Preliminary results from the first round of Vital Signs data collection in Uganda, Tanzania, Ghana and Rwanda.
EXECUTIVE SUMMARY

The Vital Signs Programme (www.vitalsigns.org) was established in 2012 to provide better data and risk management tools to optimize agricultural development decisions with the needs of the human beings they serve and the ecosystems upon which they depend.

Together with our country partners: Council for Scientific and Industrial Research in Ghana, Wildlife Conservation Society in Rwanda, Tanzania Forest Conservation Group in Tanzania and The Africa Innovations Institute in Uganda; Vital Signs has collected primary data on biophysical and socio-economic indicators from 7,197 individuals, 2,260 agricultural fields, and 5,969 soil samples from farm fields and biophysical sampling plots; with 9,092 georeferenced land cover points recorded for ground-truthing classifications.

This booklet provides the very preliminary first set of results from the data analysis. The analysis focused on topics and questions that were preselected by the country partners based on national needs.

Potential Policy Implications of Select Results:

Forests Acting as Buffers Against Malnutrition: Most policies related to access to forests tend to focus on controlling access in order to reduce deforestation. There are very few, if any, that focus on the contribution of forests to addressing malnutrition. These results suggest the need for policies that promote more sustainable access to forests in order to address malnutrition. Integrated policy and planning between the Forestry and Health Departments will be essential.

Female Headed Household’s Access to Productive Resources and Ecosystem Services: Women have less access to agricultural capital, and yet female headed households earn significantly more income from selling agricultural by-products, such as maize flour, cassava dough, coconut oil, palm oil, and banana beer. This shows they are more enterprising and contribute more to household livelihoods. Because women reinvest 90% of their food and income for the household’s welfare, interventions that target women in the households would have a far-reaching impact. The results suggest a need for specific policies directed towards this.

How Natural Resources Supplement Household Expenditure on Food: Natural resources including food and nonfood products such as medicinal products, building materials among others play a role towards meeting household needs. Specifically, households that collected natural resources to supplement their food requirements spent a lesser proportion of their budget on food. This potentially leaves them with more disposable income to spend on other household needs and increases their food security.
This underpins the value that nature plays in improving various aspects of human wellbeing. If these benefits are to be maintained, the results suggest a need for policies that promote more investments in community led conservation efforts and landscape restoration.

**How Benefits from Agricultural Intensification Relate to Household Income, Level of Education and Gender:** Proxy indicators of Ag-intensification such as fertilizer and pesticide use show variations by landscape. Differences between household use of agricultural inputs are attributed to differences in gender and household wealth such as land. The results suggest a need for policies that address the gender gap in particular as it relates to access to land and fertilizer use.

**Access and Use of Extension Services:** Access to extension services is generally reported to be low, but the results pick up a marked increase in access to extension services in those landscapes engaged in large scale commercial agriculture, with the private sector and non-state actors providing dedicated support. For example, in Otuke in Northern Uganda where the dominant crops are sunflower and simsim for commercial use, access to extension services is reported to be much higher than in other landscapes. A similar pattern is evident in Ihemi landscape in the Southern Agricultural Growth Corridor of Tanzania where commercial agriculture is dominant. These results underscore the role that private and non-governmental actors play in improving access to extension services and suggest a need for policies to promote these to complement Government efforts which appear to be overwhelmed by the need.

**Next Steps:**

Vital Signs will continue to work with the country partners to share and discuss these results with key stakeholders, and to identify entry points where the results could inform planning and policy decisions at national, regional or local level. Furthermore, Vital Signs will work with the partners to disaggregate the results by country and make them more context specific.

We hope you find these preliminary results interesting, and we look forward to sharing with you the next set of results.

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OUR PARTNERS

**Africa Innovations Institute (AfrII)** is an indigenous, not-for-profit non-governmental center of excellence in Uganda, established in 2005. It undertakes research and innovations development on agriculture and food systems to ensure sustainable increase in farmers’ income, food and nutrition security and environmental sustainability. AfrII envisions small holder farmers enjoying increased incomes and assured of food and nutrition security while protecting ecosystems and the services they provide.

**The Tanzania Forest Conservation Group’s** mission is a non-governmental organization whose mission is to conserve and restore the biodiversity of globally important forests in Tanzania. Through research, advocacy and local empowerment initiatives TFCG is working to improve the way Tanzania’s forests are managed and to support the livelihoods of those living close to the forests.

**WCS Rwanda** is a non-governmental science based conservation organization that works to conserve wildlife and wild places worldwide. It undertakes rigorous research, conservation, education and capacity building and management to implement innovative techniques that inform and promote harmonious coexistence between humans and wildlife.

**The CSIR** is a foremost national science and technology institution in Ghana mandated to carry out scientific and technological research for national development. The council’s mission is to become the force for accelerated social and economic development of Ghana through examining, exploring and creating Science and Technology catalysts for public and private creation. The council envisions using the transforming power of Science and Technology for wealth creation.
Can Forests Buffer Against Malnutrition? Evidence from Vital Signs Data Monitoring in Uganda

Many studies have demonstrated how forests and natural areas can improve dietary diversity[1], food security and nutrition[2]. Forests provide a greater variety of foods than agriculture alone[3], and can remain productive even during times of drought and climate stress, when agriculture fails. People in rural parts of the developing world depend directly on forest food products like bushmeat, fruit, nuts, insects, leaves, and honey to provide nutrition[4]. Nonfood products like building materials and medicines can also bolster food security by providing additional sources of income.

The Vital Signs monitoring system, collects and integrates primary and secondary data using standardized protocols and methods including household surveys, vegetation plot measurements and remote sensed data allowing researchers and policymakers to dig further into these trends.

Preliminary Vital Signs results show the role that forest resources play in nutrition and the toll that missing forests take is exemplified in three landscapes in Uganda: Masindi in Western Uganda, Kisoro in the southwest, and Yumbe in the Northwest.

Masindi is one of the most agriculturally productive parts of Uganda – households grow maize and sunflower, as well as cash crops like tobacco and sugarcane. Farmers use ample agricultural inputs like fertilizers and pesticides, and most use ox ploughs, with others preferring tractors. The average household in Masindi produces $341 a year worth of crops with some households producing over $1,000 annually. This high agricultural output means that malnutrition is relatively low with only 22% of children surveyed being stunted.

Kisoro, on the other hand, has some of the lowest levels of agricultural production – farmers have small fields because of the high population density, and erosion is a major issue given the rugged terrain. The average household’s total annual agricultural production is valued at only $120. Unsurprisingly, given the poor agricultural trends, rates of malnutrition are very high – 55% of the children under five surveyed by Vital Signs were stunted, indicating long term malnutrition.

Both Kisoro and Masindi illustrate how agriculture is critical to nutrition in subsistence and smallholder farmers – there is often a strong direct relationship between agricultural output and rates of stunting. One landscape in the north of Uganda, however, bucks this trend. The average household in Yumbe produces less agriculturally than Kisoro ($90/year), but has lower rates of stunting than Masindi (18%). How do people in Yumbe sustain such positive nutrition rates with relatively little agricultural production? By significantly supplementing their diets with forest products. Households in Yumbe use large quantities of honey, bush meat, shea nuts, and insects from the forest – nearly $100 worth per year (Fig1). These resources are not available to people in Kisoro or Masindi, who mostly only use building materials from the comparatively smaller forests they have nearby. The forests adjacent to the landscapes in Kisoro and Masindi are some of the largest in Uganda but they are protected and hence inaccessible by the locals.

However the woodlands in Yumbe are less destroyed and accessible for wild food and honey.

The above results underscore the role that forests play in improving nutrition, and without forest foods households can be entirely dependent on agricultural production. This leads to chronic malnutrition where agricultural output is low, and leaves children much more vulnerable to climate shocks including drought. For more on VS work and data see http://vitalsigns.org/and https://www.afrii.org/.

Notes:

Landscape is a 10km X 10km area for which high resolution satellite images are repeatedly acquired on a daily to five year interval and in which Vital Signs develops an in-depth understanding of the spatial, temporal dynamics of agriculture, ecosystems and human well-being. Within each landscape 20 Household are randomly surveyed. For each household, anthropometric measurements were taken for all children under the age of 5.


Fig1: Barchart showing the Annual Value per Household of Resources derived from Forests per Landscape
Do Female-Headed Households Have Less Access to Agricultural Capital and Services? Results From Vital Signs Data From 26 African Landscapes

In the struggle to produce more food sustainably, create economic growth, and improve health outcomes across the developing world, women play a pivotal role. Women often assume different agricultural roles than men: they grow more garden crops while men grow more commodity crops and field grains\(^1\). Women are also generally charged with childcare and eldercare, and pay more attention to household nutrition and child health. At the same time, women also face significant burdens in patriarchal societies where they have less access to land and income. Due to a range of legal and cultural constraints across Africa in land inheritance, ownership, access, control, and use, women make up only about 15 percent of agricultural land holders\(^2,^3\).

However some countries are making more progress than others in the push for equality: in Rwanda, for example, women and men have equal rights to men with regard to land ownership, inheritance, access, control and use.

Vital Signs analyzed data it collected in Uganda, Rwanda, Tanzania and Ghana to identify the key differences between female headed households and male headed households. The data Vital Signs has collected supports these narratives. We used data from 820 households – 140 of which were headed by women – to analyze characteristics that were noticeably different between households headed by men and households headed by women. Some of the starkest differences are in women’s access to agricultural capital. Women own and farm smaller areas, and they use fewer pesticides, herbicides, or purchased seeds (see below). This jives with global data, which shows that female farmers only receive about 5% of agricultural extension services, while only 15% of the world’s extension agents are women\(^4\).

Interestingly, in spite of their lack of access to agricultural capital, female headed households also earned significantly more income from selling agricultural by-products, such as maize flour, cassava dough, coconut oil, palm oil, and banana beer. A deeper analysis showed that while women are more likely than men to sell these by-products and to get more income from them, they don’t sell different by-products than men do.

It is largely recognized that women invest a substantially larger amount of their earnings back into their families (upwards of 90% by some reports, in comparison with men’s reinvestment of around 35%\(^5\)). This can have profound impacts on household food security and nutrition. Our analysis shows that in agricultural landscapes in Uganda, Rwanda, Tanzania and Ghana, women are significantly lagging in attaining those gains in income and agricultural resources that would allow them to invest in better outcomes for their children, their families and communities, and the global environment. Supporting women by giving them more access to agricultural resources and inputs could lead to large gains in terms of agricultural productivity and economic growth\(^6\).

Vital Signs is communicating these findings to stakeholders in the countries where it has collected this data, in order to encourage them to adopt gender sensitive data-driven policy solutions that will fill this critical gap in women’s access to agricultural capital.

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\(^1\) FAO. 2009. What are “women’s crops”, and why?
\(^2\) FAO. 2010. Gender and Land Rights Database.
\(^3\) FAO. 2011. The State of Food and Agriculture 2010-2011 (SOFA)
\(^4\) FAO & Farming First. The Female Face of Farming
\(^5\) UN & Clinton Global Initiative. Empowering Girls & Women
High Nutrient Soil Maps to Inform Agricultural Decisions

Vital Signs, (working with International Soil Reference and Information Center, ISRIC) has produced “high-resolution soil nutrient maps” for Uganda, Tanzania, Rwanda and Ghana.

Vital Signs has collected 5,969 soil samples from points scattered across the countries (Uganda, Rwanda, Tanzania and Ghana). Of these, 3,714 soil samples were analyzed by the World Agroforestry Center laboratory in Nairobi to produce data on soil properties including particle size, pH, nutrient availability and nutrient content. The data was then combined with other soil samples from the Africa Soil Information Service (AfSIS), One Acre Fund, Legacy soil data (and others) to generate high resolution soil nutrient maps for Uganda, Tanzania and Ghana. (NB: Soil samples from Rwanda soil samples are still being analysed and the maps will be produced later this month).

The soil maps fill critical information gaps on soil nutrients, crop suitability, land degradation and they also provide useful information for targeting agricultural investments/interventions and estimating yield gaps[1]. For example in Uganda, the maps will be especially beneficial for the “Operation Wealth Creation” which is providing seeds and other agricultural inputs to farmers in an effort to increase agricultural yields. The maps will guide these investments by showing where the soil is most fertile and for which crops. Similar information would also be useful to guide agricultural investments in the Southern Agricultural Growth corridor (SAGCOT) in Tanzania.

Secondly, in Rwanda and Uganda where large restoration efforts are planned as part of the AFR100 Forest landscape restoration initiative, the maps will be very useful in providing information about where the restoration efforts should be focused.

The maps are now available: http://vitalsigns.org/soil-nutrient-maps [1]

How Natural Resources Supplement Household Expenditure on Food—Results From 12 Landscapes in Uganda and Ghana

This analysis is a result of the collaboration between the eScience Institute Data Science for Social Good Program and Vital Signs. To learn more about this program, please visit http://escience.washington.edu/dssg/.

Non-Timber Forest Products (NTFPs) supplement the incomes of rural people throughout Africa. According to some estimates, NTFPs provide income for over two-thirds of Africa’s 600 million people. Some NTFPs, such as shea, are exported to international markets after being collected in local forests. Others, like fuelwood and building materials, are sold in local markets. Whether a part of the global economy or local economies, NTFPs are a major income source: a literature review of 51 case studies across 17 developing countries showed that, on average, forests provide 22% of a household’s total income and that households with less income were most dependent on forest resources.

Many Vital Signs communities rely on natural resources in their daily lives, including both food (e.g., fish) and other items (e.g., building materials). These resources can potentially improve multiple aspects of wellbeing, including nutrition, finances, health, and housing.

We examined self-reported collection of natural resources across Vital Signs communities in Ghana, Rwanda, Tanzania, and Uganda. While non-food items are highly valuable and often collected (particularly building materials and medicinal plants), in this blog we will focus specifically on collection of natural foods. These natural foods may provide supplemental nutrition (particularly when agricultural yields are low), expand dietary diversity, and allow individuals to save money they otherwise would have spent on purchasing food.

Nuts or seeds, bushmeat, and honey were the foods collected by the greatest number of households, with nuts/seeds being by far the most frequently collected. Overall, there was very little collection of natural food reported in Rwanda and Tanzania, perhaps due to stricter protection of natural areas in these countries. Of course, it must be considered that self-reporting of collection may be less reliable in areas where such activities are illegal.

We were interested in whether collection of natural foods saved people money, allowing them to spend more on non-food items. Due to the low volume of collection reported in Rwanda and Tanzania, this analysis focused exclusively on Ghana and Uganda. We looked at the relationship between the estimated value of collected natural foods (in USD) and the proportion of a household’s budget that went towards food. Here, the estimated value was based on how much individuals indicated they would spend on an item at a market if they could not collect it multiplied by the number of times they typically collected it in a year (e.g., $2 if they collected weekly). If an individual said they collected an item but would not buy it at the market, we used the average value placed on that item for that specific community.

Thus, these values may be underestimates, as people might buy different items at market if natural foods are unavailable (e.g., goat meat may be cheaper than bushmeat in many markets). Yet, the data still showed a significant relationship, with households that collected a greater value of natural foods spending a smaller proportion of their budget on food.

VITAL SIGNS • PRELIMINARY RESULTS FROM THE FIRST ROUND OF VITAL SIGNS DATA COLLECTION IN UGANDA, TANZANIA, GHANA AND RWANDA
This finding may suggest that availability of such resources allow families to save money on food and increase investment in other expenditures (e.g., home improvements, agricultural tools). Alternately, it is possible that families that cannot afford to spend much on food (e.g., if a family member is sick and has extensive medical expenses) are more likely to seek out natural foods, which may help buffer against hunger in hard times[5].

Regardless of the underlying cause of this relationship, it is clear that natural foods are a valuable resource for many communities in Uganda and Ghana. These results were heavily influenced by a small number of households that gathered a particularly high volume and variety of natural foods. Use also varied greatly by location, with one Ugandan community collectively collecting more than 5000USD annually in natural foods, nearly 3.5 times the value of the next highest community.

This particular community is adjacent the Mount Kei Forest Reserve, a protected area of more than 400km squared that allows for sustainable use of natural resources. Thus, the presence of such a natural area clearly proves to be an extremely valuable resource for the people living nearby.

However, both in this community and throughout Vital Signs landscapes in both Uganda and Ghana, the availability of natural foods was extensively reported to be in decline relative to five years ago. Thus, there is concern that current collection levels are unsustainable (whether due to overharvest or land conversion). As Vital Signs gathers more data over time, it will be helpful to better understand how collection of natural items is changing and what factors or practices can best predict sustainable use to ensure future availability of these valuable resources.
The Impact of Agricultural Commercialization on Household Nutrition and Food Security: Results from 489 Households in Uganda, Rwanda, Tanzania and Ghana

This analysis is a result of the collaboration between the eScience Institute Data Science for Social Good Program and Vital Signs. To learn more about this program, please visit http://escience.washington.edu/dssg/.

When subsistence farmers begin growing cash crops, they can generate income, and this can lead to positive outcomes in terms of health and education. However, producing cash crops can compete with subsistence crop production, within households and countries\(^1\). While cash cropping is a major vehicle for economic development, cash crops have been implicated in situations with worsened nutrition and food security. One example is the “Sikasso Paradox” in Mali, where Sikasso the most agriculturally fertile region of Mali is a major producer of cotton, and also the country’s malnutrition hotspot\(^2\). The earliest research on this specific issue examined several cases of cash cropping and nutritional changes. While this research found some cases of cash cropping leading to worsened nutrition outcomes, on the whole most cases lead to increased incomes and improved nutrition outcomes\(^3\).

Lately, most of the conversation in development focuses on the latter cases, and the notion that agricultural commercialization necessarily leads to improved nutrition outcomes has become a common myth\(^4\). Nevertheless, the latest science on the issue confirms that cash cropping does not always lead to improved nutrition outcomes, and can even have ambiguous or negative effects\(^5\).

For these initial analyses, we were interested in how crop commodification is related to food security. Ultimately, we wondered if increased levels of crop commodification impacts nutrition in children under the age of five, a time sensitive development period. Looking at data from 489 households in Rwanda, Ghana, Uganda, and Tanzania, we first ran a model relating crop commodification to food security and food security to child nutrition.

We measured food security as a function of dietary diversity, the Household Food Insecurity Access Scale (HFIAS), amount of food consumed per person, months of insecurity reported by households, and number of meals consumed per day. Child nutrition was measured as normalized height and normalized weight for height in relation to predetermined standards. For crop commodification, we use the Crop Commercialization Index, or the percent of the total value of a household’s agricultural output that was sold\(^6\). Ultimately, we observe relationships between crop commodification and food security in addition to a relationship between food security and child nutrition. However, we observe no direct relationship between child nutrition and crop commodification.
In terms of food security, we see that crop commodification may have no benefit in Rwanda and benefits that level off in Uganda, Tanzania, and Ghana. Further research would be needed to confirm these leveling-off patterns, as the margin of error (indicated by dark gray shading) is large at some levels of crop commodification.

This initial exploration raises interesting questions. At this point, we cannot attribute causal relationships to the relationships between commodification, food security, and childhood nutrition. Additionally, there may be latency between the time crop commodification increases and the time we begin to see improvement in children’s health. Ultimately, continuing to collect these data will provide a breadth and depth of knowledge for understanding what types and levels of commodification are beneficial, neutral, or potentially detrimental to food security and child development.

Are the Effects of Extension Services on Crop Productivity Moderated by Farmer’s Education Attainment? Results From 25 Landscapes in Uganda, Rwanda, Tanzania and Ghana

This analysis is a result of the collaboration between the eScience Institute Data Science for Social Good Program and Vital Signs. To learn more about this program, please visit http://escience.washington.edu/dssg/.

Existing studies of farmer field schools (FFS) have found that these programs exhibit a sizable positive effect on per-acre crop productivity value among households with lower educational attainment, with negligible effects on higher-education households[1][2]. In these analyses, we examined whether a similar effect can be observed when examining a broader set of extension services. Agricultural households in Vital Signs landscapes were therefore asked whether they received extension services in the past 12 months. The categories of extension services used in this study were Agricultural Production, Agro-processing, Marketing, and Livestock Production.

In the analyses, we examined the effects of extension services on crop productivity and if these services were moderated by farmers’ educational attainment. To measure receipt of extension services, we counted the total number of instances in which a given household received advice on any of the topics measured in the Vital Signs dataset. For example, if a household received advice from two sources on Agricultural Production and one source on Agro-processing, we counted that household as having received three extension instances.

For education, previous studies[2] have measured education using educational attainment of the head of the household. However, based on our team’s experience providing and examining extension services in the region, we argue that the maximum individual-level educational attainment represents a better measure. Older household members often receive fewer opportunities to study than their younger counterparts, who may be able to “translate” advice.

Otherwise, to maintain consistency with existing work we attempted to maintain the same set of independent variables as those used previous studies[2]. In particular, we controlled for country, total area farmed, household size, age of household head, gender of household head, and median household-level field distance to road and market. We also included variables corresponding to field ownership and shared field usage, discretized into “All Owned”/“Some Owned”/“None Owned” and “All Shared”/“Some Shared”/“None Shared”, respectively.

Household-level maximum education values are shown on the map and figure below. Households in most landscapes across the dataset displayed roughly similar education values, though education levels in Ghana were slightly higher than those in other countries.

Receipt of extension services varied substantially by country and landscape. Households in four out of six landscapes in Ghana received at least one form of extension on average, while households in all but one other region in the dataset received fewer than one form of extension on average. Landscapes in Ghana also varied substantially more in absolute receipt of extension services than landscapes in other countries, ranging from a maximum of 3.67 extensions/household compared with a minimum of 0.53.
To model the relationships between the dependent variable (logged total crop value by household) and the independent variables described above, we used Kernel-Regularized Least Squares (KRLS) approach[3]. KRLS is a flexible regression model which treats each observation as a weighted combination of the values of all other observations in the dataset, weighted by their similarity to the given value[3]. This approach allows us to easily explore mediating relationships like the one outlined in this paper, without making strong assumptions regarding the shape of the relationship between the variables under consideration. Controlling for the other predictor variables described previously, we estimate that the average marginal effect of the total extension services variable is positive and significant. Under this approach, each additional extension service received is associated with approximately a 12% increase in total crop value. In contrast to previous studies,[2] the effect of extension services does not appear to be moderated by education. The figure below plots the marginal effect of extension services for each household in the dataset, organized by the maximum education value in each household.

If the relationship found by[1] was present in the Vital Signs dataset, we would expect the curve in this figure to positive at lower education values and downwardly-sloping for higher education values. In words, the effect of extension services should be positive and significant for low-education households, and near-zero (or even negative) for high-education households. Instead, the relationship is slightly upwardly-sloping, suggesting that the effect of extension services is roughly constant (or perhaps slightly increasing) with education.

Based on the results presented here, extension services appear to have a positive effect albeit small on total per-household crop production. This effect does not appear to be moderated by education, unlike previous studies. Similar results using a standard linear model were found, though not all coefficients achieved statistical significance. Future versions of this analysis might benefit from a more extensive missing data strategy or a more theory-driven approach to functional form specification, as opposed to the more exploratory approach taken in this report.


Are Benefits From Agricultural Intensification Related to Household Income, Level of Education and Gender? Results From 758 Households in Uganda, Rwanda, Tanzania and Ghana

This analysis is a result of the collaboration between the eScience Institute Data Science for Social Good Program and Vital Signs. To learn more about this program, please visit http://escience.washington.edu/dssg/.

In developing countries, agricultural intensification (defined as increased input per unit of land) is a key phenomenon of interest. These inputs may include land, fertilizers, pesticides and labor including use of agricultural machinery. Increasing agricultural intensification can contribute to aggregate-level increases in food availability and economic performance. However, these benefits may not be evenly distributed, largely based on unequal access to key inputs, either across landscapes or countries or according to some demographic feature of interest.

For the purposes of this study, we focus on investigating gender- and income-based equity outcomes as they relate to availability and usage of agricultural inputs. Previous studies examining the relationship between gender and input usage have returned mixed results, for example, found organic fertilizer usage is substantially higher in male-headed households than female-headed households. By contrast, usage of improved fallows is largely unrelated to gender of household head.

Previous studies in their analysis of indicators of agricultural intensification identified nitrogen fertilizers, measurement of crop yields, pesticide use, farming systems, labor intensity, technologies among others as measures on intensification. For the purposes of this study, we focus largely on agricultural and labor inputs. In particular, we examine differences in fertilizer usage (inorganic and organic, measured by purchase price and kilograms used), pesticide/herbicide usage (measured by purchase price), and usage of hired labor (measured by total cost of hired labor and person-days used). We also include within-field intercropping rate as a further intensification indicator.

Organic and non-organic fertilizer usage

Examining fertilizer usage indicates that total input usage varies substantially by landscape and country. For example, a substantially greater proportion of households in Ghana, Rwanda, and Tanzania report using inorganic fertilizer than in Uganda. However, there is also substantial within-country variation. For example, within Rwanda, nearly 75% of households in the Volcanoes and Nyungwe regions report using inorganic fertilizer, compared with none in the Akagera region. At least in Rwanda, this pattern largely matches results from the Vital Signs qualitative households’ descriptions, which identify Volcanoes and Nyungwe as productive, cash-oriented agricultural regions.

Figure 1: Inorganic fertilizer use in Ghana (GHA), Rwanda (RWA), Tanzania (TZA) and Uganda (UGA) landscapes.
By contrast, organic fertilizer usage is much higher in Rwanda than other regions. This difference is likely attributable to high rates of livestock ownership in Rwanda, which provide an easy source of organic fertilizer to most households.

Hiring outside labor

Non-household labor usage rates form a similar pattern, with a substantially larger proportion of Ghanaian households reporting at least some outside labor usage. The landscapes outside of Ghana that report high rates of non-household labor usage are largely consistent with their counterparts on previous indicators, including Volcanoes and Gishwati in Rwanda and Masindi in Uganda.

Intercropping Rates

In our analysis, we find that on average, Ghanaian landscapes exhibited the lowest intercropping rates, maintaining the pattern from previous indicators. However, all countries show substantial variation on this indicator. Comparing this variation in intercropping rates seems at least loosely related to landscape level Vital Signs qualitative characteristics. For example, the Masindi landscape in Uganda is identified as one of the most mechanized and commercialized regions in the country, and also displays the lowest intercropping rates in the country. The Volcanoes landscape in Rwanda is identified as being similarly productive, and exhibits similarly low intercropping rates. However, this relationship is not completely consistent; for example, the Sumbawanga landscape in Tanzania is identified as a relatively intensified region, but appears to exhibit one of highest intercropping rates. Monoculture is a key indicator of agricultural intensification, making intercropping prevalence particularly worthy of investigation. For example, in his study (Martinez et al 2015) found that monoculture systems with specialized cropping and high levels of pesticide use were found to be more intensified.
Agricultural Intensification and Inequality

Disaggregating the above agricultural intensification indicators (Fig 5) by gender indicates that male- and female-headed households report approximately equal values for the indicators intercropping, pesticide, herbicide and organic fertilizer usage. A greater proportion of female-headed households however report using inorganic fertilizer and non-household labor, suggesting that these households are more likely to follow intensified agricultural practices. Male-headed households also own approximately double the land that female-headed households report (0.98 hectares/household vs 2.35 hectares/household), so inputs used for male-headed households are much larger than their female-headed counterparts in most cases. Examining agricultural input usage between countries indicate that female headed households report more inorganic fertilizer use in Ghana and Tanzania with male headed households reporting slightly higher usage in Rwanda and Uganda.

Figure 5: Agricultural intensification indicators by gender

Finally, we examined whether the benefits of agricultural intensification as measured using the various indicators constructed above were evenly distributed within Vital Signs Landscapes. We particularly focused on distribution of household income and education benefits. The results showed that landscapes with a higher proportion of households reporting fertilizer usage, intercropping, non-household labor, and pesticide usage do not appear to be more unequal (as measured by a Gini coefficient calculated on net value of agricultural goods produced) than their less-intensified counterparts. A Gini coefficient of zero expresses perfect equality, where all values are the same (for example, where everyone has the same income).

Looking at the distribution of education benefits between more and less intensified landscapes, the same story holds, where high inequality landscapes with a small number of highly educated people and a larger number of low-education people are somewhat more likely to use inorganic fertilizer, labor, and pesticides.

Conclusion

Based on the results, it does not appear that greater access to intensification-related agricultural inputs contributes to inequality as measured by income and education levels. Moreover; it does not appear that female-headed households are any less willing than their male-headed counterparts to adopt various inputs and agricultural practices associated with intensified farming. Rather, differences between household uses of agricultural inputs are largely attributable to existing differences in household wealth (as measured by land ownership). Overall, there is need to further close the gender gap for various agricultural assets in particular access to land, labor and inorganic fertilizers if the benefits to agricultural intensification are to remain evenly distributed between households. Agricultural intensification and its associated benefits are more complex than this summary analysis can provide. Further analysis and observations is therefore needed to build on the above findings.


## DATA COLLECTED SO FAR

(See more at [www.vitalsigns.org/get-data](http://www.vitalsigns.org/get-data))

<table>
<thead>
<tr>
<th>Type</th>
<th>Coverage</th>
<th>Scope</th>
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</table>
| Household Survey Data        | • 804 Households                | • Age  
• Education  
• Health and anthropometry  
• Labor and businesses  
• Food consumption  
• Natural resource use  
• Fuelwood use  
• Items owned  
• Housing materials  
• Food security and Food scarcity |
|                              | • 7,197 individuals              |                                                                      |
| Agricultural Survey Data     | • 804 Households                | • Livestock  
• Farming implements  
• Extension services  
• Crop and livestock sales  
• Inputs and input history  
• Estimated yields and by products  
• Annual crops and Permanent crops |
|                              | • 2,272 Agricultural fields     |                                                                      |
|                              | • 212 verified yield samples    |                                                                      |
| Soils                        | • 3,139 samples from biophysical plots | 52 variables, including texture, macro- and micro-nutrients, and organic carbon  
Georeferenced |
|                              | • 955 from farmer’s fields      |                                                                      |
|                              | • Of these, 1,905 analyzed using spectroscopy |                                                                      |
| Biophysical Data             | Nationwide and nationally representative | 49,588 trees measured and identified  
• 7,670 subplots assessed for erosion  
• 3,646 unique plant species identified  
All Geolocated |
|                              | • Samples from 1,334 field plots |                                                                      |
| Weather                      | 8 Weather stations constantly collecting data and transmitting to database every half hour | • Temperature  
• Relative Humidity  
• Pressure  
• Solar Radiation  
• Wind Speed  
• Precipitation |
| Land Use Land Cover          | Nationwide and nationally representative | 8,515 georeferenced land cover points recorded for ground-truthing classifications  
• 20 classified images of 10x10km landscapes |

VITAL SIGNS

OUR PARTNERS AND FUNDERS

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