How Will Women Empowerment Help Achieve Food Security Towards 2050?

Abstract

Agriculture has the potential of promoting economic growth, food security and reducing poverty by raising incomes and reducing the cost of food for all consumers. However, it faces multiple challenges towards 2050. At the same time, women empowerment would greatly benefit society by increasing agricultural productivity, reducing poverty and hunger, and promoting economic growth. In the following paper, the impact in agricultural production and food security of women's empowerment through education towards 2050 is analyzed. The key variables considered include changes in fertility rates, higher income, increase in yield potentials and higher household spending in food. The results suggest that women empowerment has the potential to bring considerable benefits to agricultural production in 2050 by reducing the demand by 9 %. Furthermore, food security would be positively affected, lowering the malnutrition count by 3.12% vs the current 2050 projections.

Keywords: *female empowerment, closing the gender gap, agriculture towards 2050, SIMPLE*

Introduction

Today, 805 million people are estimated to be chronically undernourished despite the fact that world food availability has been secured (FAO, et al., 2014). Although the proportion of undernourished population has fallen, absolute numbers remain the same as those in 1996, where the commitment of halving the number of undernourished people in developing countries was made at the 1996 World Food Summit. This target is not expected to be met before 2040 (FAO, 2012) and the projections show that feeding the world's population in the future will represent a huge challenge for the agricultural sector.

Currently, 3 out of 4 poor people in developing countries live in rural areas, accounting for over 70 % of the food insecure people in the world (World Bank., et al., 2009). Most of these people depend directly or indirectly on agriculture for their livelihoods where it has the potential to promote economic growth, food security and reduce poverty by raising incomes and reducing the cost of food for all consumers. Agriculture's role in poverty and hunger reduction is projected to continue being significant towards 2050.

Despite the increased investments in agriculture and the new opportunities arising in the sector such as the expansion of markets from globalization and trade liberalization, and advances in technology, agriculture is underperforming in many developing countries. A considerable number of development policies and projects assume that the rural and farmer work force is

Sofia K. Vielma Delano Department of Agricultural Economics, Purdue University

composed mainly from men (World Bank, 2007). In some regions though, men have abandoned the agricultural sector to seek an alternate income source, leaving behind the burden of agricultural production to women. According to the Food and Agriculture Organization of the United Nations (FAO), women compromise, in average, 43 % of the agricultural labor force of developing countries, ranging from around 20 % in Latin America to 50 % in Eastern and Southeastern Asia and sub-Saharan Africa.

Unlike men, these women often have no legal protection or rights to property ownership and face more severe constraints in accessing productive resources, markets and services. Additionally, female farmers have to deal with more legal and social barriers that limit their ability to adapt and benefit from change. Evidence today shows that the difference achieved in yields by male and female farmers is not due to biological sexual characteristics, but to a difference in access to inputs (e.g. seeds, fertilizer, pest control measures, mechanical tools) and credits (Peterman, et al., 2010, Quisumbing, 1996). FAO estimates that if the yield difference between men and women was eliminated by improving access to resources, agricultural output would increase between 2.5 and 4 percent. This increase in agricultural production would translate in a 12-17 % reduction of undernourishment, improving the lives of at least 100 million people (FAO, 2011).

Empowering women involves giving them the power in terms of capacity and internal strength to make their own decision of where they want their lives heading to, without any kind of retaliation. One of the most important and significant paths towards empowerment is education. Not only does the education gap between men and women have serious implications for access to inputs and agricultural productivity, but it also may impact incomes. This, since farmers with a higher education are more likely to adopt new agricultural technologies and modern inputs that will increase their income-earning abilities and opportunities. Income in turn, is a critical determinant of a family's ability to access food.

Women empowerment also has implications in food security and household welfare. A home's access to food not only depends on its real income, but also on who earns it. Studies since the 1980's have found that women are more likely to spend their income on food, healthcare and education for the family, as well as other items for general household consumption (Quisumbing and Maluccio, 2003).

By promoting gender equality and empowering women, hunger and extreme poverty will automatically be reduced today. Looking towards 2050, closing the gender gap would greatly benefit society by increasing agricultural productivity, reducing poverty and hunger, and promoting economic growth.

Data and Methodology

To assess the impact of female empowerment on global food security and agriculture towards 2050, I used the Integrated Market version of the Simplified International Model of Prices, Land and Use of the Environment (SIMPLE), which is a partial equilibrium model of agriculture (Baldos and Hertel 2012; and Baldos and Hertel, 2013). The model is divided into 15 geographic regions and allows analysis of the main long-run demand and supply drivers for land in agriculture.

The baseline of the model was established given projected growth in population (medium-fertility UN World Population Prospects), income (Fouré et al., 2013), biofuels (IEA 2008; IEA, 2012) and total factor productivity of crops (Ludena et al., 2007). To understand the implications of female empowerment in the future, I assumed higher education rates. Higher education of women has been linked to impacts in demographic growth, wages, public health, female autonomy, and power of decision-making within the household. Specifically in agriculture, higher education may lead to greater access to inputs, financing, and land ownership. For the following paper I considered shocks in the demand and supply drivers of crop production, as well as a shift in the distribution within household at the consumers end.

Demand Shocks

Literature suggests increasing levels of education is a key cause of fertility decline during the demographic transition (Basu, 2002; Cleland, 2002; Martin and Juarez, 1995). The demographic projections of the International Institute of Applied Systems Analysis (IIASA) explicitly includes education as a demographic dimension in global population projections. A significant and robust negative association between education received before reproductive age and subsequent levels of fertility has been established in several studies. Hence, the assumptions made in the IIASA's projections assume a gradual narrowing of educational fertility differentials with the progress in demographic transition, taking into account country- and culture-specific differences (Lutz and Skirbekk, 2014). For the current study, I used the IIASA Fast-Track Education projections to shock the population growth (*shock p_POP*) for each geographical region.

It has been established that women earn less than men, even for the same work. Estimations based on wage differentials and participation in the labor force suggest that women's estimated earned income is 30 % of men's in the Middle East and North Africa, 40 % in Latin America and South Asia, 50 % in sub-Saharan Africa and around 60 % in East Asia and industrialized countries (UNDP, 2005; UNICEF, 2007). I assumed the same income differential of South Asia and Latin America for South-East Asia, Central Asia and Central America. To calculate the income shock in the demand, I first calculated the current share of female economically active population (F_{ea}). From the baseline scenario, I then calculated the wage of men (W_M) and women (W_F) in 2050, assuming the established wage differential per region (P_{region}). In this case, I assumed the income baseline scenario as:

$$I_{Baseline} = M_{ea} * W_M + F_{ea} * W_F, \text{ where } W_F = P_{region} * W_M \quad (1)$$

Once W_M and W_F were calculated, I assumed a scenario where $W_F = W_M$ for 2050, and recalculated the different incomes per region for 2050. I used these calculations as the income

shock for our model (*shock p_INC_PC*). An assumption made was that the proportion of male and female economically active population remained constant.

Supply Shocks

As mentioned before, FAO (2010) estimates a stylized yield gap of 20-30 % between men and women. To calculate the potential gains in yields for the 20 % productivity gap scenario, I followed the same logic as the income gains. Output (Q) is defined as yield (Y) times area (A):

$$Q = Y * A \quad (2)$$

I assumed that women farmer's yields Y_F are only 80 % of men's Y_M, meaning $Y_F = Y_M * 0.8$. Based on FAO's estimates of land ownership by gender (P), I calculated the yields in the baseline scenario for both men and women with the following equation:

$$Q = Y_F * P * A + Y_M * (1 - P) * A \quad (3)$$

For the women empowerment scenario then, $Y_M = Y_F$. It is important to acknowledge that the actual gains from closing the yield gaps would be greater since the calculations do not consider an increased ownership and access to land due to empowerment.

For implementation in SIMPLE, I calculated the new output with the yield gains. I then calculated the yields in 2050 given the new output and available land. I used the percentage difference from the baseline yields as the shocks to be applied in the model. The variable shocked was *p_AOCROPr*, which is the Hicks-neutral effect index in crop production.

Household expenditure

Evidence has suggested that when resources are scare, women generally prioritize the nutrition of family members above other personal and household issues. A survey from Cameroon showed that income-earning women typically spend 74 % of their funds in family food supply, while men spend only an estimated 22 % of their income in food. Sub-Saharan Africa is one of the regions with highest undernourishment prevalence in the world. Thus, I decided to explore the double-dividends gains from gender equality in the region. This means the effect women empowerment would have in reducing children undernourishment in the region. For this, I

shocked the variable of per capita income spending (*slack_inc_pc*) by commodity (crops, livestock and processed food) for the rest of Africa by 10 %. This was calculated based on the difference in expenditure of food from the literature ($0.52), and the proportion of population under 15 years old in 2050, according to the IIASA projections.

Results and Discussion

Following the methodology described, four scenarios were considered: 1) Only demand shocks (Population and Income); 2) Only supply shocks (Yields); 3) Only change in household spending; and 4) All shocks. In the following section, the global results from each scenario will be compared against the baseline. For easiness of the reader, crop production drivers, summarized in 1, will be discussed first, followed by the impact in food security, summarized in Figure 2. Finally, a close-up of Africa and the impacts of women empowerment in the region will be briefly discussed.

Crop Production

Scenario 1:

In SIMPLE, the components that determine the global demand (Equation 1) are: a) feed use by the livestock sector (*QRCPFEED*), b) raw input use by the processed food sector (*QCRPFOOD*), c) crops for direct consumption (*QCONS*), and d) feedstock used in global biofuel production (*QCRPBIOF*). Any changes in demand is derived from this equation which establishes the market clearing conditions, where a crop demand and supply balance is assumed across all regions. In the baseline, the impacts of population and income growth on the global demand for food resulted in an increased production, which in turn resulted in an increased demand for agricultural land. The impact of demographic changes is straightforward. Income per capita though, also plays a critical role, since it determines the patterns and levels of food consumption. Another important demand driver is the increased demand for biofuels, which we will not discuss further since we assume no change.

Equation 1: Market Clearing for Crops, Feed & Crops used in Proc. Food

```
Equation (levels) E_PCROP
# crop demand and supply balance #
sum(g, REG_GEO, QCROPg(g)) = sum(y,REG_INC, QCRPFEED(y)
        + QCRPFOOD(y) + QCONS("Crops",y)) + QCRPBIOF ;
```

Assessing the impact of a higher education for women in the global demand of crop production (*p_QCROP*) results in a decrease of -9.04 % vs the baseline. This is driven by a fall of population of -10.52 %, and is partially offset by the increase in income. A higher income not only results in a higher demand for crops, but it also changes the composition of food demand by increasing livestock, processed food consumption and demand for non-food. The contraction in crop production in turn translates into a decrease in demand for agricultural land of -2.11 %. Again, the fall in fertility rates is the dominant effect driving cropland demand down, even though the increase in income results in an increase demand of 1 %.

In the model, price is an endogenous variable. Compared vs the baseline, contraction in crop demand results in a fall of the global crop price of -3.59 %. In line with crop production and land use, the main driver is total population (Δ -3.84 %) with a marginal offset from income growth (Δ 1.73 %). Since prices are endogenous, changes in global crop price encourages intensification (de-intensification) and extensification (de-extensification) of farmland, leading to high (low) global yields. In this scenario, yields fall by -4.65 %, due to a contraction of crop production and fall of crop price.

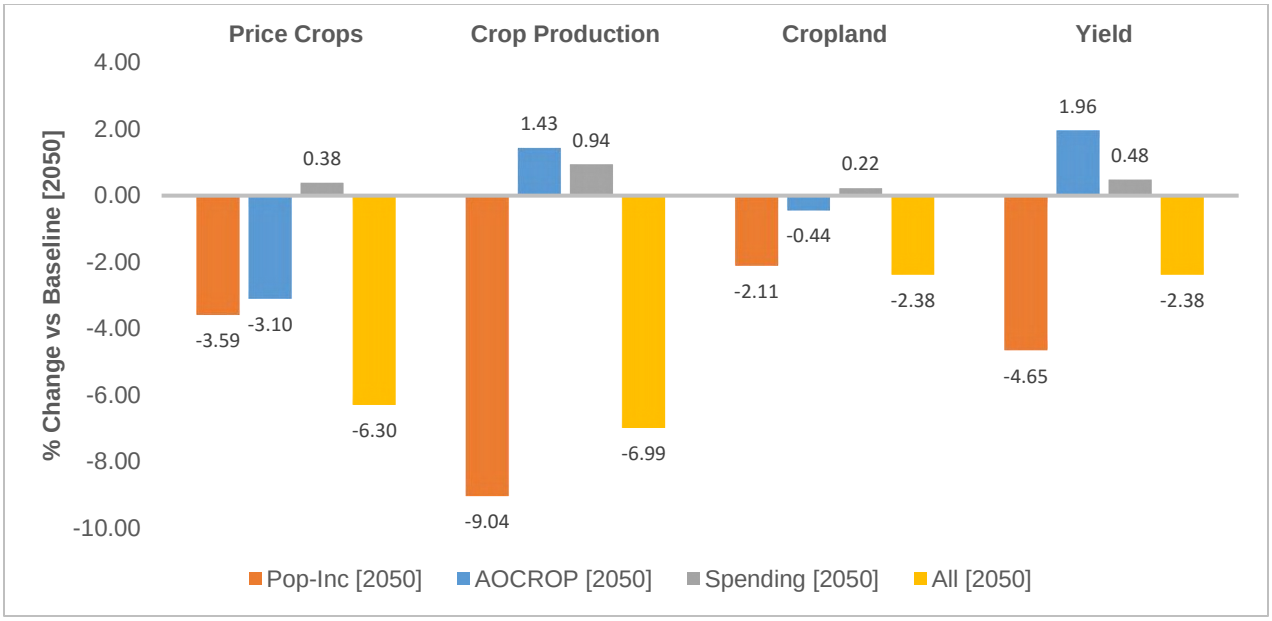

Figure 1: Global Crop Production per scenario compared vs baseline [2050]

Scenario 2:

To assess the impact of women empowerment in the supply side, we shocked the model to simulate the same yields between men and women in each region. The baseline model already assumed a uniform growth in yields of 50.9 %. In the model, this is determined through the Hicks–neutral effect index (*p_AOCROPr)*, which in turn plays a role determining total crop land, non-land inputs and crop production. When shocking this variable with the calculated yield gain from closing the gender gap, global crop production increased by 1.43 % as a result of a yield increase of 1.96 %. Yield gains from women empowerment result in higher output per acre, reducing the demand for crop land by -0.44%. This technological improvement results in a lower price by -3.10% vs baseline.

Scenario 3:

Leaving the demand and supply drivers unchanged, women power within the household in Africa has marginal effects in global crop production. Compared against the baseline from 2050, crop production increases by 0.94 % and a yield increase of 0.48 %, resulting in a price increase of 0.38 %, influenced by a higher cropland demand of 0.22 %. The impact from this scenario is a

result of a higher demand for crops to feed children. It would be interesting to assess the global impact of income spending across regions.

Scenario 4:

Taking into consideration demand and supply shocks, as well as an increase in household expenditure, crop production falls by -6.99 %. This is driven by a contraction from the demand drivers, but an increase in supply and household use. Although population falls by -10.52 %, yields only falls by -2.38 %, due to the gains in female yield potential. Both the fall in production and improvements in yield result in a fall of prices of -6.30 %, and a lower demand for crop land of -6.99 %.

Impact in Food Security

To assess the impact of women empowerment in food security towards 2050 I evaluated the changes in the caloric gap (*CALORIC_GAP*), the malnutrition count (*MAL_COUNT*) and the malnutrition index (*MAL_INDEX*). Values are summarized in Figure 2. The caloric gap reflects the average deficit per capita of caloric consumption (kcal/day), while the malnutrition count is the actual number of persons whose daily dietary energy intake is below the minimum requirements. The malnutrition index accounts for the % of the population below the minimum caloric consumption. It is important to acknowledge that the model does not account for all 4 dimensions of food security (availability, access, utilization and stability), since only food availability and partially economic access can be accounted for given the variables in the model.

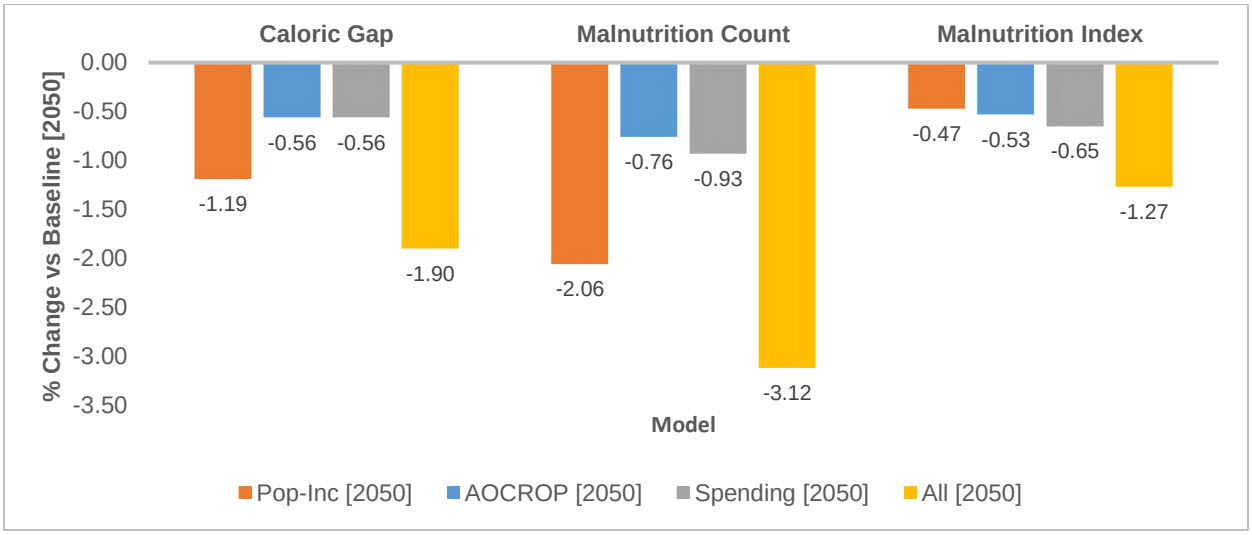

Figure 2: Global Malnutrition per scenario compared vs baseline [2050]

Scenario 1:

In the first scenario, a fall in population and an increase in income derives in a fall of the caloric gap of -1.19 %. This means that more food is available per capita, and this is primarily because of the slowdown in fertility rates due to female education. As a consequence, the number of people undernourished decreases by -2.06 %, resulting in -0.47 % of the total population in 2050.

Scenario 2 and Scenario 3:

The gains in yield potential in turn, increase food availability enough to reduce the caloric deficit by 0.56 %. The increased availability of food in African households also results in a reduction of caloric deficit by 0.56 %. However, the malnutrition count falls slightly more with a redistribution in spending (-0.93 %) than the increase in yields (-0.76 %). The reasoning behind this is that household spending has a direct impact in the caloric consumption of the population. Furthermore, Africa is one of the most affected regions in the world regarding undernutrition, and will be one of the most populated areas in 2050, translating into a direct impact in malnutrition rates. Higher yields though, are obtained by women worldwide. Hence, although the caloric gap

is narrowed globally, regions with a lower prevalence of undernutrition and a higher yield gain will result in a lower decline of malnourishment compared to Africa.

Scenario 4:

When combining the effects of women empowerment in the drivers analyzed in this paper, the impact on food security towards 2050 is significant. The caloric gap is closed by -1.90 %. Most importantly, the number of malnourished people in the world falls by -3.12 %, this is 23.85 M more food secure persons compared vs baseline scenario. According to the model, 1.48 % of the global population will be below the minimum caloric consumption threshold. This number might be too optimistic though, since food security is a complex multidimensional issue that requires a multi-disciplinary approach, and not only an increase of food production.

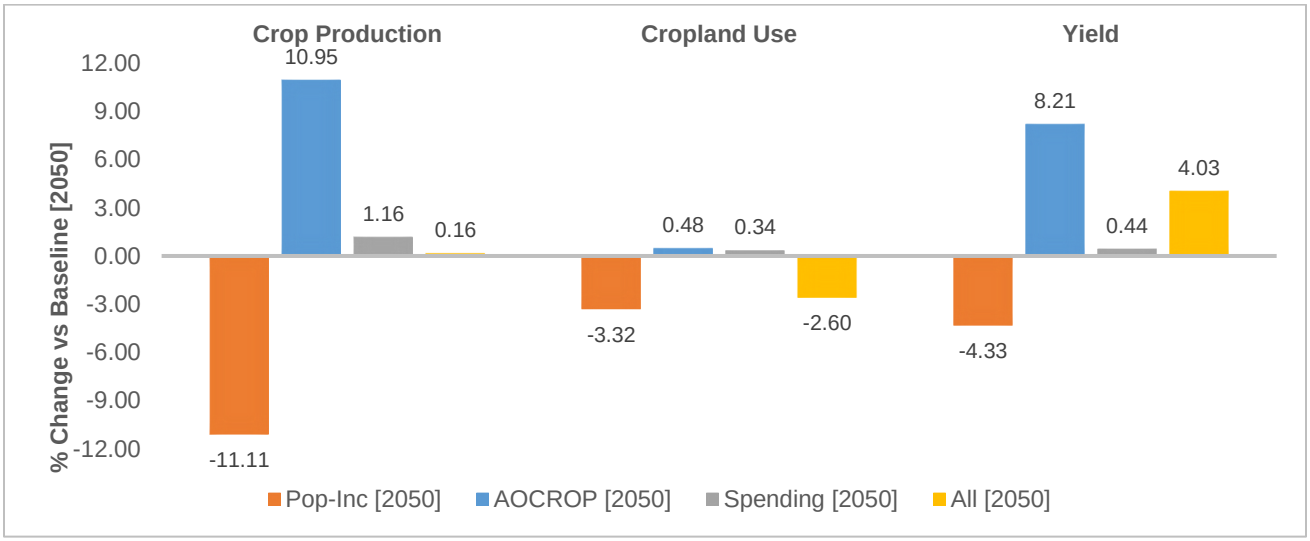

Figure 3: Rest of Africa Crop Production per scenario compared vs baseline [2050]

Implications for Rest of Africa.

Taking a closer look at Africa, the implications of women empowerment are of important consideration. Crop production variables per scenario are summarized in Figure 3 and food security impacts in Figure 4. Even though there is an important difference in population project towards 2050 of -69.83 % vs baseline, the crop production remains almost unchanged (0.16 %). Two drivers play key roles for this. First, given the changes from crop demand, the production

falls by -11.11 %. However, the improvement in female productivity yields agricultural gains of 10.95 %. The household spending contributes by increasing the demand of food for children by 1.16 %. Altogether, the overall yield improvement for the region is 4.03 % which results in a contraction of cropland use of -2.60 %.

Looking beyond the agricultural production, promoting women empowerment in Africa will have a huge impact for food security in the future. 34.71 million people are projected to be food insecure in 2050, closing the gender gap will result in 12.40 % of the population in the region being malnourished. This translates into 19.56 million people achieving food security as a result of women empowerment. This is 82 % of the global share of food secure people vs baseline scenario, meaning that the gains of closing the gender gap in Africa are significant.

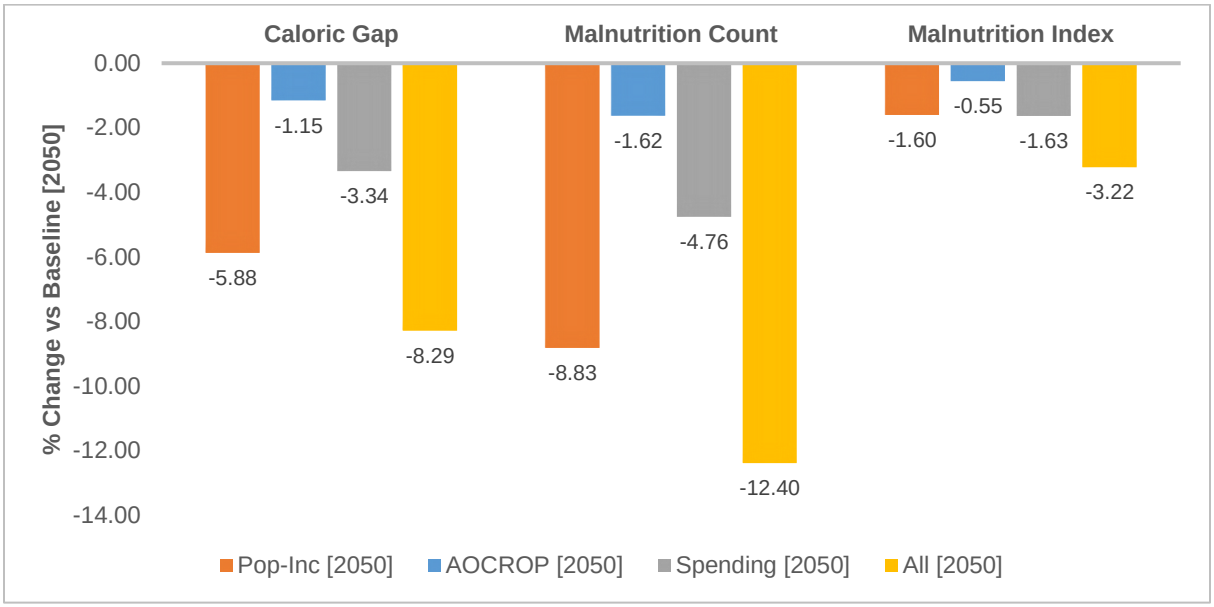

Figure 4: Rest of Africa malnutrition per scenario compared vs baseline [2050]

Conclusions

The current UN projections estimate a world population of 9.16 billion people by 2050. Significant concerns exist on how to feed the world by then. Closing the gender gap by improving women education will not only bring important gains in agriculture that will help produce enough food, but it will also result in a decline of fertility rates. This will constrain demographic growth, an

important driver towards the future, to a global population of 8.5 billion by 2050. Furthermore, the decrease in demand for cropland will result in positive efforts to achieving sustainable food systems in the future.

Global benefits of women empowerment are considerable and will have a significant effect on food security. Moreover, Africa, a region today with high prevalence of undernourishment, will be very positively impacted. The spillovers of women's education will result in a substantial number of food secure households, compared against the scenario predicted today by world leaders. Hence, appropriate policies to empower women in agriculture should be considered when analyzing global agriculture towards 2050.

Next Steps and Limitations

It is important to bear in mind that although the projections for each scenario in this paper are based on scientific evidence, generalizing and extrapolating towards 2050 has its limitations. Firstly, the model used for the analysis is an integrated market model. This assumes perfect trade among regions. In practice, this is not the case. Secondly, the data used for each calculation is based on scientific evidence. However, generalizing across regions and even countries might lead to errors not accounted for by the researchers or even omitted information. It is important to acknowledge that data at a macro level may be deficient and should be interpreted with caution. Thirdly, regarding the changes in income, there is no available data that allows the understanding of where is the additional income comes from. Lastly, food security in the model does not account for all the food security dimensions. This difference may result in very different outcomes in the real world.

Looking forward and expanding on the findings from the current paper, assessing the impact of household distribution amongst all regions would be interesting. Specifically, a close-up of South Asia, region with the highest rates of child malnutrition in spite of the increase of income per capita and rapid economic growth, could help evaluate the measure of increasing the status of women in society.

An interesting experiment would be to calculate the income gains endogenously, given the changes in crop production. This will help inform the estimations used of total income gains for human as a result of higher education. Another interesting factor would be to include ranges for each parameter, to account for the uncertainty of the variables.

References

Baldos, U. L. C., & Hertel, T. W. 2012. “SIMPLE: a Simplified International Model of agricultural Prices, Land use, and the Environment”. GTAP Working Paper No: 70.

Baldos, U. L. C., & Hertel, T. W. 2013. “Looking back to move forward on model validation: insights from a global model of agricultural land use”. Environmental Research Letters, 8(3), 034024. doi:10.1088/1748-9326/8/3/034024

Basu, A.M. 2002 ‘Why Does Education Lead to Lower Fertlity? A Critical Review of Some of the Possibilities’. World Development, 30: 1779–90.

Cleland, J. 2002 ‘Education and Future Fertility Trends with Special Reference to Mid-Transitional Countries (Background Papers No. 48/49), Completing the Fertility Transition’. United Nations: New York.

FAO. 2010. "FAO Gender and Land Rights Database." In. *http://www.fao.org/gender/landrights/home/en/*

FAO. 2011. "The State of Food and Agriculture 2010-11: Women in Agriculture - Closing the Gender Gap for Development." In Rome, Italy.

FAO. 2012. "World Agriculture Towards 2030/2050: The 2012 Revision.” In Rome, Italy.

FAO, IFAD, and WFP. "The State of Food Insecurity in the World 2014. Strengthening the enabling environment for food security and nutrition.". Food and Agriculture Organization.

Fouré, J., Bénassy-Quéré, A., & Fontagné, L. 2013. Modelling the world economy at the 2050 horizon. Economics of Transition, 21(4), 617–654. doi:10.1111/ecot.12023.

IEA. 2008. World Energy Outlook. OECD Publishing. Retrieved from http://www.oecd-ilibrary.org/content/book/weo-2008-en.

IEA. 2012. World Energy Outlook. OECD Publishing. Retrieved from http://www.oecd-ilibrary.org/content/book/weo-2012-en.

Ludena, C.E., T.W. Hertel, P.V. Preckel, K. Foster, and A. Nin. 2007. “Productivity growth and convergence in crop, ruminant, and non-ruminant production: measurement and forecasts”, *Agricultural Economics*, 37(1), 1–17.

Lutz, W. and Skirbekk, V. 2014 ‘How Education Drives Demography and Knowledge Informs Projections’. *World Population & Human Capital in the 21st Century*, 2014: 14-28.

Martin, T.C. and Juarez, F. 1995 ‘The Impact of Women’s Education on Fertility in Latin America: Searching for Explanations’. *International Family Planning Perspectives*, 21: 52–80.

Peterman, A., J. Behram, and A. Quisumbing 2010. "A Review of Empirical Evidence on Gender Differences in Nonland Agricultural Inputs, Technology, and Services in Developing Countries." In. Washington D.C., USA, International Food Policy Research Institution.

Quisumbing, A.R., and J.A. Maluccio. 2003. "Resources at Marriage and Intrahousehold Allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa*." *Oxford Bulletin of Economics and Statistics* 65:283-327.

UNDP. 2005. “United Nations Development Programme, Human Development Report 2005.”

UNICEF. 2007 “The State of the World’s Children 2007. Women and Children: The Double Dividend of Gender Equality.” USA

World Bank. 2007. "World Development Report 2008: Agriculture for Development." In. Washington D.C, USA, The World Bank, pp. 386.