

Agricultural Intensification in Ethiopia: Patterns, Trends, and Welfare Impacts

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Summary

This study examined the patterns, trends, and drivers of agricultural intensification and productivity growth during the recent decade (2012 - 2019) using three rounds of household data collected from four agricultural regions of Ethiopia. The descriptive results indicate a positive trend both in adoption and intensity of inputs and outputs, albeit from a low base and with considerable heterogeneity by access to information, rainfall levels and variability, labor, soil quality, and remoteness, among others. The econometric results show significant association between intensification, yield growth, household dietary diversity, and consumer durables. The results on the association between current yield levels and per capita consumption expenditures are however mixed (i.e., while an increase in cereal yield improves food consumption expenditures, an increase in cash crop yield improves only non-food consumption expenditures). In sum, while the increasing input intensification and the resulting yield gains are associated with improvements in household diets and consumer durables, it falls short to have strong impact on incomes (as measured by total consumption expenditures), indicating that additional efforts must be made to see meaningful impacts on higher order outcomes. Additional welfare improving productivity gains through increased input intensification may require investments in appropriate fertilizer blends; investments in improved seeds (to accelerate varietal turnover), ways to mitigate production (rainfall) risk, and investments to remodel Ethiopia's extension system to provide much needed technical support to farmers on production methods.

Background

To stimulate overall economic growth and overall welfare, Ethiopia has made substantial efforts in the last three decades to increase agricultural productivity through modern input intensification led by its public extension system. However, despite the high growth rate trends in recent years, Ethiopia's yield levels and overall intensification remain rather low – and show signs of slowing down recently (Berhane et al., 2020).

Agricultural transformation is associated with sustained increases in land and labor productivity through policy-induced intensification. However, in countries like Ethiopia where land is a major constraint, intensification efforts are further limited by demographic as well as biophysical determinants (Heady et al., 2014(a); Heady et al., 2014(b)). Theoretically, when set in motion, intensification is expected to first increase cultivated land and then cultivated land decreases due to both land constraints and decreases in aggregate prices (Rudel et al., 2008). In other words, intensification provides farmers with higher yields per hectare and growth in overall income, which in turn induces farmers to expand production through increased cultivation of additional land. Increased supply of agricultural produce in aggregate, with relatively inelastic demand, would result in decline of prices driving intensification to focus on knowledge or technology to respond better to additional inputs. In practice, the net effect is not clear from the outset and often population pressures hinder policy-induced intensification leading to undesirable outcomes. Given the lack of detailed and consistently collected data on farm practices, it is not clear what explains intensification or the lack of it and how increases in productivity translates to welfare improvements.

This study examines the patterns, trends, and drivers of agricultural intensification in the last decade using household data from four regions in Ethiopia. Specifically, it deals with the following research questions. What is the household-level evidence of agricultural intensification in Ethiopia? What explains intensification at the farm (i.e., household) levels? To what extent does modern input intensification explain observed trends in land productivity (or yield)? Do increases in land productivity translate to household level welfare improvements?

Data and methods

The study used three rounds of the Ethiopian Agricultural Commercialization Clusters (ACC) surveys conducted by the International Food Policy Research Institute (IFPRI) in collaboration with the Ethiopian Agricultural Transformation Agency (ATA). The analysis uses panel data from 1,899 households interviewed in three rounds.

We define agricultural intensification as an increase in the level of inputs applied with the goal of increasing productivity and income. We conceptualize intensification as a constrained household utility maximization problem where production and consumption are non-separable in which levels of input use or intensification are affected, in addition to input and output prices, by various socioeconomic and household characteristics. We measure yield or land productivity at the household level as real value of output per unit of land used for production. We calculate yield for all crops, mainly for cereals, pulses, oilseeds, vegetables, root crops and fruits, as well as separately for cereals and cash crops. Household welfare indicators used include household diet diversity score (HDDS), consumer durables, and adult equivalent food, non-food, and total consumption expenditures. Monthly rainfall data extracted from the CHIRPS dataset is used to proxy for production risk. In the estimation, we implement a more recent variant of the CRE model, known as the hybrid model (Allison, 2009), where the within-effects and between-effects are estimated in a random-effects model framework.

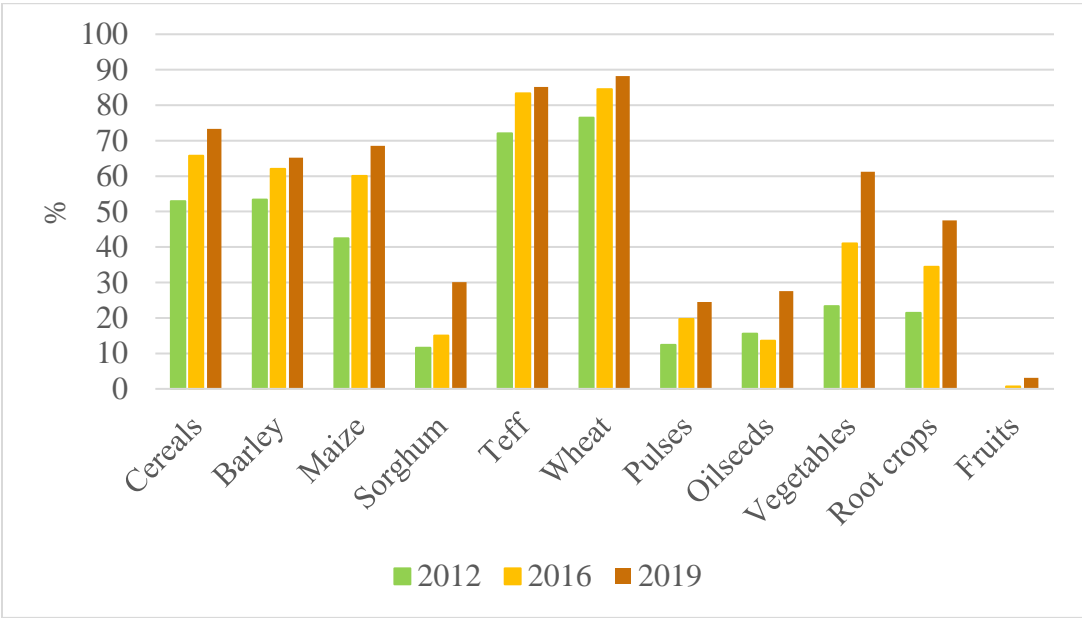
Results and discussions

Trends of input intensification

At a macro level, data from the Agricultural Sample Survey (AGSS) of the Central Statistics Agency (CSA) indicates that fertilizer applied area has increased by 55 percent between 2007/08 and 2016/17,

with overall increase in fertilizer intensification from 0.45 to 0.95 quintal per hectare in the same period. Our analysis depicts similar positive trends in the adoption and intensity of fertilizer use. Among crops, cereals account for the most part of fertilizer intensification. The ACC data shows the share of households using fertilizer on cereals increased by 20 percentage points between 2012 and 2019 (Figure 1). Likewise, the share of cereal area fertilized increased by about 6 percentage points and rates of application as measured by amount of any fertilizer use per hectare of land has doubled.

Figure 1: Fertilizer adoption by crop and survey year



Source: Authors’ analysis of data from the ATA-ACC Survey

Use of improved seeds has also increased. Between 2012 and 2019, the share of households that adopted a newly purchased seed has increased by 17 percentage points for maize and 3 percentage points for vegetables. Teff has also seen some improvements while the remaining crops have seen declines. The share of area covered by newly purchased seed varieties has also increased by 11.4 percentage points for maize and by 6.2 percentage points for vegetables. The share of area covered by root crops has also increased slightly, while for the remaining crops it has either remained the same or slightly declined. Clearly, maize and vegetables are the only crops with relatively high level of improved seed coverage, presumably the hybrid nature of maize seeds and the difficulty in collecting and storing vegetable seeds necessitate farm households to buy them on yearly basis. The share of households that jointly adopted both improved seeds and fertilizers in at least one of their plots is also limited.

Agrochemical intensification varies by crop type and is greatest on vegetables (203 birr per hectare) followed by wheat (188.9 birr per hectare), and teff (131.7 birr per hectare), perhaps due to susceptibility of both crops to pests and diseases. And, machinery use, measured by average cost of use, is highest for oilseeds (39.1 birr per hectare), followed by wheat (24.3 birr per hectare) and sorghum (18.7 birr per hectare).

Determinants of intensification and yield

Several factors stand out as important determinants of input intensification, including access to extension services, access to mobile phones and radio, soil quality, remoteness of plots, and availability of

labor in the household. On the other hand, fertilizer and agrochemical intensification are statistically significant determinants of growth in yield. Contrary to our theoretical expectation, use of purchased seeds is statistically significant with a negative sign. Other production inputs such as household labor, oxen ownership, and use of organic fertilizers also exhibit statistically strong association with yield growth.

Weather risk (measured by rainfall variability) is also an important shock, negatively associated with input intensification and hence yield growth. Radio ownership (an important source of extension information in Ethiopia), commercialization (share of output sold) and age (measuring experience) of the head of the household are also found to be statistically and strongly associated with yield growth.

Yield growth and household welfare

Does yield growth correlate with improvements in household welfare? Two important findings are drawn from this analysis. First, controlling for a host of household and location characteristics, total yield growth is strongly associated with household-level diet diversity score (HDDS), household durable assets, and adult equivalent non-food expenditures. However, total yield growth is not significantly associated with household income (measured by adult equivalent food and total expenditures). On the other hand, while cereal yield is weakly associated with adult equivalent food expenditures, cash crop yield growth is strongly associated with adult equivalent non-food and total expenditures, suggesting that improvements in cereal yields are likely to improve food consumption, while incomes from cash crops are likely to be allocated to non-food investments.

Yield growth in both cereals and cash crops is also strongly associated with increases in HDDS. This is plausible given HDDS is likely to be improved either through production diversification (via cereal production diversification), or through access to diversified food markets (via cash crop income increases). Cereal yield growth is also strongly associated with increases in household durables, implying, in small-holder contexts, early income increases are likely to improve household durables before substantive increases are made on consumer goods.

Second, intensification measures, mainly fertilizer and seed have positive and significant relationship with most of the welfare indicators. Seed intensification measured by value of seed per hectare has a strong and positive relationship with consumption expenditure.

Conclusions and policy implications

Ethiopia has in the last few decades registered significant progress in improving agricultural production. Despite these growth trends, yield levels and overall intensification remained rather low. Using three rounds of household data, this study assessed the patterns, trends, and drivers of agricultural intensification between 2012 and 2019. We find positive trends in adoption and intensity of fertilizers, agrochemicals, and improved seeds, albeit from a low base for improved seed adoption and intensification. Among important positive determinants of all input intensification include improvements in access to extension services, availability of labor, and access to mobile phones and radio. Rainfall variability, poor quality of soils, and remoteness of plots are shown to have strong negative associations with fertilizer and improved seed intensification. Yield growth is also associated with intensification of organic and inorganic fertilizers and agrochemicals, and access to own labor and oxen.

Our results also show that intensified use of inputs and subsequent improvements in total yield have improved household level diet diversity, non-food expenditures, and consumer durables, but not food

consumption expenditures. However, improvements in cereal yield have immediate important implications for food consumption, improvements in dietary diversity (partly because of the diversification in production), and improvements in household durables.

We conclude by noting the following policy implications. A lot has been done to improve Ethiopia's input intensification landscape. Our analyses suggest that progress has been made in terms of familiarizing fertilizers such that fertilizer adoption may not be a core challenge of policymakers anymore. Household datasets, including ours, repeatedly show that most farmers in Ethiopia adopt and experiment with fertilizers available to date in blanket recommendations. Thus, achieving profitable intensification remains a challenge. A deeper look into this problem therefore suggests that lack of availability of the right blend of fertilizers suitable to specific soil nutrient requirements, along with lack of customized technical support (something lacking in Ethiopia's extension system) in applying the right soil nutrient-fertilizer mixes are among those limiting transformative fertilizer intensifications.

Lack of access to appropriate improved seeds is also another hurdle to increasing productivity through proper input mix intensification. Again, our findings suggest that lack of availability of improved seeds is limiting varietal turnover and seed replacements rates and sustained intensification. Improving the structural constraints of generating locally suitable improved seeds and putting in place the right supply chains to reach out farm households on timely manner can take the sector a long way.

It should also be noted that rainfall risk, or the lack of reliable moisture is another important hurdle in the intensification of Ethiopia's predominantly rainfed agriculture. Investments in smallholder/small scale irrigation structures remains a core priority for the years to come.

Our study has also shown that all those efforts in input intensification (along with several other factors) have led to productivity (yield) increases but from a low base. It maybe that additional transformative productivity gains would come not only from improvements in the supply of the right inputs but also from putting in place the right research-extension systems to provide farmers with much needed technical support. Additional investments to remodeling Ethiopia's extension system to fit these purposes remain among top priorities of Ethiopia's policymakers and its development partners.

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