous economic work	Children aged between 6 and 13 involved in nonhazardous work (work other than manual application of spraying and use of machete), with FTE estimation based on 40 hours of work per week	Continuous
		Underage workers above minimum age for light work and below minimum age involved in nonhazardous, nonlight economic work	Children aged between 14 and 17 (14 and 16 in Viet Nam) involved in nonhazardous work, nonlight work such as manual weeding, manual harvesting, lifting, carrying heavy bags/cans, bucket irrigation, and other physically intense activities (work other than manual application of spraying and use of machete), with	Continuous

Externality type	Impact type	Description indicator	Measurement	Indicator type
			FTE estimation based on 40 hours of work per week	
	Forced labor	Forced labor	Household member forced into a labor activity against their will in the last 12 months	Binary
	Underpayment	Wage gap workers earning below minimum wage	Gap between daily minimum wage ($11.74 in Kenya and $21.67 in Viet Nam) and actual wages received by hired labor for the days worked for a household	Continuous
	Gender wage gap	Gender wage gap	Gap in female worker wages compared with the average male worker wages from the local area	Continuous
		Denied maternity leave	Value of denied maternity leave payment for women aged between 15 to 49 years. 12 weeks' leave provision for women in Kenya and 24 weeks in Viet Nam.	Continuous
	Insufficient income	Insufficient income	The gap between poverty line equivalent minimum income ($3,760.80 in Kenya and $4,870.42 in Viet Nam) and actual household income; World Bank poverty and equity brief used for the poverty cut-off value	Continuous
	Workplace health and safety (H & S) incidents	Work performed in violation of H & S standards	Worker applies pesticide or machete manually. FTE estimation: all the time = 1, less than half of the time = 0.25, about half of the time = 0.50, more than half of the time = 0.75, and never = 0. Final measure as the average of the two variables (pesticide and machete).	Continuous
		Occupational injuries with breach of H & S standards	Injured or hurt while working in the last 12 months and no H & S training	Binary
		Uninsured nonfatal occupational incidents	Injured or hurt while working in the last 12 months and no injury payment by firm or public funds	Binary
		Insured nonfatal occupational incidents	Injured or hurt while working in the last 12 months but received payment from firm or public funds	Binary

Externality type	Impact type	Description indicator	Measurement	Indicator type
		Fatal occupational incidents	Worker knows if someone lost their lives because of their work at this workplace in the last 12 months	Binary
	Occurrence of harassment	Nonphysical harassment (nonsexual)	Ever been in a situation where a co-worker, supervisor, or employer has made (nonsexual) comments, threats, or (nonphysical) actions that have made you feel humiliated, offended, intimidated, or discriminated against	Binary
		Physical harassment (nonsexual)	Ever been in a situation where a co-worker, supervisor, or employer has made physical (nonsexual) contact or aggression that made you feel threatened, unsafe, or uncomfortable	Binary
		Nonphysical sexual harassment	Ever been in a situation where a co-worker, supervisor, employer has made unwanted sexual comments or threats or (nonphysical) actions that have made you feel uncomfortable, humiliated, intimidated, discriminated against, or offended	Binary
		Physical sexual harassment (non-severe)	Ever been in a situation where a co-worker, supervisor, or employer has made unwanted physical contact of a sexual nature, such as touching, kissing, or hugging, that has made you feel uncomfortable, unsafe, humiliated, intimidated, discriminated against, or offended	Binary
		Severe physical sexual harassment	Ever been in a situation where a co-worker, supervisor, or employer has made you feel unwanted or forced violent sexual aggression or sexual intercourse in return for a favor or favors or to avoid negative consequences at work	Binary
	Excessive and underpaid overtime	Illegal overtime	Weekly total overtime hours (more than 40 hours worked)	Binary
		Underpaid overtime	Gap in worker overtime wages compared with the average worker wages from the local area	Continuous

Note: FTE = full-time equivalent.
Source: Based on True Price (2021b).

Table A3. Surveys as sources for TCA impact data

	TCA capital-type categories		
Survey questionnaire content	Natural	Social	Human
Farming household survey			
Crop/livestock outputs	●	●	●
Crop/livestock input use	●		
Water use	●		
Energy use	●		
Fuel use	●		
Transportation of produce	●		
Waste management	●		
Hired labor		●	●
Farm work incidents*			●
Workers survey			
Demographics and education		●	●
Contracts and payments		●	●
Compensation/benefits in the job		●	●
Working times/overtime/drops			●
Relationship with employer			●
Treatment at work		●	
Health and safety in the job			●
On the job training		●	

Notes: * Incidents include pesticide and other chemical poisoning and tool-handling injuries, cuts, snakebites, and fire burns. TCA = true cost accounting.
Source: Compiled by authors.

Table A4. Global impact database: Impacts, sectors, and measurement indicators

Impact categories			Sector categories	
Externality (capital) type	Impact groups	Impact types (12)	Sector groups	Sector types (19)
Social (human and social)	Labor rights	Workplace health/safety	Rice	Paddy rice
		Forced labor		Processed rice
		Child labor	Cereals/grains	Wheat
	Labor remuneration	Gender wage gap		Cereals/grains
		Underpayment	Other crops	Vegetables, fruits, nuts
				Other crops
			Cattle*	Cattle, sheep, goats, horses
Environmental (natural)	Climate	Climate change	Meat and dairy products	Raw milk
	Air	Air pollution		Animal products
				Bovine meat products
	Water	Water pollution		Meat products
		Use of scarce water		Dairy products
			Fish	Fishing
	Fossil fuels	Fossil fuel depletion	Oil	Oilseeds
				Vegetable oils and fats
			Sugar	Sugar
	Material	Material depletion		Sugarcane, sugar beet
			Food products	Food products
	Land	Land occupation	Beverages and tobacco	Beverages and tobacco

Impact measurement indicators	
Indicator	Definition
Procurement chain impact (PCI) (Int.$ impact/$ output)	The PCI reflects the impact of the entire production process of a final (or intermediate) product of a sector. Therefore, the PCI includes impacts occurring throughout the entire production chain[(a)]. The data is expressed as monetized impact per dollar output of the sector. This means that it is the impact occurring during the production process of products with a value of $1.
Value chain impact (VCI) (Int.$ impact/$ added value)	The VCI reflects the impact of adding value in a sector. As economic activity in a sector stimulates both the supplying sectors and the clients, it leads not only to external costs in that sector, but also to additional externalities in the value chain. The VCI provides impact data that aggregates the direct and both upstream and downstream effects.
VCI direct	Portion of VCI due to a sector's own impact. This is the part of the impact intensity of a sector that can be attributed to it rather than its value chain partners, based on added value.
VCI upstream	Portion of VCI due to a sector's upstream impact.
VCI downstream	Portion of VCI due to a sector's downstream impact.

Note: [(a)]The production chain is estimated based on input output analysis and therefore reflects the economically weighted average production chain of all sector goods and services.
Source: Compiled from Global Impact Database documentation (Impact Institute, 2024).

Table A5. Demographic profile of households and workers

	Kenya	Viet Nam
Household profile		
Number of women	2.8	2.4
Number of men	2.7	2.5
Number of children	2.7	1.9
Household size (number of members)	5.4	5.0
HH member with no or below primary education (%)	32.7	30.1
HH member with primary education (%)	37.9	22.5
HH member with secondary education (%)	22.1	43.8
HH member with tertiary education (%)	7.3	3.4
Average years of education (years)	6.5	6.6
HH head age (years)	54.6	46.1
HH head is female (%)	27.9	9.0
HH head education level (years)	7.1	6.6
Worker profile		
Age (years)	39.3	38.6
Female (%)	49.0	59.9
Number of years of education (years)	6.8	7.8
Maximum education: zero or less than primary (%)	44.0	31.1
Maximum education: primary (%)	42.2	19.2
Maximum education: secondary (%)	12.2	47.0
Maximum education: tertiary (%)	1.5	2.7

Note: Authors' own calculation. *Source:* Household and workers survey data. N = 1,502 in Kenya and 1,153 in Viet Nam for the household survey. N = 1,056 in Kenya and 334 in Viet Nam for the household survey. HH = household.

Table A6. Land and farming characteristics

	Kenya				Viet Nam			
	Mean (All)	Male-managed parcels	Female-managed parcels	Jointly managed parcels	Mean (All)	Male-managed parcels	Female-managed parcels	Jointly managed parcels
Land use								
Area of parcels (in hectares)	0.96	1.10	0.73	1.03	0.73	0.78	0.53	0.70
Number of cultivated parcels per HH	1.91	1.87	1.77	2.05	3.08	3.05	2.28	3.30
HH land for animal grazing (%)	4.9	4.6	4.1	5.8	10.8	11.2	10.5	10.3
HH has land left fallow (%)	33.2	30.6	34.6	34.0	10.2	8.1	8.1	14.2
HH has virgin land (%)	0.5	0.2	0.4	0.7	0.6	0.3	0.0	1.3
HH experiences erosion (%)	72.7	68.5	71.5	76.9	54.0	56.1	45.4	52.5
Crops								
Number of crops per parcel	4.52	4.20	4.45	4.83	1.85	1.78	1.85	1.97
HH practices intercropping (%)	84.0	79.5	84.6	87.1	24.6	24.3	20.9	26.1
HH cultivates perennial crops (%)	52.7	48.9	52.6	55.8	56.3	58.2	54.7	53.5
Multi-cropped parcels (%)	96.2	95.4	96.1	96.9	45.7	44.2	39.5	49.9

Notes: N = 1,502 in Kenya and 1,153 in Viet Nam. HH = household.

Source: Authors' calculation using NATURE+ Kenya and Viet Nam baseline household surveys.