Steven King (UNEP-WCMC), Moses Masiga (ENRAC, Uganda), Mark Eigenraam (IDEEA), Carl Obst (IDEEA)

Integrated Accounting for Land, Soils and Agriculture in Uganda

Introduction

Agriculture in Uganda contributes nearly one-quarter (23.7%) of GDP, about half of all commodity exports, and 73% of the aggregate employment in the country (MoFPED 2021[1]). Eighty-five percent of the population of Uganda lives in rural areas and in these areas nearly all livelihoods are based on engagement in subsistence agriculture. Uganda's Third National Development Plan (NDP III, 2020-2024) establishes agro-industrialization as one of the 18 national development programmes, aiming to increase exports, add value, increase jobs and achieve food security, and spur economic growth.

The Uganda Green Growth Development Strategy (UGGDS, 2017/18 – 2030/31) reported that decline in natural capital poses a great threat to the agricultural sector and associated revenues, livelihoods and food security. The need to enhance soil fertility through management is recognised in UGGDS, the NDP III and the country's long-term development strategy, the Vision 2040. Both the NDP III and UGGDS highlight that individual, community and subnational land use planning is needed to improve land use outcomes, address soil nutrient depletion and allow carbon stocks to accumulate.

The UGGDS also highlights the impact of agricultural expansion on forest and wetland extent in the country. Both of these ecosystem types are highlighted by the UGGDS as a focus for improved natural capital management on the basis of the benefits they provide. The UGGDS highlights national targets of restoring 3.05 million ha of forest cover and 240,000 ha of wetlands by 2040. The NDP III further highlights that reductions in forest cover and wetland degradation are development challenges for the country, including increased vulnerability to climate change due to lost regulating ecosystem services.

Both the UGGDS and the NDP III identified Environmental-Economic Accounts as a fundamental resource for information to support policy and programme interventions to achieve development targets. In response, the Integrating National Capital into Sustainable Development Decision Making in Uganda project compiled Uganda's Land and Soil Improvement Accounts to provide an integrated picture of the relationship between land use, soil fertility and agricultural production to help inform current and future interventions.

[1] MoFPED 2021 Background to the Budget for Financial Year 2020/21, Ministry of Finance, Planning and Economic Development (MoFPED), Kampala. http://www.finance.go.ug/sites/default/files/Publications/Background

This paper provides an overview of the Land and Soil Improvement Accounts compiled, their structure and key indicators and aggregates that can be derived from the accounts to support decision-making. In the following sections, a description of the Ecosystem Accounting Areas and the sequence of the accounts compiled is presented. The structure of the sequence of accounts is then demonstrated using a worked example for a single Ecosystem Accounting Area. A set of potential aggregates and indictors that can be derived from the accounts to support planning sustainable development of the agricultural sector is then presented, followed by possible extensions for this work. We would appreciate the thoughts of the London Group on the accounts presented, aggregates and indicators proposed and others that could be useful, as well as ideas for other possible extensions.

Ecosystem Accounting Areas

The accounts are organised by Zonal Agricultural Research and Development Institute (ZARDI) areas, a Ugandan sub-national scale directly relevant to agricultural development planning (Figure 1). They are designed to deliver a range of key aggregates and indicators to inform a more integrated and sustainable agricultural land use planning approach, where the trade-offs and synergies around subsistence use and/or communal use, soil fertility improvement actions, ecosystem services and biodiversity conservation can be considered.

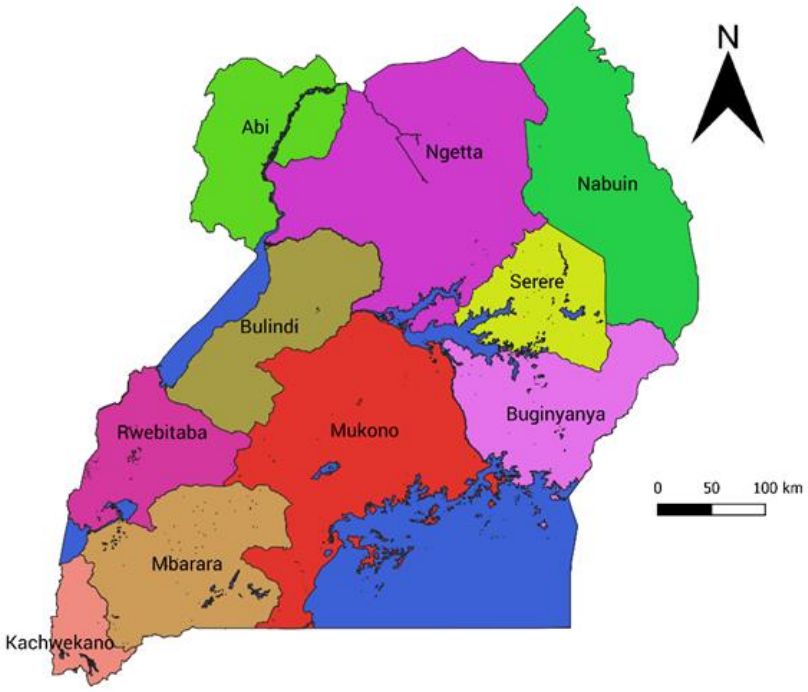

Figure 1: ZARDIs in Uganda (Dark blue areas are lake ecosystems).

Sequence of Accounts

The idea of soil asset accounting is introduced in the SEEA Central Framework, which highlights the potential to apply a "natural capital" perspective to soil. In order to better understand the nutrient flows from the environment to the economy, the SEEA CF propose the use of material flow accounts, expanded upon in the SEEA Agriculture Forestry and Fisheries (SEEA AFF) for fertilisers. However, there is no formalised structure for nutrient flow accounts within the SEEA. More generally, organising information on soils and integrating this with wider information on land use and ecosystem service flows from agricultural land has not received much attention via implementation of the SEEA in practice.

The Land and Soil Improvement Accounts for Uganda provide a practical application of the SEEA approach to agricultural ecosystems. They integrate a natural capital perspective with existing agricultural production statistics to inform land use planning and management for the agricultural sector in Uganda. This is achieved via the following set of integrated accounts:

- IPCC-based Land Cover Accounts: Provide information on land cover transitions. The accounts are compiled using the broad Intergovernmental Panel on Climate Change (IPCC) land cover categories, which are derived from aggregations of Uganda's national land cover typology developed via the National Biomass Survey. These reveal the extent of land use for crop production, extent of grasslands as natural ecosystems and for livestock production and which other ecosystem types may be lost to agricultural and urban expansion over time. This reveals land degradation due to land cover change (as described in the global SDG 15.3.1 indicator) and associated implications for ecosystem services, including global climate regulation services (carbon storage and sequestration), and for biodiversity.
- Nutrient Flow Accounts for croplands: Provide information on nutrient inflows and outflows for cropland ecosystems. The nutrient flow accounts are compiled on the basis of nationally determined coefficients for nutrient inflows (crop residues, atmospheric deposition and biological nitrogen fixation) and outflows (crop harvesting, soil erosion and leaching). They reveal insights into the long-term capacity of cropland to support current crop production patterns and provide data on the relative productivity of cropping systems in each ZARDI.
- Nutrient supply and use: The data on nutrient outflows due to crop harvesting in the Nutrient Flow Accounts is derived from information on crop production from the Annual Agricultural Survey in Uganda and

standard coefficients for macro-nutrients uptake determined by the FAO. This flow can be considered an intermediate ecosystem service.

- Ecosystem Services Flow Accounts: These provide information on the physical and monetary flows of crop provisioning ecosystem services. The physical ecosystem services accounts are compiled using information on the physical production of crops by ZARDI, as reported in the Annual Agricultural Survey in Uganda. Monetary accounts are then estimated on the basis of crop prices. They reveal insights into land use efficiency and where decreasing production may be associated with nutrient mining.
- SNA Goods and Services Accounts: The SNA Goods and Services record the transactions involving agricultural products in the economy. They disaggregate transactions between crop and livestock farmers and other economic units (i.e., households and businesses). They also reveal the level of final and intermediate consumption of agricultural output at ZARDI level. This is useful in understanding value addition in the sector at ZARDI scale.

This sequence of accounts, relationships between them and their source data is summarised in Figure 2. Further information on the accounts compilation and associated data is available in the full land and soil improvements accounts report from the project website (see box at end of paper).

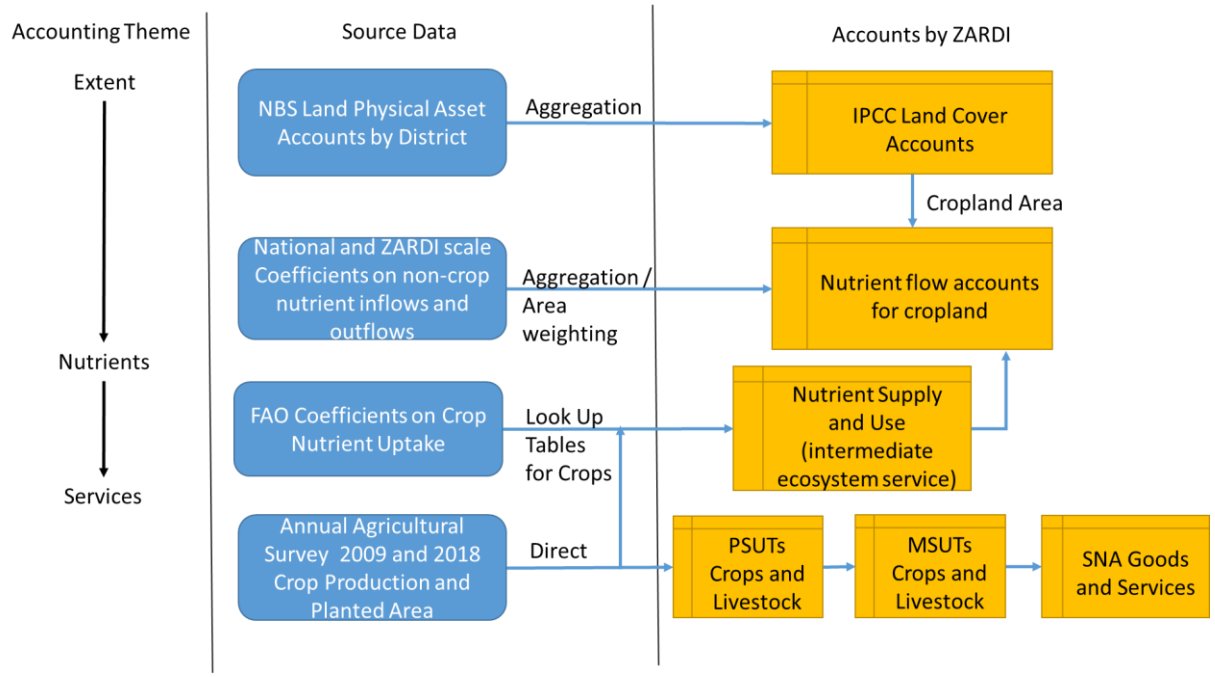

Figure 2: Sequence of integrated land and soil improvement accounts at ZARDI scale

Accounting Structures - Worked example for Ngetta ZARDI

In areas of higher poverty incidence, people are likely to be particularly vulnerable to the impacts of land degradation on their livelihoods and food security. Further, they are likely to be relatively more dependent on ecosystem services supplied by other ecosystems. As shown in Figure 3, the Buginyanya, Nabuin and Ngetta ZARDIs comprise districts of relatively higher poverty incidence in Uganda. The worked example below illustrates the accounting structures developed under the project, with a focus on Ngetta as a worked example. A full set of the accounts for Buginyanya, Nabuin and Ngetta ZARDIs are provided in an accompanying spreadsheet.

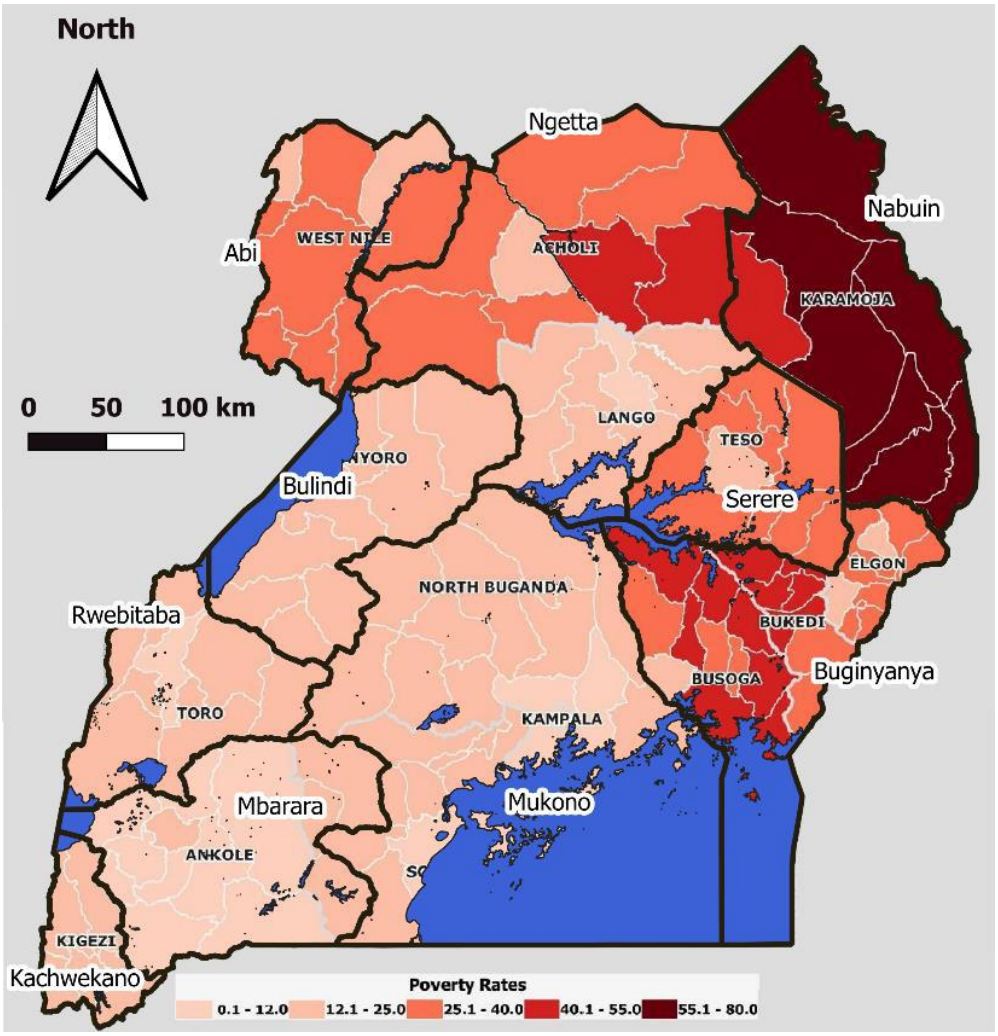

Figure 3: Poverty headcounts by District and ZARDI (2016/17)

IPCC Land Cover Account

As set in Figure 2, the sequence of accounts presented starts with accounts of broad ecosystem or land cover change, based on the IPCC land cover classes. These land cover classes were considered appropriate for communicating the

broad implications for agricultural land expansion on other ecosystems in Uganda. Adopting this classification system also allows for integration with IPCC reporting on greenhouse gas emissions and mitigation from climate change and land degradation (i.e., with respect to SDG 15.3) in the country. This can support more coherent planning of environmental-economic interventions across policy areas.

The land cover account for Ngetta is presented in Table 1. The main part of the account follows the established asset type account for land cover and ecosystem extent set out in the SEEA. Below this established structure, two additional rows are provided as extensions. These communicate information on land cover flows relevant to the impact of agricultural expansion, comprising:

- *Improvement flows:* These are the gross land cover flows from cropland or settlements to forest or wetland over an accounting period. They represent land cover transitions indicative of a move towards Uganda's national targets to actively increase forest and wetland cover.
- *Degradation flows:* These are the gross land cover flows from forest or wetland to cropland or settlements over an accounting period. The term degradation refers to the SDG 15.3.1 land cover sub-indicator for degradation in a Uganda context. These flows represent land cover transitions indicating land use decisions that negatively impact on Uganda's national targets to increase forest and wetland cover.

Table 1: IPCC Land Cover Account for Ngetta ZARDI

IPCC Land Cover Account	Ngetta				2005 to 2015			
Classifications >>	Cropland	Forest	Grassland	Wetland	Ordinary lands	Settlements	Open Water	Total
Opening Stock (2005 ha)	1,548,947	826,972	954,472	77,035	638,169	17,905	138,842	4,202,341
Additions to stock (ha)								
Total additions to stock	1,124,141	79,168	534,114	21,079	268,102	15,430	3,701	2,045,734
Reductions to stock (ha)								
Total reductions in stock	216,352	698,645	514,761	41,816	557,807	12,839	3,515	2,045,734
Net change in stock (ha)	907,788	(619,477)	19,353	(20,737)	(289,704)	2,591	185	(0)
Closing Stock (2015 ha)	2,456,735	207,495	973,825	56,298	348,465	20,496	139,027	4,202,341
Improvement flows	-	13,328	-	6,384	-	-	-	19,712
Degradation flows	412,737	-	-	-	-	1,228	-	413,965

A general point that can be made with respect to Table 1, is that accounting for land cover at a relatively broad level can make very evident changes based on available data. The land cover flows indicative of degradation in Table 1 highlight implications for natural ecosystem loss and associated pressures on species and ecosystem services. These include climate regulation services but also other

biomass related ecosystem services (e.g., fuel wood) and regulating services (e.g., hydrological regulating services). In Ngetta, Table 1 indicates over 400,000 ha of forest or wetland have been converted cropland between 2005 and 2015.

At the national scale, the implications of land cover change were that annual biomass carbon accumulation was lower by 64% in 2010-2015 compared to 1990-2000 for Uganda. Thematic carbon accounts derived from information on land cover change are presented in the full Land and Soil Improvement Accounts report on the project website.

Nutrient Flow Account

In broad terms, nutrient flow accounts provide a recording of the nutrient inputs into agricultural ecosystems and the nutrient outflows from them. From this information an overall nutrient balance can be calculated. Accounting for nutrient balances (or nutrient auditing) has been undertaken for some decades now in order to better understand the sustainability and productivity of agricultural production systems.[2] Negative nutrient balances (i.e., where removals exceed inputs for N, P or K) can be an indicator of a lack of sustainability in production since, ultimately, the production of crops cannot continue without an appropriate balance of nutrients in the soil. Eurostat & OECD (2013) have produced a handbook for calculating Nutrient Budgets. [3]

A proposed soil Nutrient Flow Account for Ngetta ZARDI is presented in Table 2. The account shows the nutrient inflows were from inorganic and organic fertilisers, biological nitrogen fixation, crop residues and atmospheric deposition. The outflows were due to crop harvest, soil erosion and leaching.

At the top of Table 2, the cropland area refers to the extent of recorded in the IPCC land cover account for 2005 and 2015. Ideally this would be for the years 2009 and 2018, to allow integration with the Annual Agricultural Survey statistics.

The cropland area provides the basis for estimating nitrogen fixation additions and soil leaching and erosion reductions using relevant coefficients from soil survey experiments in different agro-ecological areas of Uganda. Reductions due to crop harvest are estimated using FAO estimates of the nutrient content of major crop products and the physical production of these crops recorded in the Annual Agricultural Survey.[4] This informs the nutrient supply and use (intermediate ecosystem service), identified in Figure 1.

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[2] For an example in Uganda see: Wortmann, C.S., Kaizzi, C.K., 1998. Nutrient balances and expected effects of alternative practices in farming systems of Uganda. Agric. Ecosyst. Environ. 71, 115–129.

[3] https://ec.europa.eu/eurostat/documents/2393397/2518760/Nutrient_Budgets_Handbook_%28CPSA_AE_109%29_corrected3.pdf/4a3647de-da73-4d23-b94b-e2b23844dc31

[4] http://www.fao.org/fileadmin/templates/soilbiodiversity/Downloadable_files/fpnb16.pdf

Table 2: Nutrient Flow Account

	Ngetta 2009	Ngetta 2018
Cropland Area (ha)	1,548,947	2,456,735
Planted Area (ha)	921,479	1,041,515
Additions		
Inorganic / Organic Fertilisers (Tonnes, 2009)		
N (t)		
P (t)		
K (t)		
Biological Nitrogen Fixation (Tonnes, 2009)		
N (t)	10,261	16,275
Crop residues (Tonnes, 2009)		
N (t)	-	-
P (t)	-	-
K (t)	-	-
Atmospheric deposition (Tonnes, 2009)		
N (t)	10,990	17,431
P (t)	1,328	2,106
K (t)	4,833	7,665
Total Additions		
N (t)	21,251	33,706
P (t)	1,328	2,106
K (t)	4,833	7,665
Reductions		
Crop harvest (Tonnes, 2009)		
N (t)	24,349	29,083
P (t)	9,338	12,571
K (t)	19,943	30,960
Soil Erosion		
N (t)	9,404	14,915
P (t)	3,611	5,727
K (t)	8,558	13,574
Leaching		
N (t)	24,527	38,901
P (t)		
K (t)		
Total Reductions		
N (t)	58,280	82,899
P (t)	12,949	18,297
K (t)	28,501	44,534
Net Balance		
N (t)	(37,029)	(49,193)
P (t)	(11,621)	(16,191)
K (t)	(23,669)	(36,869)

The 'Planted Area' is also recorded as part of the Annual Agricultural Survey. It records the area planted by farmers based farm level surveys. It is highlighted that the same area may be planted once or twice in the same year, depending on the cropping pattern. Table 2 reveals the planted area is much smaller than the area of crop land cover identified in land cover maps for the Ngetta ZARDI. This will likely be due to shifting or rotation agriculture. This difference has increased markedly between 2009 and 2018.

The bottom of Table 2 shows the nutrient balance at the ZARDI scale. These reveal substantial nutrient imbalances across all macro-nutrients. Table 3 presents this information in per hectare cropland terms.

Table 3: Nutrient balance per hectare

	Ngetta 2009	Ngetta 2018
Nutrient balance kg / ha		
N kg / ha	-23.91	-20.02
P kg / ha	-7.50	-6.59
K kg / ha	-15.28	-15.01

The nutrient flow accounts highlight the need for improved soil fertility management in the Ngetta ZARDI. Accounts for other ZARDIs reveal similar issues with respect to negative nutrient balances. At the aggregate (i.e., national scale) the value of the net nutrient imbalances in terms of fertiliser replacement costs increased from UGX 1.7 trillion in 2009 to 3.9 trillion in 2018 (see full Land and Soils Improvement Accounts for more on this).

Table 2 shows that there are no nutrient additions due to application of fertilisers or crop residues to cropland in the Ngetta ZARDI. This reflects a lack of data on the rates of fertiliser application to cropland in Uganda. However, the NDP III identifies that, in any event, application rates are generally low at around 1.5 kg /ha and need to be addressed as part of a programme to improve the agricultural sector. Application of crop residues does occur in some ZARDIs, but is not believed to be significant in the Ngetta ZARDI based on the studies carried out in relevant agro-ecological zones.[5] However, decision making would benefit greatly from regular and systematic surveying of nutrient and soil flows at farm level in different ZARDIs and the accounts would be more complete.

Ecosystem Service Supply and Use & SNA Goods and Services Supply and Use Tables

The land cover accounts and nutrient flow accounts are intended to communicate the broad trends in the stocks of the natural capital underpinning the agricultural sector in Uganda, in this case cropland ecosystems. The Ecosystem Services and SNA Goods and Services Accounts then link this information on natural capital to economic activity. The flow of ecosystem services from cropland to the farmer (an economic unit) represent a transaction involving supply and use. However, whilst these transactions are recorded in the SEEA EA, there is not an actual transfer of funds between the ecosystem and the economic unit. To realise the monetary value of the ecosystem service, the farmer sells his harvest to consumers (households or businesses that process food). As this second group of transactions falls within the production boundary of the SNA, extended accounting presentations are required to capture the economic activity. Figure 4 sets out this sequence of transactions and the associated agents.

Figure 4: Transactions between ecosystems, economic units and consumers

The Physical Ecosystem Services Supply and Use Account for Ngetta is presented in Table 4 and the Monetary SNA Goods and Services Account in Table 5. The accounts have been compiled directly from the production statistics collated at ZARDI level under the Annual Agricultural Survey in Uganda. It is highlighted that both accounts are compiled in physical and monetary terms in the full Land and Soils Improvement Accounts report.

[5] https://openknowledge.worldbank.org/handle/10986/8647

Table 4: Physical Ecosystem Service Supply and Use account for Crop and Livestock provisioning Services for Ngetta ZARDI (2018, Tonnes)

	Economic Unit				Ecosystem types		
	Gov.	**Businesses**	**Households**	**Total**	**Cropland**	**Grassland**	**Total**
Physical Supply Food Provisioning Ecosystem Services (Tonnes, 2018)							
Maize					328,371	-	328,371
Finger millet					36,573	-	36,573
Sorghum					34,394	-	34,394
Rice					40,901	-	40,901
Beans					49,896	-	49,896
Field peas					-	-	-
Cowpeas					-	-	-
Pigeon peas					-	-	-
G.nuts					28,658	-	28,658
Sim sim					27,758	-	27,758
Soybean					80,129	-	80,129
All bananas					33,779	-	33,779
Cassava					1,109,205	-	1,109,205
Sweet potatoes					126,118	-	126,118
Irish potato					-	-	-
Coffee					-	-	-
Cattle					-	205,291	205,291
Goats					-	291,920	291,920
Sheep					-	37,778	37,778
Physical Use Food Provisioning Ecosystem Services (Tonnes, 2018)							
Maize	-	-	-	328,371			
Finger millet	-	-	-	36,573			
Sorghum	-	-	-	34,394			
Rice	-	-	-	40,901			
Beans	-	-	-	49,896			
Field peas	-	-	-	-			
Cowpeas	-	-	-	-			
Pigeon peas	-	-	-	-			
G.nuts	-	-	-	28,658			
Sim sim	-	-	-	27,758			
Soybean	-	-	-	80,129			
All bananas	-	-	-	33,779			
Cassava	-	-	-	1,109,205			
Sweet potatoes	-	-	-	126,118			
Irish potato	-	-	-	-			
Coffee	-	-	-	-			
Cattle	-	-	-	205,291			
Goats	-	-	-	291,920			
Sheep	-	-	-	37,778			

Table 5: Monetary SNA Goods and Services Accounts for Ngetta ZARDI (2018, UGX Million)

	Producer				Consumer					
	Gov.	**Business**	**Hholds**	**Total**	**Govt.**	**Hhold**	**Business**	**Change in Inventory**	**Export**	**Total**
Monetary Supply SNA Goods and Services UGX million, 2018)										
Maize	-	-	-	172,050						
Finger millet	-	-	-	30,852						
Sorghum	-	-	-	18,489						
Rice	-	-	-	72,777						
Beans	-	-	-	48,312						
Field peas	-	-	-	-						
Cowpeas	-	-	-	-						
Pigeon peas	-	-	-	-						
G.nuts	-	-	-	38,289						
Sim sim	-	-	-	39,705						
Soybean	-	-	-	87,074						
All bananas	-	-	-	11,823						
Cassava	-	-	-	747,382						
Sweet potatoes	-	-	-	38,723						
Irish potato	-	-	-	-						
Cattle	-	-	-	191,500						
Goats	-	-	-	22,074						
Sheep	-	-	-	3,056						
Total	-	-	-	**1,522,105**						
Monetary Use SNA Goods and Services (UGX million, 2018)										
Maize					-	50,938	121,112	-	-	172,050
Finger millet					-	23,425	7,426	-	-	30,852
Sorghum					-	17,805	684	-	-	18,489
Rice					-	3,926	68,850	-	-	72,777
Beans					-	38,404	9,908	-	-	48,312
Field peas					-	-	-	-	-	-
Cowpeas					-	-	-	-	-	-
Pigeon peas					-	-	-	-	-	-
G.nuts					-	23,448	14,841	-	-	38,289
Sim sim					-	39,095	610	-	-	39,705
Soybean					-	87,074	-	-	-	87,074
All bananas					-	11,010	812	-	-	11,823
Cassava					-	686,771	60,611	-	-	747,382
Sweet potatoes					-	34,592	4,131	-	-	38,723
Irish potato					-	-	-	-	-	-
Cattle					-	174,265	17,235	-	-	191,500
Goats					-	21,854	221	-	-	22,074
Sheep					-	3,025	31	-	-	3,056
Total					-	**1,215,632**	**306,473**	**-**	**-**	**1,522,105**

The Physical Ecosystem Services Supply and Use Account presented in Table 4 follows the gross biomass harvested approach described in the described in the SEEA EEA (UN et al., 2014). In this approach, the total crop harvested is used as a proxy for the quantity of the various ecosystem contributions (water, nutrients, soil retention, etc.). It is also noted that, conceptually, the Ecosystem Service associated with livestock is the feed consumed, rather than the mass of livestock produced as presented in Table 4. However, information on livestock production is included in this form to allow an understanding on how livestock production may be substituting for crop production in each ZARDI. It is also highlighted that, at this stage, it was not possible to disaggregate the use of the crop and livestock related provisioning ecosystem services by different economic units (i.e., household versus business / commercial use).

The SNA Goods and Services Accounts presented in Table 5 allow the crop and livestock related provisioning services to be linked to the economic activity they underpin. The SNA Goods and Services Accounts provide information on the type of transactions that the users of the crop and livestock related provisioning services participate in with other economic units. Table 5 presents the SNA Goods and Services Accounts in monetary terms. These values have been derived based on the prices obtained from Annual Agricultural surveys for 2009 and 2018.

Through the articulation of the Ecosystem Services Supply and Use and SNA Goods and Services Accounts, economic activity in the agricultural sector for each ZARDI can be linked to the natural capital underpinning it. This speaks to a range of development concerns. With respect to economic development, they reveal the value of exports and the level of value addition / processing activities linked to these natural capital assets. They are also structured to provide important information on subsistence consumption and post-harvest losses, although it has not been possible to integrate this information at this stage.

The integrated set of accounts aims to inform better planning of the sector with respect to land use trade-offs, sustainable land management practices, economic performance and assuring food security. Key aggregates and indicators that will help inform these planning processes are proposed in the next section.

Key aggregates and indicators

In order to be useful to decision-makers, the land and soil improvement accounts will need to yield indicators that can directly inform on key progress towards key policy goals and targets. Table 6 provides an illustration of some of the most relevant key aggregates and indicators that can be obtained from the accounts to support planning sustainable development of the agricultural sector in Uganda.

Table 6: Key aggregates and indicators for informing on sustainable agriculture planning

Key indicators	Buginyanya	Nabuin	Ngetta	Relevance to agricultural planning
Stable cropland extent ((Cropland area 2005 - Reductions 2005 to 2015) / Cropland area 2005)[6]	94%	52%	86%	Indicator of the stability of cropland under agricultural production over the accounting period. 100% suggest cropland remains productive over the accounting period
Turnover in cropland (Cropland Additions + Reductions 2005 to 2015 / Cropland area 2005)[6]	16%	86%	87%	Indicator of land turnover associated with shifting and expanding agriculture. High values indicate the spatial distribution of cropland is changing
Degradation flows as a % of net changes (2005 to 2015, land degradation flows in cropland / net change in cropland extent)	72%	-74%	45%	Indicator of the impact of agricultural expansion on forest and wetland extent and associated species habitat and ecosystem services. > 1 is possible as gross additions may be offset by gross reductions. <0 indicates cropland area is decreasing but forest and wetlands are still being converted
Cropland use efficiency (2018, Area planted / cropland area)	103%	90%	39%	Indicator of cropland use intensity. Low values indicate large areas of cropland are not planted in a year. >1 indicates intensive use of cropland area (area planted > crop land area). Care is needed in interpretation to understand if intensity is sustainable (i.e., does it imply nutrient mining, is there sufficient water, appropriate levels of crop rotation). Will vary with crop pattern and ZARDI agro-ecological condition.
NPK balance (2018, kg / ha cropland / yr)	-138 kg / ha / yr	-75 kg / ha / yr	-42 kg / ha / yr	Indicator of macro-nutrient mining and need for improved soil fertility management
Relative change in physical crop production (Net change 2009 to 2018)	-20%	328%	48%	Indicator of trend in crop output. Negative values (or values below population increase) point to potential emerging food security issues or shifts to agricultural production to satisfy local food needs.
Relative change in value of crop production (2009 to 2018)	71%	687%	178%	Indicator of trend in economic performance of the sector (need to be adjusted for constant prices)
Business consumption / total consumption (2018)	36%	31%	22%	Indicator to communicate the proportion of agricultural production that is intermediate consumption (i.e., that enters a value addition process and creates associated employment opportunities). If it is very high, this may indicate a shortage of food for local final consumption and potential food security issues.

[6] These indicators previously proposed by European Environment Agency and Statistics South Africa (e.g. http://www.statssa.gov.za/publications/D04011/D040111990to2014.pdf)

Possible Extensions

The integrated set of Land and Soil Improvement Accounts presented here are the first attempt to compile a set of integrated accounts that inform on the sustainability, performance and impacts of agricultural in Uganda. This includes accounting for impacts on other ecosystems and, by extension, the services they supply and the biodiversity they maintain. There are several extensions that could be developed to better support a more integrated approach to developing a sustainable agricultural sector that delivers on economic and social welfare objectives in a way that does not impact biodiversity and the supply of services from non-agricultural ecosystems. These include the following:

- Developing cropland condition accounts to provide more insight into the sustainability of crop provisioning services into the future. This could include more information on soil quality and indicators linked to sustainable farming practices (e.g. terracing, agroforestry, mulching or presence of other regenerative farming practices).
- Further development of the Ecosystem Services Supply and Use Accounts:
    - For livestock the relevant ecosystem services to be measured should be updated to the supply of fodder and other feed from different ecosystems.
    - At the moment the monetary ecosystem services accounts use the farm gate price as a proxy for the value of the service. This is because the focus is on making the link between natural capital issues and agricultural economic activity. This should be updated using ecosystem services values derived via residual or resource rent based approaches. Whilst this may prove to be negative in a number of ZARDI's, it would provide an important insight into the economic efficiency of the sector in different ZARDI's.
    - Include information on exports and post-harvest loss in the SNA Goods and Services Accounts. This will help agro-industrialization interventions to be determined.
- Development and integration with other natural capital accounts and information on ecosystems in Uganda:
    - Integration with water accounts to consider water available pressures created via agricultural production and where fuller use of irrigation could be achieved.

- Integration with more detailed natural ecosystem extent accounts to better understand the impact of shifting and expanding agriculture on natural ecosystems, the services they supply and the biodiversity they maintain.
- Integration of information on land tenure and size of holdings to understanding the relationship between changing structure of the agricultural sector and effects on environmental sustainability and community livelihoods.

Discussion questions

Some key questions we would appreciate feedback from the London Group on this accounting approach are:

1. What are the groups general thoughts on the structure of the accounts and tables presented?
2. What are the groups general thoughts on the aggregates and indicators presented in Table 6 and are there any further key indicators that could be used for decision-making?
3. What additional extensions could be developed?

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