Winter 1-31-2021

Egyptian Women's Agriculture Contribution; Assessment of the Gender Gap for Sustainable Development

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Egyptian Women's Agriculture Contribution; Assessment of the Gender Gap for Sustainable Development

A Thesis is submitted to Graduate Program in Sustainable Development in partial fulfillment of the requirements for the degree of Master of Science in Sustainable Development

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December 2020

Abstract

Women's contribution to the agriculture sector in developing countries is undeniable, yet they do not have equal access to the resources and opportunities they need to be more productive. Sustainable development entails inclusive and effective management of natural resources, this entails gender equity in agriculture. Bridging the gender gap in agriculture far exceeds the benefits of the individual. According to the latest estimates bridging the yield gap in agricultural productivity could possibly decrease the numbers of undernourished people in the world by around 100 – 140 million people. Sustainable agriculture development and gender equity necessitate policy interventions targeting the gender gap in agriculture resources. However, within the Egyptian national context, not enough research has been dedicated to quantifying and analyzing the gender gap in agriculture in Egypt. This thesis seeks to statistically analyze gender inequalities that constrain women's roles in agriculture and food production, and undermine their capacity to contribute to the food and nutrition security in Egypt. The contribution of women in agricultural production is conceptualized in to three separate, but complementary analytical objectives. Objective (A), reveals that the real impact of rural females' subsistence agriculture labor on rural household food security exceeds that of rural males. Investigating rural females' subsistence agriculture labor uncovers the actual contribution of Egyptian rural women to rural community sustainability and highlight their capacity for agricultural production. Objective (B) identifies the demographic and institutional differences between male and female agriculture labor. This objective provides evidence to the hypothesis that agriculture is becoming increasingly feminized within the Egyptian national context. Objective (C) estimates the yield gap between male-headed and female-headed households (as closest available proxy to agricultural autonomy), estimated by net earnings per unit generated from principal agricultural assets, namely corps cultivation and livestock. Additionally, the agriculture resources gap is examined based on the framework of agricultural resources suggested by the FAO (2011). Under this objective the data

provides evidence to the efficiency of female-headed households in agricultural production despite their limited resources compared to male-headed households. Finally, the findings of the study will lead to recommending a set of essential principles to promote inclusivity and gender-equity in agricultural development programs in Egypt.

Dedication

It is with great pleasure that I dedicate my thesis to my treasured family. Without their never-ending support, love, and encouragement I would have never been able to achieve so much.

I thank God every day for gifting me with two incredible boys. Malek and Farouk, being your mommy fills my life with so much joy and happiness.

My grand-mother who has blessed my with her love every single day of my life.

My amazing husband has always supported me. Thank you Khaled for believing in me and always encouraging me to go after my goals.

My litter sister, who is not so little anymore, for being an inspiring young woman. Hala you are exactly who you are, a strong, independent, professional, and loving young lady with so much greatness in you.

And finally, I Thank God for creating my mother, Dr. Zeinab Khadr. Words cannot describe how much you mean to me. You set the standard for selfless powerful women and mothers, anyone that knows you can attest to this. Thank you for being you. I will never forget highest appreciation is not to utter words, but to live by them. So I my only hope is to make you proud.

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1. Introduction

1.1. Background of the Issue

Women's contribution to agriculture and rural livelihoods is significant and undeniable. Recent literature has suggested that agriculture is becoming increasingly feminized, as a result of increased emigration of male family members, diseases and death from HIV/AIDS, and the escalating challenges of climate change (Krall, 2015). Additionally Krall states, "More and more women are also taking on roles that were originally male ones or assuming sole responsibility for agricultural production and livestock farming" (Krall, 2015; 20). However, despite international recognition of the importance of women in agriculture, the messages depicted in the Food and Agriculture Organization (FAO) report 'The State of Food and Agriculture 2010–11, Women in agriculture: Closing the gender gap for development' have yet to see significant national commitment. It states "agriculture is underperforming because half of its farmers—women—do not have equal access to the resources and opportunities they need to be more productive" (FAO, 2011; 3).

Considering the contemporary moment is very important in comprehending the scope of the problem. The structural transformation of many economies in the current climate of increased Capitalism and Globalization meant a decline in the contribution of the agricultural sector to the Gross Domestic Product (GDP) and a rise in industry and services. This directly impacts the demands of the labor market and the structure of employment, more specifically the increased rural–urban migration (Quisumbing, et al., 2014). Rural development discourses have often focused on the economic impacts of migration on rural livelihoods. The transformative social processes involving those who stayed behind (Grabska, 2013) - who are primarily able females- is very important to rural development and the sustainability of agriculture. Whereas rural migration

and displacement does not only results in loss, but may also create an opportunity to construct new social norms through empowering females in agriculture (Grabska, 2013).

The international body of literature on agricultural development and gender equity unanimously concludes that policy interventions targeting the gender gap in agriculture resources are required for sustainable agriculture development. These policies must target eliminating gender bias against women in access to agricultural resources, education, extension, financial services, and labor markets. Policies must work on enabling the unbiased participation of women in rural labor markets and investing in basic services and infrastructure to free women's time for more productive activities. Investing in efficient technologies (labor-saving and productivity-enhancing) can only be sustained if everyone, regardless of gender, has equal access to these technologies (Quisumbing, et al., 2014).

However, within the Egyptian context there is not enough information to support gender inclusive policies for the sustainability of the agriculture sector. Despite the attention to gender accorded by international agencies and few national actors in Egypt, agricultural research and rural community development have yet to grasp the central role of gender issues in development. Indeed, studying the real potential of females in agriculture in Egypt today can propel leapfrogging on the development ladder adaptable to the modern demands of the global economy and climate change. This thesis seeks to investigate, using nationally representative empirical data on Egypt, whether investing in women in agriculture as autonomous food producers is a sustainable solution for modern Egypt by quantifying evidence using statistical methodologies.

1.2. Research Purpose

Globally, development-scholars and decision-makers alike are aware of the detrimental implications of marginalizing women on the global populace. While many studies have examined

gender issues in economic productivity, within the scope of agriculture productivity more empirical evidence is needed to highlight the impactions of the gender gap. The evolution of social issues in sustainable agriculture development has slowly begun to garner international attention. As such, the understanding consequences of social reproduction and gendered-injustices will support broader understanding of Agriculture in Egypt.

Within the Egyptian national context, not enough research has been dedicated to quantifying and analyzing the gender gap in Agriculture in Egypt (Quisumbing, et al., 2014). Thereafter, calculating the potential impact of bridging the gender gap can have on Food Security and Rural Sustainability in Egypt. Moreover, studies are needed to pinpoint the most effective interventions and needed resources to bridge the gender gap in agriculture.

1.3. Significance of the Problem

The thesis seeks to statistically analyze gender inequalities that constrain women's roles in agriculture and food production, and undermine their capacity to contribute to the food security in Egypt. Assessing the real impact of rural females' subsistence agricultural labor on rural household food security, and comparing it to that of rural males, uncovers the actual contribution of Egyptian rural women to rural communities sustainability. Identifying the differences between male and female formal agriculture labor shows whether agriculture is indeed becoming increasingly feminized. Finally, measuring the agriculture resources gap and the yield gap between types of headship (male-headed and female-headed households), will pinpoint relevant obstacles and constraints of agriculture autonomy by gender.

1.4. Literature Review

The study is situated in the field of sustainable development, in which enticing change is the goal. Gender roles in agriculture are studied as a social, political, economic and cultural construction. The following themes are sequenced in an order that traces the evolution of the gender gap in agriculture.

Patriarchy is a strong feature of agricultural work in developing countries. Patrilineal of property and resources is a common practice in patriarchal societies, which limit of women's control over resources such as land and credit, mobility, secure housing and freedom from violence (Brody, Demetriades, & Esplen, 2008). Nonetheless, the literature on the gendered struggle in agriculture alludes to the fact that despite the obvious patriarchy of agriculture, the contributions of women in agriculture labor and food production are undeniable and immense

The global rally for international development, articulated in UN agendas, has achieved significant contemporary successes in closing the gender gap in fields such as health and education. This signifies the realization of development-scholars and decision-makers alike of the detrimental implications marginalizing women has on the global populace. However, in the field of agriculture, development interventions have yet to reach this consensus despite the abundance of empirical research on the gender gap in agriculture.

1.4.1. Evolution of female in agriculture in international agendas.

Theme 1: The Gendered Struggle.

Historical evidence of the gendered struggle in agriculture production in developing countries can be traced to the commercialization of the agriculture sector in colonial times. Ester Boserup's book (1970) on the role of women in development emphasizes the negative effects of past colonialism

and present capitalism on subsistence economies and women's role in agriculture production. In the colonial era land reforms were imposed based on European belief that cultivation was properly men's work. Hence not only were the third world colonies forced to produce commercial crops instead of food for national consumption and household subsistence, women were excluded from agriculture education and technical assistance on modern farming systems. Boserup's analysis also correlates the influence of farming systems on migration patterns. African women's involvement in agricultural cultivation resulted in the predominantly male migration to urban cities. While in Latin America the comparatively low participation of women in agriculture generated higher female migration patterns. Despite Boserup liberal generalization of the two aforementioned situations, her argument alludes to the traditional values preserved in the rural village and subsequently its impact of the structure of labor on a nation's economy (Beneria & Sen, 1981; Boserup, 1970).

Throughout history women in agriculture have been consistently confined by colonists, and subsequently in modern times by developers, to a gendered division of labor based on women's subordination to men. This included unpaid labor to assist the male head of the household in the cultivation of commercial cash-crops. To this day women continue to be the primary subsistence farmers despite the commitment of contemporary independent governments to economic development along capitalist means. While in reality, many scholars in humanitarian fields contribute the work of women in subsistence farming to reproducing cheap labor for international capitalism by 'liberating' male workers to be employed in the waged work for the cultivation of cash-crops. On the other hand, subsistence agriculture has also undoubtedly played a vital role in pressuring for fair treatment and better work conditions, supporting waged workers during times of conflict in labor strikes and political protests. This theory highlights the strategic importance of rural women's access to land and agricultural resources for their communities, and consequently, the capitalist schemes of companies

and governments. Even if relocated to urban centers, means to cultivate crops and other agriculture practices allows to maintain a degree of autonomy from the market (Federici, 2004).

Social gender inequalities are persistent and often accentuated in the development process and projects. In modern economies women have been excluded from –essentially- a human right to productive resources, and to own and manage property. Laws and traditional customs common in developing countries precluded women from owning or inheriting and managing property, and subsequently access to credit. The patrilineal of property and agricultural resources in patriarchal societies restrict women to dependency on a male relation, thus vulnerable and at risk to losing livelihoods and homes. This fact was best articulated by Enakshi Thukral in her 1996 article on development displacement and gender "a just development policy is one which has provision for women to have access to productive resources and to own and manage property" (Thukral, 1996; 1500).

The global response to the many inequalities women face manifested in the international development agendas. The United Nations Development Agendas articulate the realization of development-scholars and decision-makers alike of the detrimental implications of marginalizing women has on the global populace. Therein, the evolution of gender in agriculture development has slowly begun to garner international attention.

Theme 2: International Development Agendas (MDG and SDG).

The 2000 Millennium Development Goals lacked focus on gendered sensitivity in comprehensive economic development despite a separate goal for gender equity MDG3. The lack of gender-sensitive approaches in the development process of the agriculture sector and rural development has proven its failures and unsustainability (Farnworth, 2010).

"MDG3: Promote gender equality in all levels of education and *empower women."*

Moreover, there was only one target under MGD3 fixated on education only:

"Target 3.A: To eliminate gender disparity in primary and secondary education by 2005, and in all levels of education by 2015."

Despite the successes achieved globally under MDG3 in equality in education, employment and political representation, particular positioning was needed in the post-2015 development agenda to critical areas of gender inequality (UN, 2015). The MDG monitor emphasized under MDG3 that equal participation of both men and women are needed in the sustainability of the overall development process in improving poverty reduction and food security, and sustainability of rural development; "Without gender equality and the economic and social improvement for rural women, food security cannot be achieved" (MDG monitor, 2016).

The global commitment to "Leave No One Behind" is the foundation of the 2030 Agenda for Sustainable Development to achieve a better and more sustainable future for all (UN, 2015). Therein, the articulated 17 Sustainable Development Goals (SDG) construct the shared agenda for peace and prosperity, to end poverty, improve health and education, reduce inequalities, and spur economic growth for all. The 2030 Agenda is the development framework UN Member States are required to localize in the form of their own National Development Frameworks to be achieved by 2030 (UN, 2015).

Before the espousal of the 2030 Agenda and in light of the lessons learned from the pursuit of the 2000 Millennium Agenda, substantial research was conducted on gender issues in agriculture. Research commissioned by Food and Agriculture Organization of the United Nations (FAO) and the International Food Policy Research Institute (IFPRI) was presented the publication of "The State of Food and Agriculture 2010–11, Women in agriculture: Closing the gender gap for development." Additionally, the sheer volume of new empirical evidence and research from all over the globe have conceded to new knowledge that could no longer be ignored in the field of agriculture development.

The 2030 Sustainable Development Goals sets gender equity in economic development at the forefront of achieving sustainable development.

SDG 5 “Gender equality and empower all women and girls.” (UN, 2015)

With multiple targets therein promoting the women’s full and effective participation in the labor market, and equal opportunities for financial independence and prosperity. The topic of this thesis places specific emphasis on target 5.A:

Target 5.A “Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws.” (UN, 2015)

Therein indicator 5A.1 articulates:

“Indicator 5A.1: (a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; (b) share of women among owners or rights-bearers of agricultural land, by type of tenure.” (UN, 2015)

Theme 3: Autonomy of Females in Agriculture.

Empowerment in agriculture is synonymous with autonomy in making decisions related to agriculture, and access to the inputs, material, and social resources required to implement those decisions (Alkire et al., 2013).

Based on the latest international statistics, women account for almost half of the agricultural labor force, constituting 43% of the agricultural labor force in developing countries (FAO, 2011) and 60% of agriculture employment in least developed countries (UN classification) (ILO estimate, 2019 ; WB, 2019). Unfortunately most of the women working in agriculture are situated in subordinate and supportive roles in agricultural labor. The scarcity of updated agriculture data disaggregated by gender has hindered regional estimates on the autonomy of females in agriculture (FAO, 2011). The latest

available data from the agriculture census in Egypt reveals that civil female agriculture holders decreased from 5.22% in 1999 to 3.94% in 2009 (MALR, 2009; MALR, 1999).

Women's agriculture activities are largely underestimated in labor force statistics; due to the fact that women are less likely to define their activities as agriculture work despite working longer hours than men (FAO, 2011). Constraints for productivity include the unpaid household duties that women shoulder, take them away from income-generating activities; such as child care, and fetching fuelwood and water (Huyer, 2016).

The autonomy of female agricultures as food producers is limited by their significant disposition in acquiring land, credit and other financial services, extension services, markets, and in accessing information from agricultural research and development (FAO and ADB, 2013). Development scholars have realized that despite the contributions of rural women in food production and the agricultural sector, they are continually marginalized in policies, such as policies for land distribution. Rural women are confined in specific gendered roles in agriculture development programs despite international and national recognition of rural women's importance (Thukral, 1996).

In 2011 the Food and Agriculture Organization of the United Nations published a major report relating food security to gender equity in agriculture. In this edition of 'The State of Food and Agriculture 2010–11, Women in agriculture: Closing the gender gap for development' the state of women in agriculture in developing countries was explored and their potential was extensively investigated. Within this report noteworthy statements were presented based on the global analysis of women and men agriculture farming systems in developing countries:

- Women farmers are just as good at farming as their male counterparts, however the gap in yield [1] is almost entirely due to difference in input quality and resources;

[1] The 2011 FAO report is based on a number of studies measuring productivity in a variety of ways, but the most common method is based on output per hectare of land, or yield.

- Women farmers can achieve the same yield levels as men if they acquired equal access to resources and equal quality of agriculture input;
- The calculated yield gap between averages of men and women farmers was around 20–30% based on studies mostly out of sub-Saharan Africa countries, but generalized because similar input gaps have been documented for other regions.
- Bringing yields would increase national agricultural output in developing countries between 2.5-4% [2], which could reduce the number of undernourished people in the world by 12–17% (FAO, 2011).

BOX 1: The methodology to estimate potential agriculture output by bridging yield gap (source FAO, 2011)

Output (Q), Yield (Y), Area (A): Q = Y*A.
Assuming 20% productivity gap, women farmer's yields are only 80% of men. Yf = 0.8*Ym.
Therefore: Q = Yf *P*A + Ym*(1-P)*A,
P: is the share of land cultivated by women farmers.
Solve this problem for Ym and then use Yf = 0.8*Ym to obtain Yf.
Assuming the gender gap in productive assets is closed, set Yf equal to Ym and find the new output level.

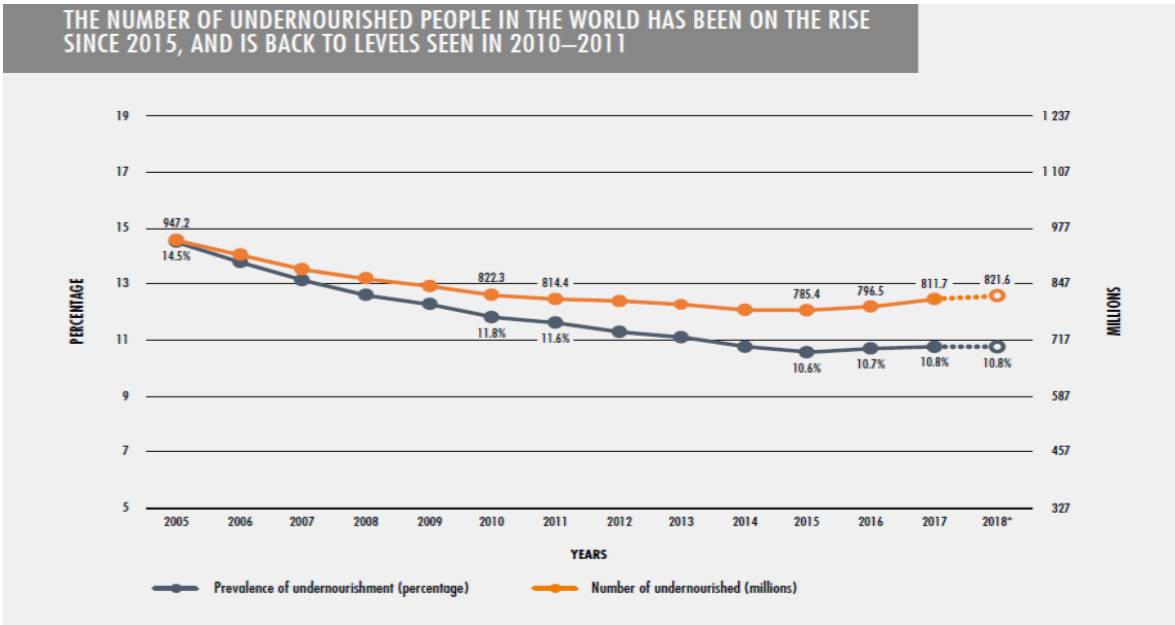
The potential outcomes of achieving gender equity in agriculture. Indeed the potential outcomes of achieving gender equity in the agriculture sector of developing countries far exceeds the benefits of the individual. According to the latest FAO's figures of 2019 the percentage of undernourished people in the world [3] has remained virtually unchanged at 11%, while the total number of undernourished has been slowly increasing for several years. The number of undernourished people in the world has reached levels previously seen in 2010; with a little over 820 million people suffering from hunger, corresponding to about one in every nine people in the world. This underscores the

[2] Based on calculations of women agricultural holders for 52 countries.

[3] At the time of the 2011 FAO report the number of undernourished in the world people was reported at 925 million

immense challenge posed in achieving 'SDG1: Zero Hunger' by 2030. According to the FAO (2019) findings, bridging the yield gap could possibly decrease the numbers of undernourished people in the world by around 100 – 140 million people (FAO, 2019).

Figure 1.1: Number of undernourished people in the world (source: FAO, 2019)



NOTES: * Values for 2018 are projections as illustrated by dotted lines and empty circles.

Closing the gender gap in agricultural assets refers to women owning and controlling productive assets. This both increases their autonomy as capable breadwinners, as well as positively impacts their wellbeing and self-esteem. An empowered female in agriculture, with access to needed inputs and resources, is able to make decisions on crops to cultivate on her plot and will be more productive in agriculture. An empowered woman will also be able to ensure the health and well-being of her children and herself (Quisumbing, et al., 2014).

*Climate Change and Gender Inequality in Agriculture***.** Climate change is an irrefutable reality of our world today. Just as achieving gender equity in agriculture holds great potential in increasing food production and decreasing the number undernourished, climate-smart approaches focusing on

natural resource management are equally as important for sustainable agriculture development (UNDP, 2019). The exponential increase in natural hazards globally; such as erratic monsoon patterns, flooding and extended periods of drought, implies a shrinking window of opportunity for action in response to the Earth's changing climate. Women are particularly susceptible to the implications of climate change; as gender constraints the limit of women's control over resources such as land and credit, mobility, secure housing and freedom from violence (Brody, Demetriades, & Esplen, 2008).

In the agriculture sector women -particularly those in developing countries- are even more vulnerable as they are heavily reliant on local natural resources for their livelihood. Yet women are powerful agents of change. One of the key messages of the 2019 Human Development Report highlight the need for more focus on the role female agricultures in natural resource management in sustainability policies and projects (UNDP, 2019). A participatory field research project by Action Aid International and the Institute of Development Studies (IDS) was conducted on women in rural communities in the Ganga river basin in Bangladesh, India and Nepal. The women participating in the field research were from both male and female-headed households who were either responsible for the household's main source of income, or significantly contributed to it. This area suffers from massive flooding, erratic monsoon patterns, and extreme rainfall, which is expected to intensify in the future. The study aimed at depicting how these women in poor areas have been able to adapt to climate change, despite their disproportionate vulnerability to climate change. In spite of little to no resources, information, or government support these women were able to articulate exactly what they need to support their livelihoods and families. They were able to develop effective coping mechanisms in their farming practices, which include changing to flood- resistant (or drought) crops such as rice that will grow tall enough to remain above the flood water level, or crops that can be harvested in the periods between flood seasons. As noted in the report, "They [the women who took part in the research] might not be aware of all the possible adaptation strategies, of all the ways to overcome constraints to the

ones they are using, but they certainly know their present situation best and have an urgent list of priorities to secure a livelihood in the face of the new challenges" (Mitchell, Tanner, & Lussier, 2007: 14). The actions of these women provides evidence that immense potential women in rural agriculture-based areas have to face climate change. Their listed priorities articulate their readiness to entice sustainability measures and change within their communities. These priorities include safe housing, secure storage for harvest and livestock, access to information, technology, and agriculture extension services to secure livelihoods and wellbeing, and institutional support with sustainable strategies to extend resources and overcome constraints (Brody, Demetriades, & Esplen, 2008; Mitchell, Tanner, & Lussier, 2007).

1.4.2. Empirical evidence on women in agriculture work and the gender gap.

Gender refers to the power relations between men and women. Similar to feminism movements, gender is often wrongly accused of solely focusing on women. However, in the context of agricultural development, most of the focus has been on men as the typical rural farmers. Therefore, targeting gender equality requires rebalancing the scales of power by tailoring agriculture development projects sensitive to the contextual gender-bias against women (Quisumbing, et al., 2014).

Theme 4: Women Agriculture Labor Participation and Subsistence Farming.

Generally, the assumption is that women in the rural household produce food for their family's consumption. Thus, the term subsistence farming is widely associated with female agricultures "a form of farming in which nearly all of the crops or livestock raised are used to maintain the farmer's family, leaving little, if any, surplus for sale or trade" (Britannica, 2020).

The importance of subsistence farming on household food security is undeniable. The conceptual model developed by Drammeh, Hamid, and Rohana in their 2019 article reviewing the determinants of Household Food Insecurity and its association with child malnutrition in Sub-Saharan Africa, relate

several factors under each of the four integral components of Household Food Insecurity: availability, accessibility, utilization, and stability (FAO, 2008). At the forefront under the availability component is farm food production for the family needs. Additionally, their research identifies the correlation between food production and several other influential household factors, such as age and gender of household head, education of farmers. Where female household heads, older household heads, and uneducated farmers were more vulnerable to household food insecurity due to hinders in food production (Drammeh, Hamid, & Rohana, 2019).

However, despite the importance of subsistence farming for rural welling and sustainability, especially in Africa and Asia where most of the world population lives, it is very difficult to measure. The literature cites two main reasons for this difficulty. The most obvious reason is the fact that many women themselves do not describe it as work, as it is unwaged work and often is not done on a formal farm. The capital bias was described by Federici in her 2004 article "Women and Land-struggles" as a bias in favor of production for the market and direct contribution to the Gross National Product of a state. Hence what is categorized under 'housework' or 'domestic responsibilities' is still not considered by many as 'real work.'

Secondly, the definitions used internationally to monitor labor participation statistics have previously failed to sufficiently capture women's real contribution to the national economy. Noted for instance the discrepancies in national surveys to capture women's real contribution to the national economy in Pakistan. Where women's labor force participation varied from 3% (1981 Population Census) to 12% (1981 Labor Force Survey), while the 1980 Agriculture Census estimated 73% of women in agriculture households were economically active. Moreover, in their subsequent 1990/91 Labor Force Survey women's economic contribution ranged from 7% using the conventional questionnaire and 31% with questions on specific activities typically considered domestic

responsibilities of women, such as transplanting rice, picking cotton, grinding, drying seeds and tending livestock (FAO, 2020; UN, 1992).

Theme 5: Contextual Implications for Measuring Gender Gap in Agriculture.

Gender analyses in agriculture data requires appropriate sex-disaggregated data that examines the comparative behaviors of both men and women in agriculture, as well as the contexts facing both. Despite the deficiencies in much of the agriculture data available disaggregated by gender globally, the gender gap in agriculture resources and inputs are undeniable. The constraints and opportunities faced in agriculture are largely influenced by gender. For example in the agriculture labor market, the decision to seek employment in the formal or informal sector, and accessibility of financial credit markets all vary by gender. Cheryl Doss's work on the data needs for gender analysis in agriculture has argued for the inclusion of the full range of agriculture production processes from farm to table, which include preparation and processing that are largely done by women, into the measurements of agriculture productivity to provide better insight to gender in agriculture (Doss, 2014).

Studies that have sought to measure the agriculture gap in productivity are often faced with the dilemma of household-level data rather than plot-specific ownership variables. A study that attempts to understand gender differences in agricultural productivity used plot-level data from Uganda (2003) and household-level data from Nigeria (2005). In Uganda, the plot-level data was able to deduce that plot-level productivity is lowest among crops from mixed-gender ownership compared to female owned plots and male ones. This highlights the difficulties of intra-household bargaining between men and women. On the other hand in Nigeria, in which only household-level data was available, the gender of the household head was used to disaggregate agriculture data. In Nigeria female-headed households were associated with lower productivity in the dry savannah area; however, no significant productivity differences are seen between male and female households in the humid forest zone. The study concluded that the social constraints females face significantly impacts their agriculture

productivity. As women in the dry savannah environment are burdened by time-consuming household duties that take them away from income-generating productive activities, including fetching fuelwood and water (Peterman, Quisumbing, Behrman, & Nkonya, 2010).

Within the context of a specific society the gender relations in agriculture are affected by the social, institutional, and political milieu. Thus, agricultural researchers must be conscious of how gender and agriculture affect the livelihood, income, and well-being of men and women in rural settings. As such measuring the gender gap in agriculture requires a mixed-method approach, utilizing different information and data beyond quantitative indicators typically gathered in agricultural censuses. Household surveys with standardized questionnaires are important to gather data on agriculture production (yield and income) and consumption, and the decision-making process within the household. However quantitative data in agriculture is also required to move beyond the unitary models of households and to divulge into the individual rather than just the household or the farm (Alderman et al., 1995). This level of questions inquiries into the specifics of agricultural holdings and the holder, and allows a broader range of analyses across individuals based on age, status and bargaining power within the household, and other individual characteristics (Doss, 2014).

Qualitative data collection methods and ethnographic tools can provide key insight to the social context that detail the gender relations. Qualitative surveys allow greater attention to other dimensions, such as social standing, self-esteem, power within and outside the household, and access to institutions which might be missed in quantitative questionnaires. For example when collecting data on assets, there are often important gender differences in the understanding of ownership. As ‘owning’ an asset does not necessarily mean ‘use’ or ‘control’ of the asset (Behrman, Meinzen-Dick, & Quisumbing, 2014).

Measuring Women's Empowerment in Agriculture. **The Gender and Agriculture Research Network of the Consultative Group of International Agricultural Research (CGIAR)** (2011–2019) brings together a global network for agricultural innovation and research. In response to the global recognition of the continued marginalization women in agriculture despite their vital contributions to food provision, CGIAR recommended two indicators to evaluate agriculture empowerment:

- The first is women's decision making power over important agricultural resources such as land, livestock, water, common property, seeds, fertilizers, agricultural machinery and valuable tools, financial resources, and the income generated from sales of crop, livestock or products.
- The second is women's control over her own time use and income, and their power in organizations (Akter, et al., 2017).

Generating Evidence and New Directions for Equitable Results (GENDER) is CGIAR's new platform designed to put gender equality at the forefront of global agricultural research for development. Established in January, 2020 this platform published standards for collecting sex-disaggregated data for gender analysis. Therein key research guidelines were stipulated to collect sex-disaggregated data and conduct gender analyses in agriculture:

- Collect individual information from both men and women. Which many may wrongly construct this to interviewing twice as many people, however this allows the contextual aspects of gender roles and its ramifications on agriculture to be correctly measured. As it makes no sense in measuring women's land ownership without knowing the comparable percentage of the land owned by men (Doss, Meinzen-Dick, Quisumbing, & Theis, 2018).
- When shedding light on gender in any field of study, researchers must adapt to the social context and the gender dynamics specific to each community. This requires researchers to be

aware of the social construct of a community in order to know what questions to ask and how. Confidentiality assurances is essential for gender topics addressing sensitive issues; such as asset ownership and domestic violence. Although, additional costs may be needed to assimilate to cultural sensitivity, it is considered essential to collecting sex-disaggregated data (Doss, Meinzen-Dick, Quisumbing, & Theis, 2018).

- Comparing male and female headed households is not gender analysis. Diversity is not necessarily attributed to the sex of the household head. This unitary model of the household renders the role of women in male-headed households invisible to the overall measure of women's contribution. However, analyses that disaggregated information gathered based on type of headship (such as de jure or de facto) or marital status can contribute to a more understanding of how type of headship relate to process outcomes (Doss & Kieran, 2014).

The Women's Empowerment in Agriculture Index (WEAI). The WEAI is a comprehensive and standardized measure to directly describe women's empowerment in rural areas, whether they are farmers, waged workers, or engaged in other non-agricultural work (Alkire, et al., 2013). The index was jointly developed by the United States Agency for International Development (USAID), International Food Policy Research Institute (IFPRI), and Oxford Poverty and Human Development Initiative (OPHI). WEAI is a survey-based measured index based on individual-level data collected from both men and women in the households. The main aim it to reveal hinders women face in agriculture, monitor gender-equity and measure empowerment, agency, and women's inclusion in the agricultural sector (IFPRI, 2020).

The WEAI is composed of two sub-indices: one measures the five domains of empowerment for women (listed below), and the other measures the Gender Parity Index (Alkire, et al., 2013). The Gender Parity Index is the intra-household gender inequity estimated by comparing the empowerment

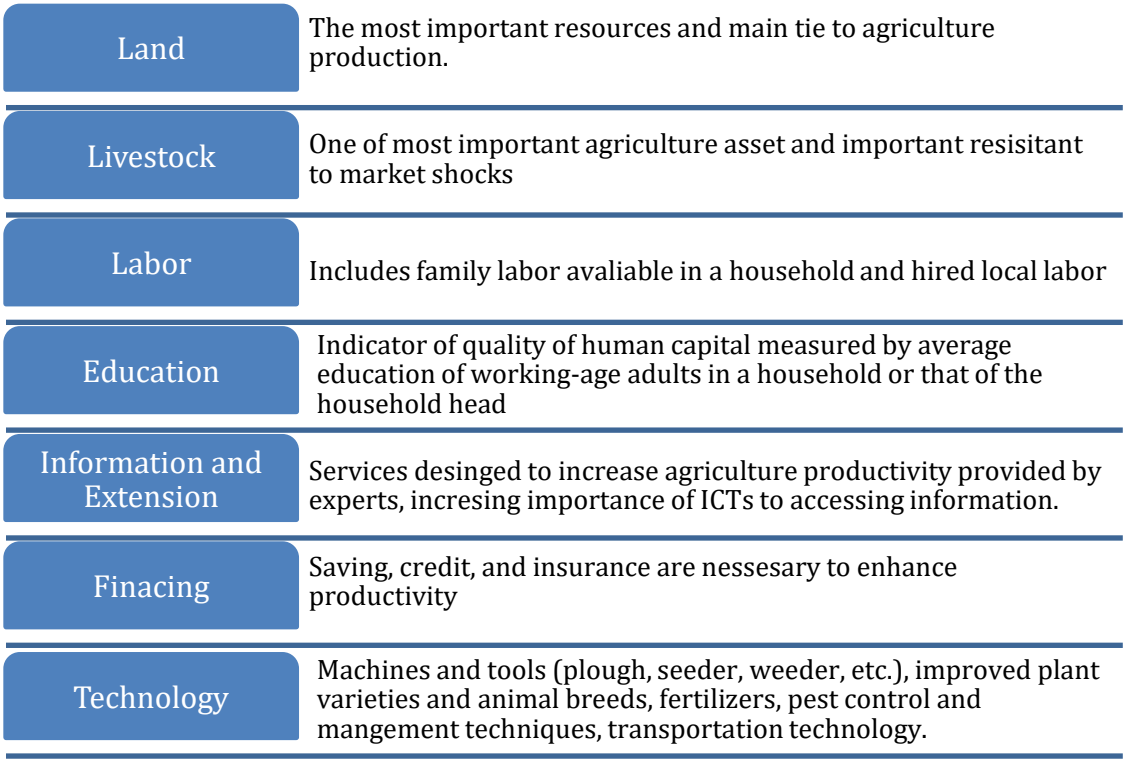
gap between the primary male and female in each household. The five domains of empowerment measured in the WEAI are:

1) Production: Decision-making power over agriculture input and production. The first is constructed from data on the decision making process with regards to food-crop and cash-crop farming, livestock and fisheries. The second measures autonomy of a person's ability to act on what s/he values, this includes inputs to buy, crops to grow, and marketing.
2) Income: Control over use of income generated and expenditures. This entails decisions about income s/he participated in generating.
3) Resources: Captures an individual's ownership of land and other assets, in addition to their ability to make decisions over theses productive resources.
4) Leadership: Membership in economic or social groups and confidence in voicing opinions and ideas publically. This is not restricted to formal agriculture groups, as it also includes all civic or social groups that offer empowering networks and social capital. As these groups may provide important agricultural information or inputs.
5) Time: Assesses allocation of time spent on activities over the past 24 hours between productive and domestic tasks and leisure activities.

Measuring Gender Gap in Agriculture. The literature has described the gender gap in agricultural productivity as the disparity between men and women in productivity resources. The difference between male and female agriculture productivity is generally measured by comparing yield per land unit (hectare). However, till recent studies did not follow a comprehensive systematic framework to fully account for the yield differences between male and female farmers. As previously mentioned, the majority of the agriculture data does not disaggregate control of resources by gender, and maintains the household or the farm as the primary sampling unit. While the contextual details may differ across

regions, generally agriculture resources have been categorized into seven main types of resources; land, livestock, labor, education, information and extension, financing, and technology.

Figure 1.2: Main Agriculture Resources (FAO, 2011)



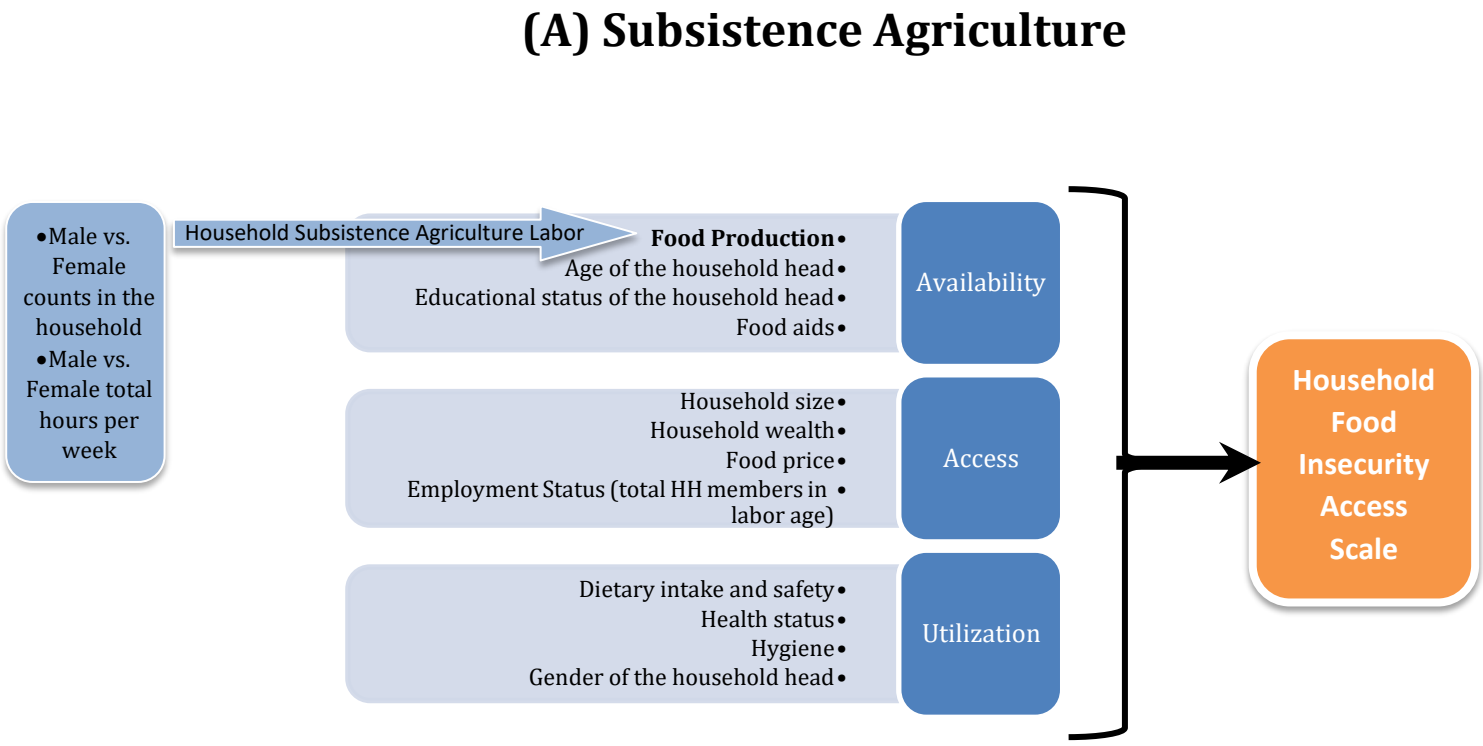
1.5. Conceptual Framework

Gender analyses in agriculture data requires the examination of the comparative behaviors of both men and women in agriculture, as well as the contexts facing both. Thus, the analysis will take into consideration the difference between males and females in each of the formulated objectives. Conceptualizing the contribution of women in agriculture was segmented into separate but complementary analytical objectives. The following figures depict the formulated conceptual frameworks based on the literature review and the researcher's own approach to the topic at hand.

(A) Impact of female **subsistence agriculture** on rural household food security: The generalized hypothesis that women in agriculture are the main subsistence farmers in rural

households requires contemporary data evidence specific to the Egyptian context. The analysis Objective (A) seeks to quantify the difference between time occupied in subsistence farming by male and female rural inhabitants. Additionally, the analysis will test the impact of female subsistence farming on rural household wellbeing measured by household food security, in order to substantiate the potential impact of investing in women in agricultural productivity.

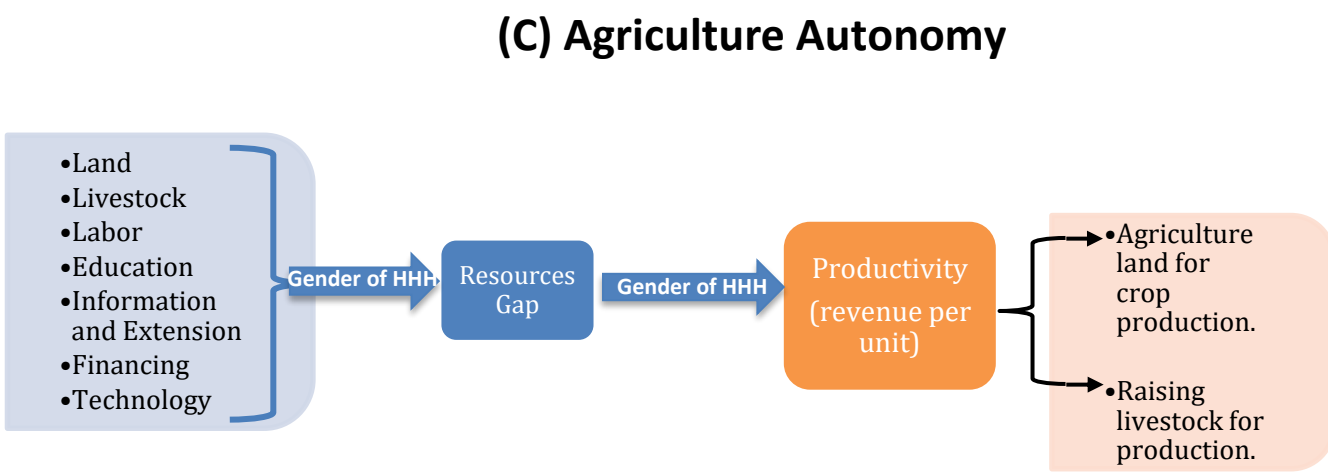
Figure 1.3: Conceptual Framework of Objective (A) Subsistence Agriculture



(B) Determining the profile of **agriculture labor:** This objective will examine the hypothesis that agriculture is becoming increasingly feminized. The analysis will attempt to determine the profile of agriculture labor over two time periods 2018 and 2012.

(C) Proxy to **agriculture autonomy**: The impact of the gender of household head on agriculture productivity and resource will be analyzed as the closest possible proxy to autonomy given the available data. Here the hypothesis that women farmers are just as good at farming compared to their male counterparts, and gap in yield is almost entirely due to difference in input quality and resources, will be statistically tested. A recognized drawback of analyzing agriculture production based on gender of household headship, is that it limits the results to the unitary model of the household, and ignores the role of women (and junior men) within male-headed households. However, disaggregating based on type of de jure headship can contribute to a more understanding of how different forms of headship relate to development and process outcomes. Moreover, although agriculture productivity is a household-level section in the dataset used (2018 EMPLS), the household representative answering this section is asked to specify the household member in control of the agriculture production of each crop cultivated. Thus, the analysis will attempt to substantiate the gender and autonomy of agriculture holders.

Figure 1.4: Conceptual Framework of Objective (C) Agriculture Autonomy



In other words, the research questions targeting each of the above mentioned objectives within the Egyptian context are:

1. Are females in rural household subsistence farming more than males? Examined with respect to specific measures detailed in results (Objective A)
2. What is the impact of male versus female subsistence farming on rural household food security? (Objective A)
3. Is agriculture becoming increasingly feminized? (Objective B)
4. Describe the agriculture resource gap between male and females headed households. (Objective C)
5. What is the average yield gap between male headed households and female headed households farming? (Objective C)

1.6. Conclusion

The 2030 Sustainable Development Goals sets gender equity in economic development at the forefront of achieving sustainable development. As such, the evolution of social issues in sustainable agriculture development has slowly begun to garner international attention. In the field of sustainable agricultural development, many studies have provided empirical evidence to highlight the implications of the gender gap on agricultural productivity. The messages depicted in the FAO (2011) report "The State of Food and Agriculture 2010–11, Women in agriculture: Closing the gender gap for development" require national commitment. However, within the Egyptian context there is not enough information to support gender inclusive policies in the agriculture sector. Despite the attention to gender accorded by international agencies and few

national actors in Egypt, agricultural research and rural community development in Egypt have yet to grasp the central role of gender issues in development.

The literature review on women in agriculture has proposed several assumptions on the consequences of social reproduction and gendered-injustices on agriculture productivity. Studying these hypotheses using contemporary data is important to support broader understanding of Agriculture in Egypt. The above mentioned conceptual framework proposes an evidence based approach to conceptualize women's agricultural contribution. As such, analysis seeks to understand and quantify women's contribution in agriculture in order to substantiate the potential impact of investing in women in agricultural productivity. Each of the three identified objectives of the conceptual framework will test several hypotheses cited in the literature review.

- The hypotheses tested under Objective (A) include the assumption that women in the rural household produce food for their family's consumption, thus the main subsistence farmers. While the impact of subsistence farming on rural household food security is understandable, the analysis will highlight the impact women's subsistence contribution to agriculture for rural community sustainability measured by household food security.
- The international literature has claimed that agriculture is becoming increasingly feminized. Although the latest statistics on agricultural labor in developing countries provides empirical evidence to this claim, females in agricultural work lack autonomy as independent producers. Thus, the analysis for Objective (B) will attempt to compare the gender profile of agriculture labor between 2018 and 2012 (respective ELMPS datasets).
- A focal message depicted in the 2011 FAO report is that agriculture is underperforming because half of those working in agriculture do not have equal access to productive resources. Under Objective (C) the analysis seeks to test the hypothesis that women

farmers are just as good at farming as their male counterparts and the gap in yield is almost entirely due to difference in input quality and resources. This implies describing the agricultural resource gap between genders. Additionally, the impact of headship on income generated from agriculture activity (generated income per unit) will be inferred. Although this limits the analysis to the unitary model of the household disaggregating based on type of de jure headship can contribute to a more understanding of how different forms of headship relate to development outcomes

Indeed, studying the real potential of females in agriculture in Egypt today can propel leapfrogging on the development ladder adaptable to the modern demands of the global economy and climate change. This thesis seeks to investigate, using nationally representative empirical data on Egypt, whether investing in women in agriculture as autonomous food producers is a sustainable solution for modern Egypt by quantifying evidence using statistical methodologies.

2. Data and Methodology

This chapter aims to detail the research approach used to statistically analyze and qualify the gender inequalities that Egyptian women face in agriculture and food production, that undermine their capacity to contribute to the food security in Egypt. Essentially, the analysis will estimate the real impact of women in agriculture in order to identify whether targeting public investment in women as independent agricultures is a feasible and sustainable solution for Egypt's agriculture sector. This chapter comprises of three main sections:

- The first section provides an overview of the contemporary situation of Egyptian women in Agriculture in terms of autonomy, labor, representation and visibility. Additionally, the Egyptian government's commitment to gender issues in agricultural development is examined in the most relevant national strategies, namely "The Sustainable Agriculture Development Strategy" and "The Women's Strategy."
- The second section of this chapter presents the secondary datasets used in the analysis. The research objective of this thesis is to statistically quantify the contribution of Egyptian women in Agriculture using contemporary and nationally representative data. For this purpose, the datasets collected in the Egypt Labor Market Panel Survey (ELMPS) were acquired; as it provides empirical and periodical data on the economic activities of the Egyptian population over time.
- The third section of this chapter details the analysis approach for each of the analytical research objectives. The aforementioned conceptual framework constructed for the research segments for Egyptian women in agriculture into three separate but complementary analytical objectives:

  (A) Impact of **female subsistence agriculture** on rural household food security.

(B) Determining the profile of **agriculture labor**.

(C) Proxy to **agriculture autonomy** analyzing impact of household head's gender on agriculture productivity and resource.

The analysis approach for each objective applies grounded statistical methodologies to estimate the real impact of Egyptian women in Agriculture. The methodology for each analytical objective details the analysis plan applied to target objective (A), (B), and (C) separately. Finally, the statistical tools used for descriptive and inferential analysis are presented.

2.1. Contemporary Situation of Egyptian Women in Agriculture in the Egyptian National Context.

According to the latest available Agricultural Census (2009) the number of female agricultural holders in Egypt decreased from 236.6 thousand in 1999 to 212.7 thousand in 2009 (representing 5.22% and 3.94% of all agriculture holders respectively). The scope of the Egyptian Agricultural Census covers all agricultural activities, including both crop and livestock production, as well as aquaculture activities (MALR, 1999). The enumeration unit was the agricultural holding, which includes agricultural assets, with or without land. The agricultural holding was defined as an economic and technical unit comprising all livestock kept and all land used wholly or partly for agricultural production purposes. A holding was defined as being within a single administrative district unit (MALR, 2009). Further comparison between the last two rounds of the Agricultural Census (1999 and 2009) reveals that the total number of civil agricultural holders[4] increased; from

[4] Civil agriculture holders in Egypt hold almost all of the agriculture holdings according to both censuses. The few number of Corporation, Cooperatives, Government and other legal statues that operate agriculture holdings decreased from 4565 in 1999 to 2963 in 2009 (representing 0.01% and 0.05% of agriculture holders respectively). However, the total area of land in their control increased from 217.9 thousand ha in 1999 to 321.7 thousand ha in 2009 (representing 5.8 % and 7.9% of agriculture area respectively).

4.54 million (1999) to 5.40 million (2009) (representing 99.9% of all agriculture holders for both years). Additionally, the total area operated by civil persons increased; from 3.53 million (ha) (1999) to 3.77 million (ha) (2009) (representing 94.9% and 92.1% of all agriculture holdings respectively). However, this increase was obviously disproportionately in favor of male agricultural holders, as civil female agricultural holders decreased from 5.22% of all holders (1999) to 3.94% (2009) [5]. However, intra-household data reveals the percentage of females in the households of the holders engaged in agriculture activity was reportedly unchanged between the two censuses at approximately at 35% of household members, despite the increase in total household members from 12.6 million (1999) to 14.7 million (2009). This finding indicates the unchanging gender roles assigned to females within the household in terms of agriculture contribution over time and regardless of the change in the woman's in title within a household (daughter, wife, mother, etc.) (MALR, 2009; MALR, 1999).

The Labor Force Survey of 2015 shows high concentration of Egyptian women's employment in the agriculture sector accounting for 40.1% of total female employment, second only to the service sector with 54.2% of total female employment. Additionally, in terms of new entries to the Egyptian labor market in 2015, 53.4% of female new entries found work in the agriculture sector compared to only 15.6% of male new entries. Disaggregating the agriculture labor data by sex reveals that women represented a third (32.9%) of those employed in agriculture in 2015, representing a 2.3% increase from 2010. While men in agriculture labor remain to exceed women, the data here reveals relative stability of female agriculture labor compared to that of men which have favored the Construction and, Service sectors in recent years. As between 2010 and 2015 male labor in agriculture has declined by 336 thousand men, and female labor in agriculture has

increased by 63 thousand women. (CAPMAS, 2016; Bruni, 2017) However, as per the latest labor statistics in the Labor Force Survey of 2017, agricultural employment (agriculture, forestry and cutting trees and fishing) has dropped from 25.2% in 2015 to 21% of total labor force in 2017 (Bruni, 2017; CAPMAS, 2018). Moreover, in 2017 agricultural labor represented 21.7% of total female employment and 18.5% of total male employment (CAPMAS, 2018).

Indeed, Egyptian women play an active role in maintaining the agricultural sector and in the rural areas in general. Deeply embedded in rural traditions, women take on many responsibilities in agriculture work: sowing seeds, weeding, cultivating, harvesting the crops and selling the surpluses, in addition to tending the garden. However, despite the contribution of Egyptian women in the agriculture sector, they continue to be marginalized in their access to agricultural resources. As reported by the World Bank (2014), women in rural Egypt produce approximately 60% of the food for household consumption and sale in local markets, however, according to their findings from Findex 2012 data only 7% of women farmers have an account at a formal financial institution and only 3.6% have acquired a loan, compared to 12% and 6.1% for men respectively (World Bank, 2014). Their lack of sufficient collateral (owning assets, property, cash) constraints their access to formal finance, credit, and loans essential for agricultural autonomy. While the Egyptian Constitution protects women's ownership and inheritance of land and livestock, with Article No. 11 of the Egyptian Constitution[6], the patriarchal culture prevalent in Egyptian societies often imposes patrilineal land inheritance. Notwithstanding, under Islamic inheritance laws female children receive a half the share of their male siblings, effectively fragmenting agricultural

[6] Recent amended to the Inheritance Law 77/1943 came into effect in January 2018 stipulates "the penalty of imprisonment for a period of not less than six months and a fine of not less than twenty thousand pounds, and not exceeding one hundred thousand pounds, or one of these two penalties each deliberately refrained from handing over one of the heirs his legitimate share of inheritance."

holdings. Conservative traditions, especially prevalent in rural Egypt, often allow women little control over their own assets and in many cases place valuable assets under the guardianship of a male family member, making her unable to use them as collateral. In turn, banks impose higher collateral requirements for women as they are perceived as more risky, primarily due to the many obstacles women face that constrain their entrepreneurship and economic opportunities. Social culture has confined women in gender roles within the household, consuming their time for work and restricting their mobility outside the home (World Bank, 2014).

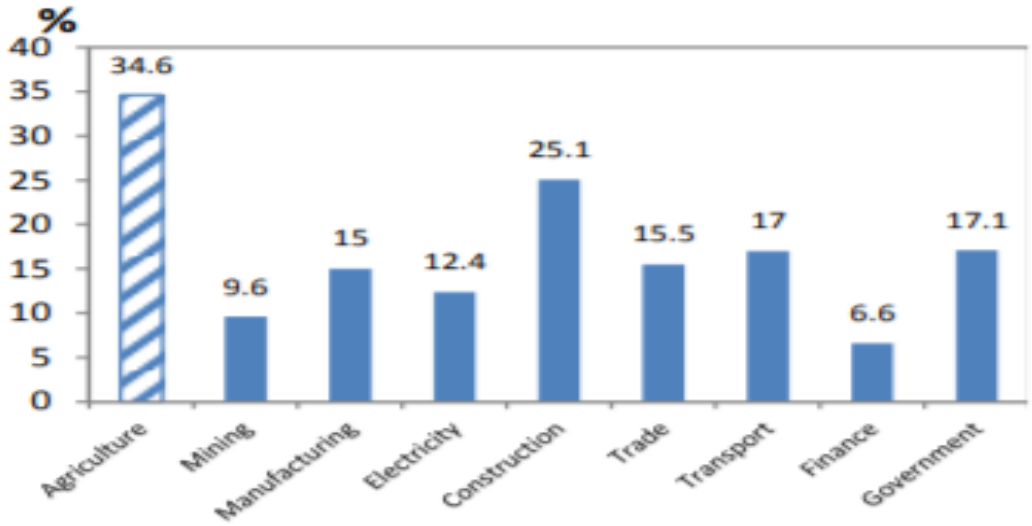
Egyptian women lack visibility in the agricultural sector and are virtually invisible in formal decision-making structures. Field work conducted by Somaya Ibrahim (1998) in Minia on the appraisal of water-user associations (WUAs), which began in the mid-1990s, exemplifies this gender bias against women in rural institutional structures. Despite the reported success of Water-User Associations (WUAs) in improving on-farm water-user efficiency, and distribution of irrigation water while reducing the cost of irrigation, the irrigation needs of women were often subordinated to male interests. The case study of Ibrahim reported that despite the presents of many women-headed households, the assumption was that the women themselves did not take part in irrigating land. As a result, the women were not informed of irrigation issues and subsequently did not have a voice in policy relating to the distribution of water. All the WUA board members were men, as the women were not consulted on selection of board members and did not know the terms of reference of office holders. This bias was mirrored in the problems of agriculture raised in the study. While men brought up issues related to machinery and prices of irrigation, the women's main issue was water shortage and night irrigation slots mainly due to unfair competition with male famers who can better defend their interests. The appraisal concludes that identifying and targeting the social context that maintains the gender-bias and marginalization of women, will

enable the WUA initiative to achieve sustainable rural market liberalization. It will also improve the situation of a broader range of rural social segments, namely women, small land holders, and landless rural inhabitants (Bush, 2004).

2.1.1. Gender in Egypt's Agricultural Development Strategies

Despite the structural transformation the Egyptian economy has witnessed, with the decline in dependency on agriculture in national GDP and in labor force employment, the agriculture sector remains to play an important role for Egypt's sustainable development. Half of Egypt's population resides in rural areas, where agriculture is the main source of livelihoods. However, poverty is concentrated in the agricultural sector, as 34.6% of those in agriculture are poor and more than 80% of the extreme poor are in rural areas (World Bank, 2014).

Figure 2.5: Concentration of Poverty by Economic Sector (Source: Household Income, Expenditure, and Consumption Survey (HIECS), 2013)



Land holding is directly correlated with poverty in rural areas; with the prevalence of high poverty rates and very small land holding in rural areas; 81% of famers own less than 3 feddans[7]

[7] A feddan is divided into 24 kirat; 1 kirat equals 175 square metres. 1 hectare is equivalent to 2.381 feddan

accounting for just 38% of total landholding (World Bank, 2014). Access to finance is a huge issue with agriculture in Egypt today, as bluntly stated by the World Bank in their report 'Principal Bank for Development and Agriculture Credit (PBDAC) Restructuring Program' (2014): "Egypt's financial sector has little interest in rural or agricultural finance" (World Bank, 2014; 5). Access to financing in agriculture is largely met through the informal sector; rotating savings and credit associations (gam'eyas) and borrowing from acquaintances. These informal means undermine bank and credit culture significantly. However, the contextual disposition of women in agriculture, particularly those residing in rural areas, adds an additional burden of difficulty on making ends-meet (Kassim, Mahmoud, Kurdi, & Breisinger, 2018).

Contextual approaches to gender issues in agricultural development in Egypt's national policy frameworks is revealed in "The Sustainable Agriculture Development Strategy" and "The Women's Strategy." These documents are presented to reflect the Egyptian's government views and their degree of commitment to the autonomy of females in agriculture. Worth noting, in Egypt′s 2018 Voluntary National Review, which depicts the state's self-assessment in accomplishing Sustainable Development Goals (SDG) targets, there was no mention of progress explicitly rendered for achieving gender equity in agricultural production. However, it does reiterate the national direction for providing financial and non-financial support to start-ups and income-generating small/micro projects[8].

Egypt Sustainable Agricultural Development Strategy towards 2030 (SADS) (2010– 2030). This strategy was published in 2009 by the Ministry of Agriculture and Land Reclamation (MALR). It sets a wide range of objectives and goals to achieve a sustainable and growing agricultural sector. The

[8] In 2017, the Ministry of Social Solidarity, in collaboration with NGOs, carried out vocational and business development training for 31,425 women. Over the last three years it has released EGP 193 million to fund 69,000 projects targeting low-income, poor and vulnerable households, with more than 90 percent of the money targeting rural women. (Egypt's Voluntary National Review, 2018)

SADS emphasizes the roles of women in agriculture and rural development under the policies to improve livelihood of rural inhabitants. Therein the SADS emphasizes the importance of strengthening the role of women in agricultural development through media campaigns promoting the role of women, consolidating all the entities working for rural women, and stimulating institutional support to implement the proposed policy. Additionally, it underlines creating new concessional credit lines compatible with the economic conditions of rural women, as well as other forms of financial support such as facilitating group lending procedures and women's associations. However, the sole national program particular to women proposed to achieve these objectives in the SADS appears less focused on agriculture production, rather centered on improving rural living conditions of rural women and their participation in the different activities (MALR, 2009).

National Strategy for the Empowerment of Egyptian Women 2030. Women's empowerment is defined based on a rights based approach with five main elements: self-appreciation and confidence; options to avail their situation; access to resources and opportunities; ability to control their lives; and direction towards positive social change. A few issues related to agriculture and rural development are contained in the strategy. Under the economic empowerment pillar the vulnerability of rural women is expressed. As such, rural women's need for social insurance and income security, particularly due to the prevalence of seasonal agriculture workers and temporary paid jobs or unpaid household work. The strategy also emphasizes the role of women in agriculture in coping with environmental risks and climate change through promoting sustainable management of natural resources and organic agriculture (NCW, 2017).

2.2. Egypt Labor Market Panel Survey (ELMPS) Datasets

The statistical analysis of this research utilizes the data collected in the Egypt Labor Market Panel Survey (ELMPS). The ELMPS dataset is a longitudinal periodical survey carried out by

the Economic Research Forum (ERF) in cooperation with the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS)[9]. The fourth wave was conducted in 2018 follows previous waves in 1998, 2006 and 2012. The ELMPS has served as a model for similar longitudinal surveys in Jordan (2010 and 2016) and Tunisia (2014). Over its history, the ELMPS has provided researchers with empirical data on the changes in the Egyptian labor market over the years. While the ELMPS has also served many studies on the different dimensions of human development in Egypt, the topic of women in agriculture and analyzing the gender gap in agriculture was not amply examined (Krafft, Assaad, & Wahe, 2019). All the analytical objectives will be investigated using the 2018 ELMPS dataset. However, due to the specific nature of Objective (B), the time comparison will compare between agriculture labor statistics between 2012 and 2018.

2.2.1. Limitation of data available:

The literature defines an autonomous agricultural holder as "the person or group of persons who exercise management control over an agricultural holding. The holding may be owned, rented or allocated from common property resources and may be operated on a sharecropped basis" (FAO, 2011; p.23). However, the lack of sex-disaggregated data specific to individual agriculture production is a persistent issue in agricultural research. This is a limitation of the ELMPS dataset, as when inquiring about agricultural assets the survey uses the household as the sampling unit. Particularly in the context of developing countries with traditional patriarchy cultures, measuring the real contribution of women in agriculture, autonomy, farming systems, and the agricultural resource gap requires sex-disaggregated data, as well as a mixed method approach to collect such data. Unfortunately, the reality

[9] ERF also received support from other donors in the 2018 wave of the ELMPS, namely; the World Bank, the International Labour Organization, Agence Française de Développement, UN Women, and the Arab Fund for Economic and Social Development.

is most datasets has continued to be at the level of the household, thus the analysis of "gender" in agriculture production is limited to comparisons of "male-headed" and "female-headed" households. The result has been an implicit unitary model of the household, ignoring the role of women (and junior men) within male-headed households. Some data sets have been able to distinguish between de-facto and de-jure[10] female headed households, identifying de-jure households are more likely to suffer from a range of economic and social disadvantages (Quisumbing, et al., 2014). Nonetheless, analyses that disaggregates data based on gender of headship can contribute to an understanding of how different forms of headship relate to development and process outcomes (Doss & Kieran, 2014).

2.3. Analysis Approach

Conceptualizing the contribution of Egyptian women in agriculture was segmented into separate but complementary analytical objectives:

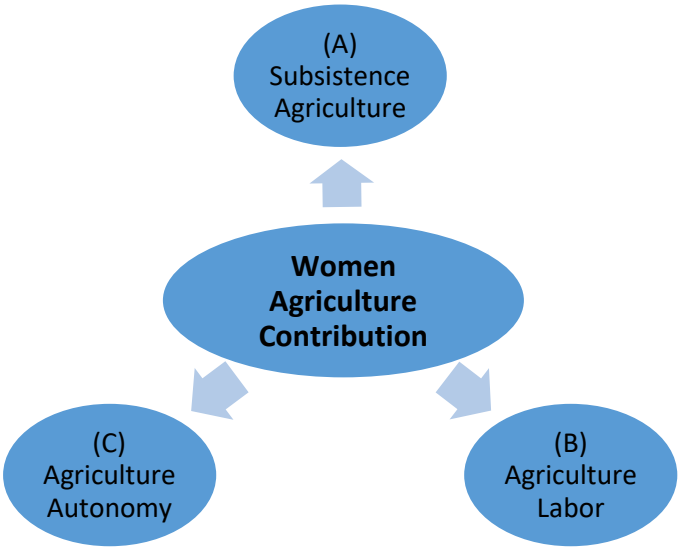
(A) Impact of female **subsistence agriculture** on rural household food security.

(B) Determining the profile of **agriculture labor**.

(C) Proxy to **agriculture autonomy** analyzing impact of household head gender on agricultural productivity and resources.

[10] De facto; those in which an adult male partner is working away from the household but remains involved through remittances and other economic and social ties. De jure; those which have no male partner, such as women who are widowed, divorced or never married.

Figure 2.6: Analytical Objectives to Measure Women's Agriculture Contribution



As indicated in the literature, gender analyses in agriculture data requires the examination of the comparative behaviors of both men and women in agriculture, as well as the contexts facing both. Thus, each objective was analyzed taking into consideration the difference between males and females. The sections below detail the methodology for Objective (A), (B), and (C) separately. In the final section of this chapter, the statistical analysis tools used for descriptive and inferential statistical analysis are presented, along with the theoretical assumptions and purposes of each tool. Therefore, the analysis for each objective will include:

1. Descriptive characteristics of analytical samples specific to each objective.
2. Significant correlations between relevant variables in analysis.
3. Inferential regression models to measure impact of gender controlling for other variables when applicable.

2.3.1. Methodology of Objective (A): Impact of Female Subsistence Agriculture Labor on Rural Household Food Security

The purpose of this objective is to provide evidence on the capacity of rural women in agricultural productivity to achieve household food security. The analysis will test several hypotheses mentioned in the empirical body of literature on women in agriculture. Identifying the gender profile of subsistence labor in rural areas will determine whether women in rural households are the main subsistence farmers. Subsequently, the analysis will assess the impact of male versus female subsistence agricultural labor on household food security. This will substantiate the potential impact of investing in women in agricultural productivity.

In Objective (A) the definition of Food Security is used to identify the scope of the research objective's dependent and independent variables. The definition of Food Security by the Food and Agricultural Organization (FAO) is "At the individual, household, national, regional and global levels is achieved, when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Hence, Food Insecurity "exists when people do not have adequate physical, social or economic access to food as defined above" (FAO, 2010). The level of household food security is used as a representation to household wellbeing and sustainability, in other words the dependent variable in the analysis carried out for Objective (A). Additionally, this definition of food security is focal to determine the independent variables by identifying four integral components: Availability, Accessibility, Utilization, and Stability which will be further detailed below (FAO, 2008).

*A.1. **Dependent Variable:** Household Food Insecurity Access Scale*

An established measurement of household food insecurity is the Household Food Insecurity Access Scale (HFIAS). HFIAS is an experience-based scale developed between 2001 and 2006 by the USAID-funded Food and Nutrition Technical Assistance II project (FANTA) in collaboration with Tufts and Cornell Universities, among other partners (Project INDDEX, 2018). Indicators calculated from the HFIAS module provide detailed data on: *access-related conditions* of the surveyed households; *access-related domains* whether anxiety and uncertainty, insufficient quality, and insufficient food intake; *prevalence* in which households are categorized into 4 main groups ranging from food secure to severely food insecure; and provide an access *scale score*. The HFIS indicators are useful for estimating prevalence of household food insecurity, and for assessing the impact of an intervention program activities has on the dimensions of household food insecurity (access) (Coates, Swindale, & Bilinsky, 2007).

In the ELMPS 2018 questionnaire the set of questions specified in HFIAS were included to measure household food insecurity under the section titled "Household Shocks and Coping Means." Therein, seven items (conditions) were inquired with a recall period of four weeks (30 days) prior to the survey (observe table 1 below). The household representative is asked about occurrence– that is, whether the condition in question happened at all in the past four weeks (yes or no). If the respondent answers "yes" to an occurrence question, a frequency-of-occurrence question follows. The frequency-of-occurrence determines whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) during the recall period (four weeks). The HFIAS occurrence questions relate to three different domains of food insecurity (access) found to be common across cultures: Anxiety and uncertainty about the household food supply, Insufficient Quality (includes variety and preferences of the type of food),

and Insufficient food intake and its physical consequences. The occurrence questions and domains are listed in Table 1 below. The generic occurrence questions were translated verbatim into Arabic for the Egyptian sample (Coates, Swindale, & Bilinsky, 2007).

Table 2.1: HFIAS Occurrence Questions and related Domains of food insecurity (access) (source: (Coates, Swindale, & Bilinsky, 2007)

Question #	Occurrence Questions	Scope
Q1	1. In the past four weeks, did you **worry that your household would not have enough food**?	1) Anxiety and uncertainty about the household food supply
Q2	2. In the past four weeks, were you or any household member **not able to eat the kinds of foods you preferred** because of a lack of resources?	2) Insufficient Quality (includes variety and preferences of the type of food)
Q3	3. In the past four weeks, did you or any household member have to **eat a limited variety** of foods due to a lack of resources?	2) Insufficient Quality (includes variety and preferences of the type of food)
Q4	4. In the past four weeks, did you or any household member have to **eat some foods that you really did not want to eat** because of a lack of resources to obtain other types of food?	2) Insufficient Quality (includes variety and preferences of the type of food)
Q5	5. In the past four weeks, did you or any household member have to **eat a smaller meal** than you felt you needed because there was not enough food?	3) Insufficient food intake and its physical consequences
Q6	6. In the past four weeks, did you or any household member have to **eat fewer meals** in a day because there was not enough food?	3) Insufficient food intake and its physical consequences
Q7	7. In the past four weeks, was there ever **no food to eat of any kind** in your household because of lack of resources to get food?	3) Insufficient food intake and its physical consequences

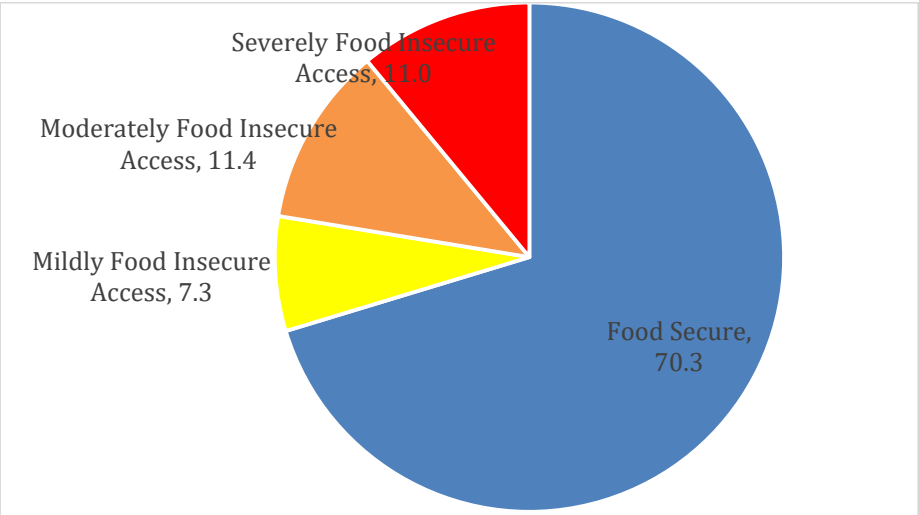
Worth noting two additional items (Q8: Go to sleep hungry and Q9: Go a whole day and night without eating) in the original HFIAS scale were not included in the 2018 ELMPS. However, these two items were particular to the categorization of the severely food insecure category (Sieverding & Hassan, 2019). This will not impact the dichotomous dependent categorization used in the logistic regression latter in the analysis. To calculate the Household Food Insecurity Access Variable, the following computations were conducted on ELMPS 2018 variables with SPSS.

Table 2.2: Method of Computing Household Food Insecurity Access Categories (source: (Coates, Swindale, & Bilinsky, 2007)

	Food Secure	Mildly Food Insecure Access	Moderately Food Insecure Access	Severely Food Insecure Access
Q1: Worry about food	Never or rarely	Sometimes or often	-	-
Q2: Unable to eat preferred foods	Never	Ever	-	-
Q3: Eat just a few kinds of foods	Never	Rarely	Sometimes or often	-
Q4: Eat foods they really do not want eat	Never	Rarely	Sometimes or often	-
Q5: Eat a smaller meal	Never	Never	Rarely or sometimes	Often
Q6: Eat fewer meals in a day	Never	Never	Rarely or sometimes	Often
Q7: No food of any kind in the household	Never	Never	Never	Ever

The household samples in the ELMPS data were then categorized using the definitions of the HFIAS categorization following Coates et al. (2007) (Coates, Swindale, & Bilinsky, 2007). Seventy percent of rural households were categorized as food secure (70%), while severe food insecurity reached 11% of households.

Figure 2.7: Household Food Insecurity Access Scale Score (n=9735, 2018)



- **Food secure households** rarely experience some worry about food access, and they do not experience food access restrictions.
- **Mildly food insecure households** worry about food access sometimes or often, and/or are unable to eat preferred foods or a diversity of foods (monotonous diet), but rarely. The households do not cut back on quantity nor experience any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating).
- **Moderately food insecure households** experience these conditions of non-preferred or monotonous diets more regularly. The households may have resorted to cut back on food quantity by reducing the size of meals or number of meals, rarely or sometimes, but do not experience any of the three most severe conditions.
- **Severely food insecure households** in the ELMPS data is one that cuts back on food quantity (meal size or number of meals) often. The households have experienced any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely. In other words, any household that experiences one of these three conditions even once in the last four weeks (30 days) is considered severely food insecure.

A.2. Independent Variables: Determinants of Household Food Insecurity

The definition of food security identifies the four integral components to be fulfilled simultaneously: Availability, Accessibility, Utilization, and Stability (FAO, 2008). The 'Stability' component pertains to the consistency of the other three dimensions over time. Under this component, one is considered food insecure even if food intake is adequate today, but inadequate on a periodic basis, thus risking nutritional and health deterioration. Hence, adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) can be

detrimental to food security. Although 'Stability' is a vital component of the sustainability of household food security and its wellbeing, it would require longitudinal panel analysis which will not be handled in the scope of this thesis.

The analysis will integrate the conceptual model developed by Drammeh, Hamid, and Rohana's (2019) article reviewing the determinants of Household Food Insecurity and its association with child malnutrition in Sub-Saharan Africa. The authors compiled evidence form several empirical studies in different developing countries relating several factors to the three main components of Household Food Insecurity (Drammeh, Hamid, & Rohana, 2019; FAO, 2008):

- **Economic Access to food** pertains to the provision of food at the national or international level but does not guarantee household food security. This component concerns policy focused on incomes, expenditure, markets and prices in achieving food security. Determinants of the Access component include: income and its distribution within the household, the household size, food prices and employment status.
- **Food Utilization** is the result of good care and feeding practices, food preparation, dietary diversity and intra-household distribution of food. The sufficient nutrient intake for the body, combined with good biological utilization of food consumed, determines the nutritional status of individuals. Determinants of the Utilization component include: dietary intake, dietary safety, gender of household head and hygiene.
- **Food Availability** addresses the physical supply of food. It is determined by the level of food production, stock levels and net trade. Variables included under this component are education and age of household head, trade and food aids, and farming food production. The farming food production renders subsistence agriculture labor in the ELMPS 2018 dataset. (Drammeh, Hamid, & Rohana, 2019; FAO, 2008).

Computing the Subsistence Labor Variables

The subsistence agriculture variable was initially computed for individuals and then aggregated on the household level. In the ELMPS 2018 dataset all individuals in the household of labor age (6 to 64 years) were asked about 15 separate subsistence labor tasks specific for the needs of their respective families during the week prior to the survey in the form of a time-use-survey. The frequency and duration of each activity is a measurement approach which is typically used in labor force surveys (Pentland, Harvey, Lawton, & McColl, 2002). The first 3 listed tasks in the subsistence labor section of the ELMPS survey signify the subsistence agriculture labor tasks and the remaining 12 were subsistence non-agriculture labor tasks.

Table 2.3: List of Subsistence agriculture and Non-Agriculture Tasks in ELMPS 2018

Subsistence Agriculture Labor Tasks:

- 1. Agriculture work
- 2. Raise livestock
- 3. Dairy production

Subsistence Non-Agriculture Labor Tasks:

- 4. Making non-food (clothing, baskets)
- 5. Fetching wood or fuel
- 6. Collecting water
- 7. Cooking for family
- 8. Washing dishes
- 9. Doing laundry
- 10. Managing family affairs (paying bills, recoding accounting, purchasing goods and services)
- 11. Cleaning household
- 12. Assisting in home construction
- 13. Shopping for hh (buying food, clothing, and hh needs)
- 14. Care for elder hh members
- 15. Care for children

The number of household members engaged in subsistence agriculture and non-agriculture labor was computed by:

1. Aggregating individual-level variables (for each subsistence agriculture and non-agriculture labor) with the sum function over households (HH ID number) and gender.
2. Computing separate variables for each gender by recording the alternating genders with zero.
3. Aggregating resulting variables (eg number of females in subsistence labor) with the maximum function by households (ID number).
4. Repeat for alternating gender (eg number of males in subsistence labor).

The number of hours each individual dedicated weekly to subsistence labor tasks was calculated by multiplying time in hours each day by the number of days in a week. Individuals that did not partake in the activity were coded "0: zero hours weekly." In the following step the individual data is aggregated on the household level; by summing the total number of hours all females in each household dedicates to subsistence labor. Then this step was repeated for the total number of hours all males in each household spends weekly in subsistence labor tasks.

Imputations of Missing Values in the Subsistence Labor Variables

In order to validate the results of the computed variable pertaining to the number of hours each individual dedicated weekly to subsistence labor tasks, missing values were imputed using an imputation method. Worth noting 46 cases were missing cases in subsistence agriculture tasks and 137 cases in subsistence non-agriculture tasks. The steps for the method of imputation of missing values for Subsistence Labor tasks are as follows:

1. Selection of labor age (6:64 years) and rural regions;
2. Correction of each task to 'Yes' if valid answer present in days spent in each task;
3. Calculation of hours per week for each task;

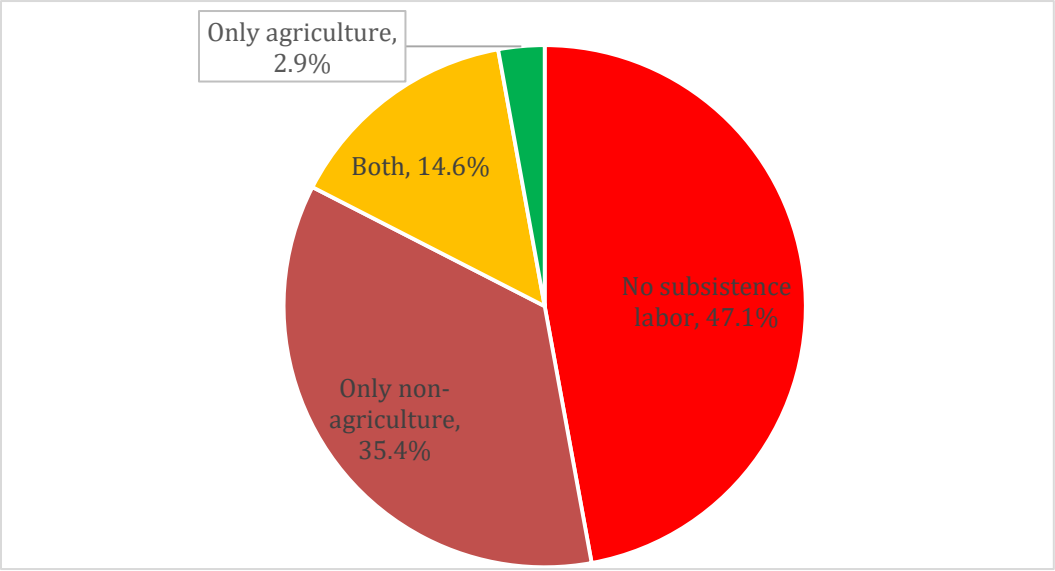
4. MISSING VALUES in ‘hours per week for each task’ was imputed by replacing with ‘mean value of hours per week for each gender.’

Additionally, to further validate the analytical data computed from the time-use survey on the number of hours each individual dedicated weekly to subsistence labor tasks, those that stated over 10 hours daily in any task were capped at 10 hours. However, the data did not show a significant difference. Therefore, the number of hours were not capped at any limit and used reported data.

Individual-Level Subsistence Labor Variables

As mentioned above on the individual-level (not aggregated on household level) 78% of the rural sample are in labor age. Close to half of all the individuals in the rural sample in the labor age do not partake in any subsistence labor (47%) and over a third partake in only non-agriculture subsistence labor (35%). Approximately 17% partake in any subsistence agriculture labor for their households. However, as apparent from the figure most of those that partake in subsistence agriculture were involved in other non-agriculture subsistence labor, as only 3% of the sample were solely occupied with subsistence agriculture for their families.

Figure 2.8: Distribution of Agriculture and non-Agriculture Subsistence labor among all rural individuals in labor age. (n=30493, ELMPS 2018)



Household-Level Subsistence Labor Variables

The following tables provide further data on the subsistence labor activities of the individuals and aggregated on the household level. Although the focus of the research seeks to highlight the contribution of women in agriculture, the fundamentals of gender analysis entails comparing between men and women in the social context. Predictably, most of the households contain at least one woman (in labor age 6-64yrs) occupied in non-agriculture subsistence labor (93%). However, the data shows that approximately 36% of all rural households contain women occupied in agriculture subsistence labor. In approximately 14% of household women partake in subsistence agriculture up to 7 hours weekly. In approximately 10% of rural household women are engaged in subsistence agriculture for over 7 hours to less than 12 hours weekly, and in approximately 11% of rural households women work in subsistence agriculture over 12 hours weekly.

Table 2.4: Distribution of total females in rural household members in Subsistence agriculture and non-agriculture labor (n=9735, ELMPS 2018)

Categories		%
Total FEMALE household members engaged in Subsistence agro	Zero	64.2 %
	1	31.1 %
	2	3.8 %
	3	0.8 %
	4 – 6	0.1 %
	Total %	100 %
	Total count	9735
Total FEMALE household members engaged in Subsistence non-agriculture	Zero	7.2 %
	1	72.2 %
	2	15.5 %
	3	4 %
	4	0.9 %
	5 -10	0.2 %
	Total %	100 %
	Total count	9735
Total hours FEMALE household members engaged in Subsistence agro [1]	Zero	65.6 %
	Less than 1 hr	0.5 %
	Over 1 hr to less than 3 hrs	5.5 %
	Over 3 hrs to less than 7 hrs	7.7 %
	Over 7 to less than 12hrs	9.8 %
	12 hrs+	10.9 %
	Total %	100 %
	Total count	9735

[1] 138 women reported preforming Subsistence agro labor but Zero hours

On the other hand, most male household members do not partake in any subsistence labor. The data shows that approximately 37% of all rural households contain males occupied in non-agricultural subsistence labor. Whereas 11% of rural households contain at least one male member (in labor age 6-64yrs) occupied in agricultural subsistence labor. In approximately 2% of household men partake in subsistence agriculture up to 7 hours weekly, in approximately 1.5% of rural households men work over 7 hours to less than 12 hours weekly, and in approximately 8% of rural households men work over 12 hours weekly.

Table 2.5: Distribution of total males in rural household members in Subsistence agriculture and non-agriculture labor (n=9735, ELMPS 2018)

Categories		%
Total MALE household members engaged in Subsistence agro	Zero	87.6
	1	9.7
	2	2.1
	3 -5	0.6
	Total %	100 %
	Total count	9735
Total MALE household members engaged in Subsistence non-agro	Zero	62.7
	1	31.7
	2	4.7
	3	0.9
	4-5	0.1
	Total %	100 %
	Total count	9735
Total hours MALE household members engaged in Subsistence agro [1]	Zero	88.6
	Less than 1 hr	0.2
	Over 1 hr to less than 3 hrs	0.7
	Over 3 hrs to less than 7 hrs	1.0
	Over 7 to less than 12hrs	1.5
	12 hrs+	8.0
	Total %	100 %
	Total count	9735

[1] 95 men reported preforming Subsistence agro labor but Zero hours

Additional Household-Level Variables

The analytical rural household sample is comprised of 9735 households. In total the households contain 39225 individuals, of which approximately 78% (30493 individuals) are in the labor age 6 to 64 years. The sample of rural households was almost evenly divided between Upper Egypt governorates and Lower Egypt governorates (53% and 47% respectively). The following tables depict the main properties of the household and the characteristics of the household head referenced in the literature pertaining to the scope of the study. These variables were controlled in the analysis in order to adequately measure the impact of female subsistence agriculture labor on household food security. The majority of the households comprise 3 to 5 household members with approximately 58% of the sample. The wealth variable used in the analysis was a pre-computed variable by the Economic Research Forum (ERF) data collectors. The wealth variable divides households into equal wealth quintiles specific to the rural population.

Table 2.6: Properties of rural household sample (n=9735, ELMPS 2018)

Categories		%
Household size	1	7.4 %
	2	15.6 %
	3 to 5	57.9 %
	6+	19.1 %
	Total %	100%
	Total count	9735
Rural Wealth Quintiles [1]	Poorest	20.9 %
	Poor	20.2 %
	Middle	19.7 %
	Rich	19.6 %
	Richest	19.6 %
	Total %	100%
	Total count	9613

[1] 122 missing cases

Typical to the traditional values of rural communities the majority of household heads are males (81%). Almost a third of the sampled household heads are illiterate (34%). Those with less than an intermediate level of education range from those able to at least read and write to preparatory levels of education (21%). The intermediate and above intermediate level pertain to the general secondary or Azhari, 3 or 5-year technical secondary schooling, and middle institute; these represent 34% of rural household heads. Finally, the remaining 11% of rural household heads have pursued a higher education degree. Most of the household heads in the analytical sample are between 30 to 49 years of age (49%) and less than a fifth are below 30 years of age (16%).

Table 2.7: Characteristics household heads of rural household sample (n=9735, ELMPS 2018)

Categories		%
Gender	Male	81.5 %
	Female	18.5 %
	Total %	100 %
	Total count	9735
Education of household head [1]	Illiterate	34.4 %
	Less than Intermediate	20.6 %
	Intermediate and Above Intermediate	34.3 %
	University	10.7 %
	Total %	100 %
	Total count	9633
Age group [2]	15 to 19	0.5 %
	20 to 29	15.3 %
	30 to 39	29.9 %
	40 to 49	19.3 %
	50 to 59	15.9 %
	60+	19.1 %
	Total %	100 %
	Total count	9723

[1] 102 missing cases
[2] 12 missing cases

2.3.2. Methodology of Objective (B): Determining the Profile of Formal and Informal Agriculture Labor

Women's contribution to agriculture work takes many forms. Women are autonomous farmers on their own account, paid labor on other farms or agricultural enterprises, and unpaid labor. They produce food for their households, commercial cash crops and manage mixed agricultural operations involving crops, livestock and fisheries. Women in agriculture are involved in both subsistence and commercial agricultural labor. All this is considered part of the agricultural labor force. According to the FAO (2011) the agricultural labor force "includes people who are working or looking for work in formal or informal jobs and in paid or unpaid employment in agriculture. That includes self-employed women as well as women working on family farms. It does not include domestic chores such as fetching water and firewood, preparing food and caring for children and other family members" (FAO, 2011).

Objective (B) will examine the hypothesis that agriculture is becoming increasingly feminized. The analysis will attempt to determine the gender profile of formal and informal agricultural labor in 2012 (ELMPS third wave) and 2018 (ELMPS fourth wave). The analysis will highlight the changes in agriculture labor over the two time periods among men and women (controlling for the impact of gender). As such the methodology specific to Objective (B) will use the standardized classification of agriculture economic activity based on the International Standard Industrial Classification of All Economic Activities Rev.4 (ISIC-4). This classification was provided in the ELMPS datasets on the individual-level data.

B.1 Definition of Agriculture Economic Activity *based on The International Standard Industrial Classification of All Economic Activities Rev.4 (ISIC-4)*

The fourth revision of ISIC is the United Nations industry classification system used throughout the world for collecting and reporting of economic activity statistics. The structure of the fourth revision of ISIC was formally approved by the United Nations Statistical Commission in March 2006. Since then it has been the internationally recognized classification of economic activates replacing the third revision of the classification and its update (revision 3.1) which have been in use since 1989 and 2002 respectively. This ISIC revision responds to the need to identify many new industries that have taken precedence in recent years, such as a separate section for "Information and communication." All categories at each level of the classification are mutually exclusive based on a set of internationally agreed concepts, definitions, principles and classification rules. In addition, ISIC does not distinguish between formal and informal or between legal and illegal production (UN, 2008).

In the ELMPS datasets all individuals above 6 years of age and higher, engaged in formal or informal labor were 15472 individuals in the 2012 EMPLS dataset and 20579 individuals in the 2018 EMPLS dataset. The following figures show the change in the percentage agricultural labor (all those categorized under agriculture, forestry, and fishing economic activity) among all individuals engaged in labor in the 3 months prior to the surveys and based on the ISIC-4 classification between 2012 and 2018. The percentage engaged agricultural labor in the 3-monts reference period has increased from approximately 31% in 2012 to reach 36% in 2018.

Figure 2.9: Agriculture labor among all individuals in labor. (n= 15472, ELMPS 2012)

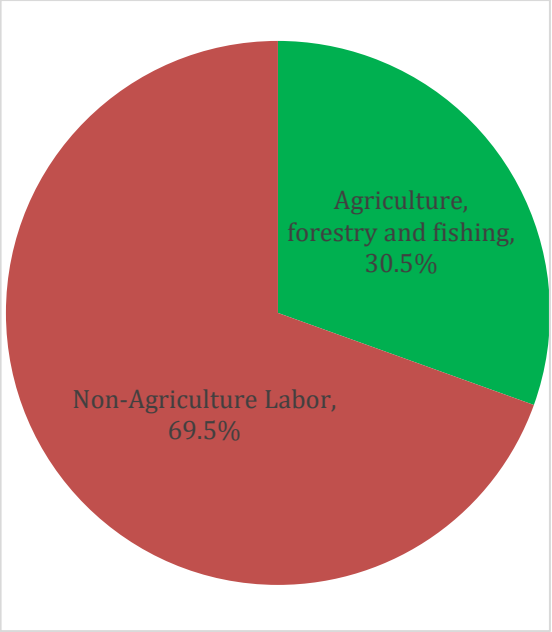
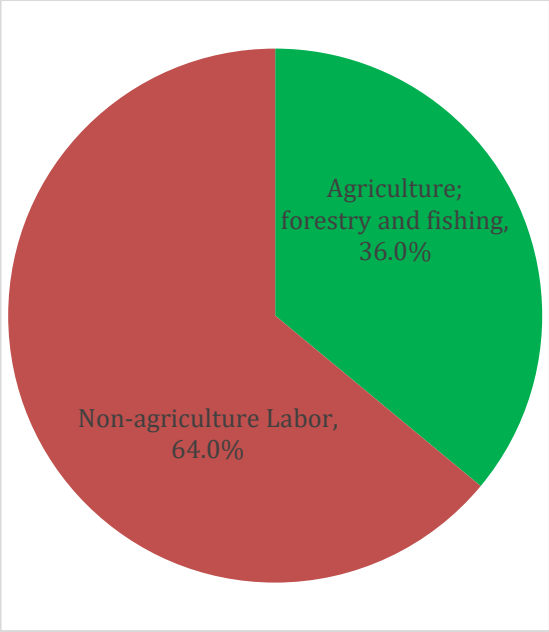


Figure 2.10: Agriculture labor among all individuals in labor. (n= 20579, ELMPS 2018)



Henceforth, the analysis and the subsequent independent variables will focus on the individual-level data engaged agricultural labor (agriculture, forestry, and fishing economic activity) in the 3-months reference period identified in both datasets. As such the analytical samples for Objective (B) consist of 4718 individuals in ELMPS 2012 and 7413 individuals in ELMPS 2018.

B.2. Background Characteristics of Agriculture Labor

In this section the main properties of agricultural labor are presented in order to identify the changes over the two periods of time. First the main demographic and household properties of agriculture labor are presented in the table below, directly followed by the labor properties and detailed agriculture work.

With respect to household structure, in 2012 agricultural labor were mainly the household heads (36%), followed by their respective spouses (32%), and their sons or daughters (25%). Whereas in 2018, agricultural labor were mainly spouses of the household head (38%), followed

by household heads (37%), and then their sons or daughters (21%). In terms of marital status, most of those engaged in agricultural labor were married in both datasets (73% in 2012 and 75% in 2018). Half of agricultural labor in both datasets were between 20 and 39 years of age. In terms of level of education, the majority of agricultural labor are either illiterate (40% in 2012 and 45% in 2018) or have acquired an intermediate level of education (26% in 2012 and 28% in 2018). Additionally, agricultural labor appear to be associated with lower levels of wealth quintiles in both datasets reaching up to 34% and 36% of the poorest wealth quintile in 2012 and 2018 respectively. Finally, agricultural labor is understandably more prevalent among rural residents; reaching 87% and 88% in 2012 and 2018 respectively.

Table 2.8: Demographic and Household Properties of Agriculture Labor (n=4718, ELMPS 2012; n=7413, ELMPS 2018)

Categories		*ELMPS 2018*	*ELMPS 2012*
Relation to the head of household	Head	37.1%	36.2%
	Spouse	38.3%	31.9%
	Son/daughter	20.6%	25.1%
	Grandchild	0.4%	0.7%
	Parent	0.4%	0.6%
	Brother/sister	0.5%	1.1%
	Other relations	2.5%	4.4%
	Servants & others	0.0%	0.1%
	Total %	100%	100%
	Total count	7413	4718
Marital status	Less than minimum age (15 yrs)	5.1%	8.5%
	Never married	14.8%	14.3%
	Contractually married	0.1%	0.1%
	Married	74.8%	72.9%
	Divorced	1.0%	0.8%
	Widowed(er)	4.3%	3.4%
	Total %	100%	100%
	Total count	7389	4718
Age groups	6-11	2.2%	1.6%
	12-14	2.9%	2.7%
	15-19	8.0%	9.1%
	20-29	23.6%	29.1%
	30-39	25.3%	20.6%

	40-49	16.8%	16.0%
	50-59	12.9%	12.7%
	60-64	5.2%	4.9%
	65+	3.1%	3.4%
	Total %	100%	100%
	Total count	7413	4718
Educational Attainment	Illiterate	40.7%	45.0%
	Reads & Writes	7.8%	5.4%
	Less than Intermediate	19.5%	19.8%
	Intermediate	27.8%	26.0%
	Above Intermediate	0.8%	0.8%
	University	3.4%	3.0%
	Total %	100.0%	100.0%
	Total Count	7333 [1]	4687 [2]
Quintiles of household wealth	Poorest	34.4%	35.5%
	Poor	27.9%	28.7%
	Middle	20.1%	20.7%
	Rich	12.1%	10.9%
	Richest	5.5%	4.2%
	Total %	100%	100%
	Total count	7413	4718
Does the household live in an urban or rural area?	Urban	11.8%	13.5%
	Rural	88.2%	86.5%
	Total %	100%	100%
	Total count	7413	4718

[1] 80 cases did not mention level of education in 2018 ELMPS dataset

[2] 31 cases did not mention level of education in 2012 ELMPS dataset

The table below provides more information on the employment specifics of agricultural labor. The data show an increase in unpaid family workers; form 57% in 2012 to reach 62% in 2018. Whereas irregular waged labor has decreased from 16% in 2012 to 14% in 2018. Similarly, independent employers in agricultural labor has also decreased from 17% in 2012 to 9% in 2018.

Table 2.9: Labor Properties of Agriculture Labor (n=4718, ELMPS 2012; n=7413, ELMPS 2018)

Categories		*ELMPS 2018*	*ELMPS 2012*
Institutional Sector Prim. Job (ref 3-month)	Self-Employed Agri.	5.0%	5.2%
	Employer	8.6%	16.7%
	Unpaid Fam. Wrk. Agri.	62.3%	57.1%
	Irregular Wage	13.9%	15.8%
	Informal Private Regular Wage	9.0%	4.8%
	Formal Private Regular Wage	0.4%	0.3%
	Public Enterprises	0.0%[1]	0.0%[1]
	Government	0.8%	0.2%
	Total %	100%	100%
	Total count	7399[2]	4718

[1] Categories of 0.0% represent counts 2 or 1.
[2] 14 individuals in 2018 did not provide information on institutional sector (missing)

The table below provides more information on the main type of agricultural labor carried by the analytical sample. Growing of non-perennial crops includes cultivating grains, legumes, oilseeds, rice, vegetables, melons, roots and tubers, sugar crops, tobacco, fiber crops, and other non-permanent crops. This category was the most common form of agriculture in both datasets; reaching 91% in 2012 and 94% in 2018. The data at hand also shows a relative decline in animal production dropping from 8% in 2012 to 5% in 2018.

Table 2.10: Type of Agriculture Production (n=4718, ELMPS 2012; n=7413, ELMPS 2018)

Categories		*ELMPS 2018*	*ELMPS 2012*
Economic activity of prim. job (based on ISIC4, ref. 3-mnths)	Growing of non-perennial crops	93.6%	90.6%
	Growing of perennial crops	.1%	.1%
	Plant propagation	-	.1%
	Animal production	4.7%	7.5%
	Mixed farming	.0%[1]	-
	Support activities to agriculture and post-harvest crop activities	.7%	.4%
	Silviculture and other forestry activities	.0%[1]	-
	Logging	.0%[1]	.0%[1]

	Support services to forestry	-	.0%[1]
	Fishing	.8%	1.3%
	Aquaculture	.1%	.1%
	Total %	100%	100%
	Total count	7413	4718

[1] Categories of 0.0% represent counts 2 or 1.

2.3.3. Methodology of Objective (C): Proxy to Agriculture Autonomy Analyzing Impact of Household Head Gender on Agriculture Productivity and Resource.

One of the most notable statements of the Food and Agriculture Organization report 'The State of Food and Agriculture 2010–11, Women in agriculture: Closing the gender gap for development' is that women farmers are just as good at farming as their male counterparts, however the gap in yield[11] is almost entirely due to differences in input quality and agricultural resources. Hence, under objective (C) the analysis will estimate the agricultural gender gap in Egypt using household-level data to pinpoint relevant obstacles and contrarians of agricultural autonomy by gender. As such the gender of the main agricultural worker is identified by headship; male-headed households and female-headed households. The principal agricultural assets specified to quantify agricultural productivity are crops cultivated in the past 12 months and livestock.

Although measuring agriculture autonomy by gender requires individual-level data, the data on agricultural assets available in the 2018 ELMPS dataset is at the household-level[12]. Under the household unit the household head is assumed to be the main decision maker regarding their agricultural assets. This is further substantiated in the dataset as the decisions regarding 89% of all

[11] The 2011 FAO report is based on a number of studies measuring productivity in a variety of ways, but the most common method is based on output per hectare of land, or yield.

[12] The data is at household level, which means each individual in a single household has the same answer to every query. Thus to eliminate duplication of results (from the same households), only responses of the household heads were selected.

the crops cultivated were made by the household head[13], additionally 91% of primary livestock herders within the family were either the household head (46%) or their spouse (45%). As cited in the literature agricultural autonomy is synonymous with one's autonomy in making decisions related to agriculture and access to the agricultural resources (Alkire et al., 2013). Thus, the analysis will use the 2018 ELMPS dataset as the closest available proxy to determine the most effective resources needed to bridge the gender

Most research studies have sought to quantify the agricultural productivity gap between male and female famers by comparing their average yield calculated by output per unit of land (hectare[14]). However, empirical research recommends looking into the difference between agricultural inputs and resources to explain the differences in agricultural productivity (FAO, 2011). Therefore, the analysis under objective (C) aims to investigate two main points of inquiry:

1. **The agricultural productivity of households;** in order to measure yield gap between male headed households and female headed. The analytical sample for the first point of inquiry includes all the households that reported any of the principal agricultural assets; cultivating crops and raising livestock, and reported any net earnings from their principal agricultural assets.
2. **The agricultural resource;** in order to describe the resource gap between male and females headed households. The analytical sample for the second point of inquiry includes all the households that reported any of the principal agricultural assets; cultivating crops and raising livestock, regardless if a reported income was generated from these assets.

[13] Decisions regarding all the crops cultivated were: 6% by the spouse, 3% by the eldest son/daughter, 1% by the grandchild, and 2% by other family members

[14] Hectare is the metric unit of land. 1 hectare is equivalent to 2.381 feddan. Feddan is a historical unit of land typically used in Egypt. A feddan is divided into 24 kirat; 1 kirat equals 175 square metres.

Approximately 23% of all households in ELMPS 2018 cultivate crops or raise livestock, representing 3626 households (section 3.3.2). Among all the households that cultivate crops or raise livestock less than half (42.4%) reported an income generated from these assets in the past 12 months, representing 1537 households (section 3.3.1.). In the following sections the sample properties of each point of inquiry will be presented in terms of supplementary agricultural resources, household properties, household-head characteristics, and net earnings per unit generated form the principal agricultural assets.

2.3.3.1. Gender gap in agricultural productivity (yield) by households:

The average farming yield of households is estimated in terms of net earnings (in EGP) per unit of the principal agricultural assets (cultivated land and/or livestock) during the 12 months prior to the survey. This method standardizes net earnings to compare the productivity of male versus female headed households, regardless of size of agricultural land or variety of livestock. Additionally, the prevalence of the supplementary agricultural resources are presented, as per the comprehensive framework of agricultural resources suggested in the 2011 FAO report. Finally, the contextual details to the households are depicted through the main household properties and characteristics of the household-head.

C.1. Dependent Variable: *Net Earnings from Principal Agricultural Assets*

In the analysis agricultural productivity is estimated by net earnings per unit from two principal agricultural assets. The first principal agricultural asset is the total crops cultivated from the agricultural land controlled by any member of the household in the 12 months prior to the ELMPS 2018 survey. Since the net earning was the sum of all harvests over the total 12 months, the size of land cultivated is the sum of all areas of land for each crop cultivated for each period of time (seasons). Therefore, crop productivity was calculated by total net earnings from crops per

feddan[15] of land cultivated for each crop (per season). The second principal agricultural asset is the livestock raised by any member of the household. The literature regarding livestock productivity recommends using the Tropical Livestock Units (TLU) to standardize livestock by species mean live weight, in other words 1 TLU is equivalent to 250 kg live weight. The literature cites that an increased number of animals per adult household member available to support the household, indicates improved food security and household resilience (FSC, 2020). Although there is no one uniform set of converting factors for livestock species, the most common Tropical Livestock Unit (TLU) conversion factors are:

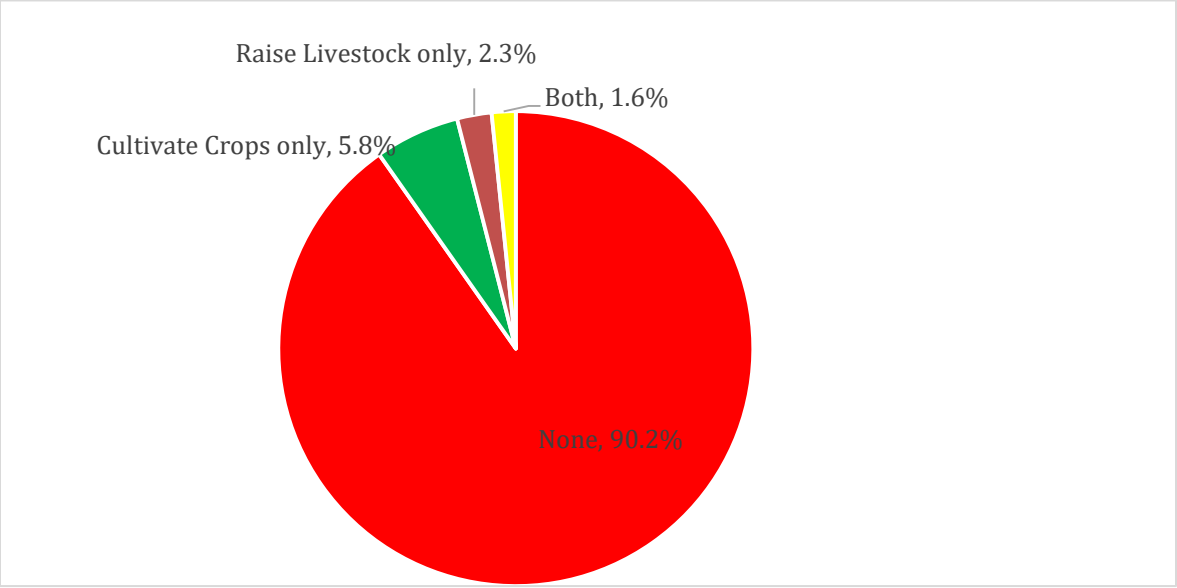
Table 2.11: TLU conversion factor for each species of Livestock (Peden, Freeman and Astatke, 2006)

Types	**TLU conversion factor**
Camels	1.4
Cattle	1
Sheep	0.11
Goats	0.11
Horses	0.8
Mules	0.7
Chickens	0.01

Therefore, these two principal agricultural assets were used to measure productivity or yield by calculating net earnings (in EGP) per feddan of land and/or net earnings (in EGP) per TLU of livestock. Approximately 9.8% of all households in ELMPS 2018 cultivate crops and/or raise livestock, and have income generated from these assets in the past 12 months, representing 1537 households.

[15] A feddan is divided into 24 kirat; 1 kirat equals 175 square metres. 1 hectare is equivalent to 2.381 feddan

Figure 2.11: Principle Agricultural Assets with Reported Net Earnings (n=15746, ELMPS 2018)



The ELMPS 2018 data shows that 1520 households cultivated crops in the past 12 months, among which 23.3% neglected to report any net earnings. As such the number of households that cultivated crops and generated income was 1167 households. The average net earnings per feddan of cultivated land was approximately 9600 EGP. Additionally, 3270 households raise livestock, among which 80.8% neglected to report any net earnings from livestock sales or products (eggs, dairy products, and milk). As such the number of households that raised livestock and generated income was 627 households[16]. The average net earnings per TLU of livestock was approximately 2500 EGP. Approximately 23% of all households in ELMPS 2018 cultivate crops or raise livestock, representing 3626 households (section 2.3.3.2). Among all the households that cultivate crops or raise livestock less

[16] It must be noted that 67 households reported only 1 EGP in net earnings from their livestock and 97 households reported less than 50 EGP in net earnings. Therefore the net earnings from livestock was capped at a minimum of 49 EGP for these 97 households.

than half (42.4%) reported an income generated from these assets in the past 12 months, representing 1537 households[17]. In total productivity from crops and/or livestock reached approximately 8300 EGP.

Table 2.12: Net Earning per unit of crops, livestock, and both (n=1167, n=627, n=1537, ELMPS 2018)

Categories	**Net Earnings from Crops per feddan**	**Net Earnings from Livestock per TLU**	**Total Net Earnings**
Mean	9,582.4 EGP	2,482.6 EGP	8,288.4 EGP
Std. Deviation	10,187.4 EGP	8,783.3 EGP	11,061.1 EGP
Minimum	3.43 EGP	5.96 EGP	3.43 EGP
Maximum	10,8000.0 EGP	191,890.41 EGP	195,340.41 EGP
Total %	100.0%	100.0%	100.0%
Total count	1167	627	1537

By dividing the total net earnings of the households into approximate quintiles, reveals that the lowest fifth of the sample generated less than 1000EGP, while the highest fifth generated more than 12000EGP.

Table 2.13: Quintiles of total net earnings from crops and livestock per unit (feddan or TLU) (n=1537, ELMPS 2018)

Categories	Households
Under 1,000 EGP	19.4%
1,001 thru 4,000 EGP	19.6%
4,001 thru 8,000 EGP	22.8%
8,001 thru 12,000 EGP	19.1%
12,001 EGP and higher (195,340)EGP	19.1%
Total %	100.0%
Total count	1537

[17] Since the data cannot tell us whether the reaming households did not achieve a profit or simply refuses to divulge the details of their earnings, these households will be omitted from analysis when analyzing yield gap, but retained when analyzing resource gap (section 2.3.3.2.).

C.2. Independent Variable: Supporting Agriculture Resources and Household Properties

The literature has described the gender gap in agricultural productivity as the disparity between men and women in productivity resources. However, until recent studies did not follow a comprehensive systematic framework to fully account for the yield differences between male and female farmers. While the contextual details may differ across regions, as described in the 2011 FAO report agriculture resources have been categorized into seven main types of resources; land, livestock, labor, education, information and extension, financing, and technology (FAO, 2011). Additionally, the contextual premise of each household plays an important factor in their agricultural productivity. As such the main properties of the households are detailed in the analysis, as well as the main characteristics of the household head representing the autonomous agricultural worker.

Agricultural Resources of Household that Generated Earning from Crops and Livestock

The agricultural resources cited in the literature (FAO, 2011) are depicted in the table below.

1. **Agriculture Land**; the most important resources and main tie to agriculture production. Approximately 76% of all households in ELMPS 2018 that generated an income from the specified principal agricultural assets cultivated agricultural land in the past 12 months; where the average area of agricultural land cultivated by the sample was 1.7 feddans. The size of land cultivated for crop production was calculated by summing the total area for each crop cultivated over the past 12 months, accounting for each crop cultivated over different periods of time (seasons).
2. **Livestock**; One of most important agriculture asset and important resistant to market shocks. As previously mentioned the literature regarding livestock productivity recommends using the Tropical Livestock Units (TLU) to standardize livestock by species

mean live weight, in other words 1 TLU is equivalent to 250 kg live weight. In the sample 18% of the households that generated income from the principal agricultural assets did not own any livestock, and 28% have less than 1 TLU and 22% have between 1 and less than 2 TLU. In total the average TLU of livestock was 1.6 TLU.

3. **Agricultural tools and machinery**; a total of 21 valuable agricultural tools and machinery used in agriculture were inquired. This includes owning tractors, plows, irrigation systems and pumps, threshers, insecticide pumps, pulled carts, beehives, office equipment, boats, and others. Among the households that generate an income from crop cultivation or livestock, 62% do not have any agricultural tools or machinery, while approximately 20% have only one agricultural tool.
4. **Labor**; ideally this includes family labor in a household and hired local labor available to tend to livestock or crops. Definitions of adult labor force differ by country, but usually refer to the population aged 15 and above. In the dataset the percentage of family labor was used to estimate the impact of labor. As such, 45% of households that generate income from crops or livestock have 1 or 2 adults in labor age (over 15), 22% of households have 3 adults in labor age.
5. **Information and Extension**; these are services designed to increase agriculture productivity provided by experts, increasing the importance of Information and Communications Technology (ICTs) to accessing information. While detailed information on these services is not available in the 2018 ELMPS data, 30% of households include at least one person that uses the internet on mobile phones, tablets, or computers.
6. **Financing**; this category includes savings, credit, and insurance are necessary to enhance productivity. The percentage of households that have any members with savings, loans,

borrowed money, or participated in one or more ROSCA (gam`iya(s)) reached 23% of all households that hold any agricultural assets.

7. **Education**; The level of human capital in a household is usually estimated in empirical studies with the education of the head of household or the average education of working-age adults in the household. The literature strongly correlates this variable with agricultural productivity, household welfare and income, nutritional status of a household or community, and ultimately the economic growth at the national level (FAO, 2011). The data at hand shows that the education of household heads are notably low; as close to half of the household heads were illiterate (46%) and 22% are less than intermediate.

Table 2.14: Agricultural resources among households that reported net earnings from principal assets (n=1537, ELMPS 2018)

		Total Households
Area of Agricultural Land Cultivated over 12 months (Feddans)	Mean	1.67
	Std. Deviation	3.93
	Minimum	0
	Maximum	72.13
	Count	1537
TLU of Livestock	Mean	1.60
	Std. Deviation	4.30
	Minimum	0.00
	Maximum	152.02
	Count	1537
Variety of Tools	0 Tools	61.5%
	1	19.5%
	2	10.2%
	3+	8.8%
	Total %	100.0%
	Total count	1537
Total Family Labor Available in Household	0	0.3%
	1	4.7%
	2	39.9%
	3	22.3%
	4	16.8%
	5	10.0%
	6 +	6.1%
	Total %	100.0%
	Total count	1537
Internet	No	69.6%

	Access to Internet	30.4%
	Total %	100.0%
	Total count	1537
Finance	No	76.7%
	Access to Finance	23.3%
	Total %	100.0%
	Total count	1537
Education Level of Household Head [1]	Illiterate	46.0%
	Less than intermediate	21.9%
	Intermediate/ Above Intermediate	27.3%
	University	4.8%
	Total %	100.0%
	Total count	1527

[1] 10 missing cases

Properties of Household that Generated Earning from Crops and Livestock

The contextual premise of each household are important factors to consider when measuring agricultural productivity. The main properties of the households and the main characteristics of the household head is presented in the table below. Most of the household heads were between 30 and 60 years of age; where 21% were in their 30's, 21% in their 40's, and 25% were in their 50's. The majority of the household heads were married (87%) and 11% were widow(er)s. Over half (61%) of the household heads reported agriculture, forestry or fishing as their main economic activity in the past 3 months based on ISIC Revision-4 classifications of economic activity.

Table 2.15: Demographic characteristics of household heads that reported net earnings from principal assets (n=1537, ELMPS 2018)

Categories		Total Households
Age groups [1]	15-19	0.4%
	20-29	7.0%
	30-39	20.9%
	40-49	20.5%
	50-59	25.9%
	60-64	9.5%
	65+	15.8%
	Total %	100.0%
	Total count	1533

Marital status [2]	Less than minimum age (15 yrs)*	0.3%
	Never married	0.8%
	Married	87.3%
	Divorced	0.7%
	Widowed(er)	10.9%
	Total %	100.0%
	Total count	1531
Agro Economic activity (based on ISIC4, ref. 3-mnths)	Agriculture, forestry and fishing	61.0%
	Other	39.0%
	Total %	100.0%
	Total count	1537

[1] 4 household heads were below 15 years-of-age
[2] 6 missing cases

With respect to household structure, 3% were single households and 14% had only two members. Additionally, 54% of households comprised of three to five members, and 30% were six members or higher. Additionally, agriculture appears to be associated with lower levels of wealth quintiles; where 34% are in the poorest wealth quintile and 30% are in the poor wealth quintile. Finally, agricultural labor is understandably more prevalent among rural residents; where 35% were Lower Rural residents and 55% were Upper Rural residents.

Table 2.16: Properties of household that reported net earnings from principal assets (n=1537, ELMPS 2018)

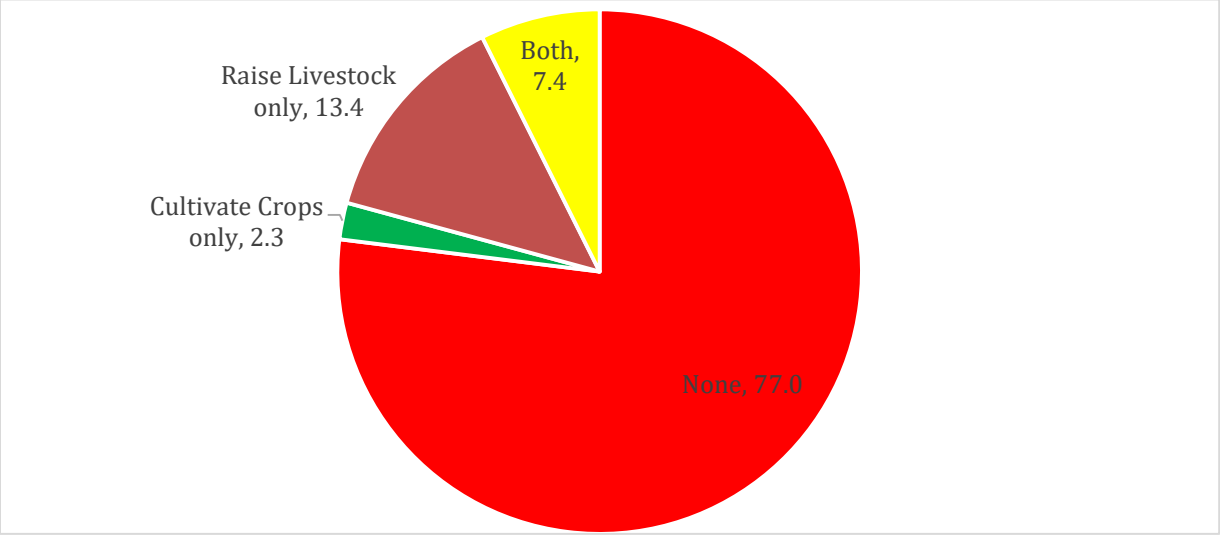
Categories		Total Households
Household size	1	3.0%
	2	14.2%
	3	15.5%
	4	17.9%
	5	20.4%
	6	13.5%
	7+	15.5%
	Total %	100.0%
	Total count	1537
Quintiles of household wealth	Poorest	34.3%
	Poor	29.7%
	Middle	20.6%
	Rich	10.7%
	Richest	4.6%
	Total %	100.0%

	Total count	1537
Region	Alx. Sz C.	0.3%
	Urb. Lwr.	2.3%
	Urb. Upp.	7.5%
	Rur. Lwr.	35.3%
	Rur. Upp.	54.5%
	Total %	100.0%
	Total count	1537

2.3.3.2. Gender gap in agricultural resource regardless of earnings:

The analytical sample for the second point of inquiry includes all the households that had any of the principal agricultural assets; cultivating crops and raising livestock, regardless if an income from these assets was reported. Approximately 23% of all households in ELMPS 2018 cultivate crops or raise livestock, representing 3626 households. The distribution of principal agricultural assets is presented in the Figure below. Noteworthy, less than half (42.4%) of all the households that cultivate crops and/or raise livestock reported an income generated from these assets in the past 12 months, representing 1537 households (previously discussed in section 2.3.3.1.).

Figure 2.12: Principle Agricultural Assets Regardless of Net Earnings (n=15746, ELMPS 2018)



As previously described the FAO has recommended a comprehensive systematic framework to fully account for the differences in agricultural resources between male and female farmers. The agricultural resources have been categorized into seven main types of resources; land, livestock, labor, education, information and extension, financing, and technology (FAO, 2011). Additionally, in this section the prevalence of each agricultural resources among all households that reported any of the principal agricultural asset in the 2018 ELMPS dataset is presented. Similar to the above, the analysis will also show the main properties of the households and the main characteristics of the household head representing the autonomous agricultural worker.

Agricultural Resources with Principal Agricultural Assets

The supporting agricultural resources cited in the literature (FAO, 2011) are depicted in the table below.

1. **Agriculture Land**: In total 42% of households cultivated crops on agricultural land in their tenure, representing 1520 households. The average size of agricultural land was approximately 1 feddan.
2. **Livestock**: In the sample 90% of the households own any livestock; where 57% have less than 1 TLU and 15% have between 1 and less than 2 TLU, and the remaining 18% have 2 TLU or more.
3. **Agricultural tools and machinery**: In total 22% % of households own any agricultural tools and machinery, representing 789 households. Among the households that reported crop cultivation or livestock, 12% have only one agricultural tool.
4. **Family Labor**; this includes adult labor force available in a household, which is most commonly referred to as those aged 15 and above. As such, 52% of households have 1 or 2 adults in labor age and 43% of households have 3 to 5 adults in labor age.

5. **Information and Extension**: A third (33%) of households include at least one person that uses the internet on mobile phones, tablets, or computers.
6. **Financing:** Overall the percentage of households that reported any financing resources in the past 12 months reached 25% of all households that hold any principal agricultural assets. While 8% of households that confirmed any savings, the most prevalent sources of financing resources were informal; borrowing money from individuals (12%), followed by 6% participating in one or more ROSCA (gam`iya(s)). On the other hand, only 5% have acquired a loan from a formal institution, while 0.1% were rejected, 0.1% are pending a response to their loan request, and approximately 95% have never applied for a loan.
7. **Education**: Illiteracy was prevalent among household-heads, accounting for 40% of the sample. Close to a quarter (23%) attained a below intermediary level of education and 30% acquired an intermediate or above intermediate level of education.

Table 2.17: Agricultural resources among households regardless of reported net earnings from principal assets (n=3626, ELMPS 2018)

Categories		Over Total Households
Area of Agricultural Land Cultivated over 12 months (Feddan)	Mean	0.83
	Std. Deviation	2.88
	Minimum	0.00
	Maximum	72.13
	Count	3626
TLU of Livestock	Mean	1.09
	Std. Deviation	4.24
	Minimum	0.00
	Maximum	152.02
	Count	3626
Variety of Tools	No Tools	78.2%
	1	11.6%
	2	5.6%
	3+	4.6%
	Total %	100.0%
	Total count	3626
	0	0.1%

Total Family Labor Available in Household	1	7.3%
	2	45.1%
	3	19.7%
	4	14.7%
	5	8.6%
	6 +	4.5%
	Total %	100.0%
	Total count	3626
Internet	Access to Internet	32.8%
	Total %	100.0%
	Total count	3626
Finance	Access to Finance	25.3%
	Total %	100.0%
	Total count	3626
Education of household head [1]	Illiterate	40.6%
	Less than intermediate	22.5%
	Intermediate/ Above Intermediate	29.7%
	University	7.2%
	Total %	100.0%
	Total count	3601

[1] 25 missing cases

Properties of Household with Principal Agricultural Assets

The main properties of the households and the main characteristics of the household head presented in the table below depicts the contextual premise of households that controls any of the principal agricultural assets. Similar household properties are observed to the sample above (generate income from principal agricultural assets). As such, most of the household heads were between 30 and 60 years of age; where 25% were in their 30's, 22% in their 40's, and 22% were in their 50's. The majority of the household heads were married (87%) and 11% were widow(er)s. Close to half of the household heads (46%) reported agriculture, forestry or fishing as their main economic activity in the past 3 months based on ISIC Revision-4 classifications of economic activity.

Table 2.18: Demographic characteristics of household heads among households regardless of reported net earnings from principal assets (n=3626, ELMPS 2018)

Categories		Over Total Households
Age groups [1]	15-19	0.4%
	20-29	9.2%
	30-39	24.5%
	40-49	22.4%
	50-59	21.6%
	60-64	8.8%
	65+	13.0%
	Total %	100.0%
	Total count	3620
Marital status [2]	Less than minimum age (15 yrs)*	0.2%
	Never married	0.7%
	Married	86.7%
	Divorced	0.7%
	Widowed(er)	11.7%
	Total %	100.0%
	Total count	3614
Agro Economic activity (based on ISIC4, ref. 3-mnths)	Agriculture, forestry and fishing	45.7%
	Other	54.3%
	Total %	100.0%
	Total count	3626

[1] 6 household heads were reported below 15 years-of-age thus recoded as missing cases
[2] 12 missing cases

The household structures of the sample that controls any of the principal agricultural assets was also very similar to those that generated any earnings (section 2.3.3.1.). Only 4% were single households and 14% had only two members. Additionally, 55% of households consisted of three to five members, and 27% were six members or higher. Lower levels of wealth quintiles were more common among this sample; as 32% are in the poorest wealth quintile and 27% are in the poor wealth quintile. Finally, agricultural labor is understandably more prevalent among rural residents; where 36% were Lower Rural residents and 52% were Upper Rural residents.

Table 2.19: Properties of household regardless of any reported net earnings from principal assets (n=3626, ELMPS 2018)

Categories		Over Total Households
Household size	1	3.9%
	2	14.4%
	3	14.9%
	4	18.7%
	5	21.2%
	6	13.6%
	7+	13.3%
	Total %	100.0%
	Total count	3626
Quintiles of household wealth	Poorest	31.5%
	Poor	27.4%
	Middle	21.2%
	Rich	13.1%
	Richest	6.9%
	Total %	100.0%
	Total count	3626
Region	Gr. Cairo	0.2%
	Alx. Sz C.	0.2%
	Urb. Lwr.	4.0%
	Urb. Upp.	7.9%
	Rur. Lwr.	36.0%
	Rur. Upp.	51.6%
	Total %	100.0%
	Total count	3626

2.3.4. Statistical Analysis Tools

All the analysis conducted in the research utilizes grounded statistical tools for descriptive and inferential analysis. These statistical tools are:

1. **Persons Chi-Squared test for independence** (Solutions, 2020):

Assessments of independent relation between two categorical variables will be measured using Persons Chi-Squared test for independence. This popular nonparametric or distribution free test is considered a staple statistical tool utilized in applied fields in psychological, sociology and all research analyzing categorical data. The measure will be used to convey whether the differences

between the responses of the two independents samples were statistically significant at 95% level of confidence (p-value >=0.05).

2. **Pearson's Correlation Coefficient** (Solutions, 2020):

This test statistic measures the linear association between two continuous variables. It is based on the method of covariance and gives information about the magnitude of the correlation, as well as the direction of the relationship. Thus, the p-value calculated for the correlation coefficient indicates whether the relationship between two variables is statistically significant at 95% level of confidence (p-value >=0.05). If so, the value of the correlation coefficient shows the direction and strength of this relationship.

3. **Student's Test for Independent Samples (T-Test)** (Siegle, 2002)**:**

This type of inferential statistics is used to determine whether there is a significant difference between the means of two groups. The level of probability (alpha or level of significance or p-value) signifies the willingness to accept a significant difference between the means before we collect data. The commonly used value is (p-value < 0.05) or (95% level of significance).

For the purpose of Objective (A), the *t*-test for Independent Samples will be used to identify whether there is a significant difference in the weekly mean hours in subsistence labor between males and females. Since the samples (males and females) have different numbers of subjects, Unequal Variance is assumed[18].

4. **Logistic Regression** (Fávero & Belfiore, 2019)**:**

Under Objective (A) the analysis seeks to identify the impact of subsistence agricultural labor of females on the probability of a rural household falling into food insecurity. The data collected from the ELMPS 2018 pertaining to the experience of Household Food Insecurity was recoded

[18] Separate-variance t test and df dependents on a formula, but a rough estimate is one less than the smallest group

into a dichotomous binary variable: 1 “Food Secure” and 0 “Mild to Severe Food Insecurity.” Thus, Logistic Regression was the most suitable inferential tool to control for the other factors that have been empirically proven to impact household food insecurity. In evaluating the performance of the resulting model, the model Chi-Square assesses the significance of the overall model, in addition to percent correct predictions from the resulting model, and the cox and snell R-square.

5. **Multiple Regression** (Fávero & Belfiore, 2019)**:**

Under Objective (C) the analysis will investigate whether the gender of the household head has a significant impact of on the household’s agricultural productivity. Agricultural productivity is estimated by the net earnings (per unit) generated from each of the two principal agricultural assets[19], and the sum of both together. This regression technique studies the linear relation between multiple independent explanatory variables, and a quantitative dependent variable (net earnings per unit). While the gender of the household head is the primary independent variable under investigation, the additional independent explanatory variables include agricultural resources, household properties, and background characteristics of the household head. The evaluation of the performance of the resulting model, the model regression ANOVA assesses the significance of the overall model, in addition to model summary R-square and R-squared adjusted.

Finally, all the analysis was conducted by the researcher on the software program ‘Statistical Package for the Social Sciences (SPSS®) version 24.’ This is an IBM software platform for advanced statistical analysis. SPSS offers a vast library of automated learning algorithms, text analysis, open source extensibility, and integration with big data. (IBM, 2020).

[19] The first principal agricultural asset is the total crops cultivated per unit of agricultural land (feddans) controlled by any member of the household in the 12 months prior to the ELMPS 2018 survey. The second principal agricultural asset is the livestock per 250 kg of live weight (TLU) raised by any member of the household.

In summary the analysis approach detailed above will examine the comparative behaviors of both men and women in each of the analytical objectives, as well as the contexts facing both. The methodology for the first objective (A) will estimate the significance of female subsistence agriculture on rural household food security. As for the second objective (B), the methodology selected will compare between the descriptive statistics of agricultural labor (as defined by ISIC-4) between 2012 and 2018. The third objective (C) will estimate the impact of the gender of household head on the agricultural productivity measured by net earnings from principal agricultural assets. Additionally, objective (C) will estimate the gender gap in agricultural resources (FAO framework) approximated by resources of male-headed households versus that of female-headed households.

3. Results

Empirical studies on agricultural development and gender equity conducted worldwide have unanimously concluded that policy interventions to close the gender gap in agricultural resources are required for sustainable agricultural development (Quisumbing, et al., 2014). However, within the Egyptian national context, not enough research has been dedicated to quantifying and analyzing the gender gap in agriculture in Egypt. As such, the aim of this research is to estimate the real impact of Egyptian women in Agriculture. Ultimately, the analysis seeks to identify whether directing public investment in women as independent agriculture producers is a feasible and sustainable solution for the agriculture sector in Egypt. The results presented in this chapter will provide evidence on Egyptian women's real agricultural contribution from nationally representative data on Egypt. Egyptian women's contribution to agriculture has been conceptualized in the following separate but complementary analytical objectives:

(A) Impact of female subsistence agriculture on rural household food security.

(B) Determining the profile of agricultural labor.

(C) Proxy to agriculture autonomy analyzing impact of household head gender on agricultural productivity and agricultural resource.

Hence, the analysis will estimate the importance of women's agricultural contribution for the wellbeing of their households (Objective A), agricultural labor (Objective B), and agricultural productivity and resources (Objective C). As indicated in the literature, gender analysis of agriculture data requires the examination of the comparative behaviors of both men and women in agriculture. Thus, the results for each objective will present the gender profile of their respective analytical sample.

The fourth wave of the Egypt Labor Market Panel Survey (ELMPS 2018) is the main dataset used in the analysis of the three analytical objectives. However, due to the specific nature of Objective (B), the time comparison will present agricultural labor statistics computed between the last two waves of the ELMPS datasets (ELMPS 2012 and ELMPS 2018).

3.1. Objective (A): Impact of Female Subsistence Agricultural Labor on Rural Household Food Security

Women's contributions to the most nation economies include a huge amount of work that is not valued as labor, and in turn their real contribution is not included in gross national calculations (Verschuur, 2019). As indicated in the literature female subsistence agriculture (as well as other forms of unpaid subsistence labor) is often disregarded in national labor estimates. This underestimation of women's contribution has led to unequal benefits, rights, protection and space for political participation (Verschuur, 2019). By comparing the subsistence agricultural labor of women to that of men in the rural, uncovers the real impact of Egyptian rural women on their family's food security.

Subsistence Agriculture refers to producing food for the family's consumption. The term 'Subsistence Farming' or 'Subsistence Agriculture' is widely associated with female agriculture and is often categorized under household responsibilities and not real work (Federici, 2004). The primary aim of the analysis under Objective (A) is to test the impact of female subsistence farming on Egyptian rural household food security. The first section of analysis starts with identifying the gender profile of subsistence agricultural and non-agricultural labor to illustrate the division of labor within rural households. This section will clarify whether women in rural households are in fact engaged in subsistence agriculture more than rural men. Subsequently, the analysis will quantify the difference in the time spent in subsistence agricultural and non-agricultural labor between men and women.

The second section of analysis under Objective (A) will measure the real impact of female subsistence labor on the wellbeing of rural households in Egypt. In order to adeptly identify the importance of subsistence agriculture in rural Egypt, the analysis examines whether subsistence agriculture is associated with lower wealth categories. Although it is sometimes described as 'peasant work' (Verschuur, 2019), the literature has cited its importance in protecting vulnerable households from spikes in market food prices and allows to maintain a degree of autonomy from the market (Federici, 2004). Finally, the significance of female subsistence agricultural labor on household food security, controlling for the effect of other factors, is estimated. These factors are derived from the conceptual model developed by Drammeh, Hamid, and Rohana in their 2019 article reviewing the determinants of Household Food Insecurity and its association with child malnutrition in Sub-Saharan Africa. Therein, the authors relate several factors under the four integral components of Household Food Insecurity (Drammeh, Hamid, & Rohana, 2019). The four integral components of Household Food Insecurity are: Availability, Accessibility, Utilization, and Stability (FAO, 2008). At the forefront under the Availability component is Subsistence Farming, referenced in the article as 'farm food production for the family needs.' Additionally, the research has identified the correlation between subsistence farming and several other influential household factors, such as age and gender of household head, and education of farmers. Where female household heads, older household heads, and uneducated farmers were more vulnerable to household food insecurity due to hinders in food production. (Drammeh, Hamid, & Rohana, 2019)

The variables in the ELMPS dataset were used to compute the needed information on Subsistence Agriculture. Data on subsistence labor was collected in the form of self-reported time-use survey referencing the week prior to the survey interview. All individuals in labor (6 to 64 years of age) were asked about the total time (days in reference week and average hours per day) occupied in fifteen

separate subsistence and domestic tasks. The first three listed tasks represent the subsistence agricultural labor tasks, and the remaining twelve were subsistence non-agricultural labor tasks. The individual data was then aggregated on the household level (Observe Table 3 in Chapter 3 Methodology).

3.1.1. Gender Profile of Subsistence Agricultural and Non- Agricultural Labor

The analytical sample consisted of rural residents in the labor age 6 to 64 years, reaching in total 30493 individuals. Approximately, 53% (16124 individuals) of the sample partook in at least one of the listed subsistence labor tasks, with non-agricultural tasks taking precedence over agricultural tasks (approximately 50% and 17% respectively) (observe Figure 4; Chapter 2).

The following sections identify the gender division of subsistence labor among rural residents in the labor age. The first section looks into the difference between men and women engaged in any subsistence agricultural labor. The second section looks into the difference between men and women engaged in any subsistence non-agricultural labor. Therein, the analysis will provide quantitative statistics on the gender division of domestic work. Finally, the third section will quantify and compare the time occupied in any subsistence labor between men and women. In the third section the analysis will provide evidence on the effect of the gender bias against women in time spent on domestic work versus time available for productive (agricultural) activities.

Gender division of Subsistence Agricultural Labor tasks

Describing the type of work occupied in subsistence agriculture is important to further understand the gender division in agriculture and food production. The following table shows that although females participated less than their male counterparts in agricultural work (approximately 9% women and 23% men), females dominate livestock production (71% women and 11% men) and dairy

production (8% women and 0.5% men). The differences between men and women in each of the listed subsistence agricultural labor tasks were found to be statistically significant (p-value =0.000 for each).

Table 3.20: Gender division of each Subsistence Agricultural task among analytical sample engaged in any Subsistence Agricultural Labor (n=5324, ELMPS 2018)

Activity	Male	Female	Total
Agricultural work *	23.29%	8.51%	31.80%
Raise livestock *	11.19%	71.04%	82.23%
Dairy production *	0.47%	8.09%	8.56%
Any Subsistence Agricultural Labor	26.61%	73.38%	100%
Total Count	1417	3907	5324

* Significant difference between male and female rural residence using Chi-squared test of Association

Gender division of Subsistence Non-Agricultural Labor tasks

It is also important to observe the non-agricultural subsistence labor that both genders occupy to further understand the structure of household responsibilities within the rural households. The data shows that in rural areas more females partake in subsistence non-agriculture; with approximately 73% of all subsistence non-agricultural labor. Females dominated most of the listed subsistence non-agricultural labor particularly those related to domestic labor for the family such as; cooking (66%), washing dishes (67%), laundry (61%), cleaning the household (66%), and shopping for household needs (37%). On the other hand, males exceeded in two listed non-agricultural activates; managing family affairs (paying bills, recoding accounting, purchasing goods and services), and assisting in home construction work (8 % and 2% respectively).

Table 3.21: Gender division of each Subsistence Non-Agricultural task among analytical sample engaged by any Subsistence Non-Agricultural Labor (n=15252, ELMPS 2018)

Activity	Male	Female	Total
Making non-food (clothing, baskets, etc.)	0.05%	0.20%	0.26%
Fetching wood or fuel *	0.54%	0.77%	1.31%
Collecting water	1.31%	3.23%	4.54%
Cooking for family *	2.27%	65.96%	68.23%
Washing dishes *	1.51%	67.38%	68.89%
Doing laundry *	1.27%	61.35%	62.61%
Managing family affairs (paying bills, recoding accounting, purchasing goods and services) *	8.26%	4.46%	12.73%
Cleaning household *	1.51%	64.65%	66.16%
Assisting in home construction *	2.27%	0.80%	3.07%
Shopping for hh (buying food, clothing, and hh needs) *	19.79%	37.02%	56.81%
Care for elder hh members	0.15%	0.37%	0.52%
Care for children *	0.12%	1.44%	1.57%
Any non- agricultural labor	26.6%	73.4%	100%
Total Count	4051	11201	15252

* Significant difference between male and female rural residence using Chi-squared test of Association

Time occupied in Subsistence Labor tasks

As mentioned above, this section seeks to identify the effect of the non-agricultural domestic responsibilities women shoulder on the time available for productive agricultural activities. Hence the sample was adjusted to include anyone in the original analytical sample (in rural and in labor age) engaged in any subsistence labor (both agricultural and non-agricultural). By observing the gender division of those engaged in any subsistence labor, rural females obviously exceed their male counterparts in both agricultural and non- agricultural subsistence labor tasks (observe figure 2 and 3 below). In figure 2 the data shows that among those engaged in any subsistence labor 24% were women in agricultural tasks, while only 9% were men in agricultural tasks. The remaining 67% were not engaged in any agricultural tasks, but reported some non-agricultural tasks. In figure 3, the data provided evidence to the dominance of women in non-agricultural domestic tasks. Approximately 70% of those that reported any subsistence labor were women in non-agricultural subsistence labor and

only 25% were men. Similarly, in figure 3 the remaining 5% reported only agricultural tasks. Moreover, these findings were further substantiated, as the chi-squared test of independence reveals the difference between genders in both agricultural and non-agricultural subsistence labor to be statistically significant (p-value =0.000 for both).

Figure 3.13: Gender distribution of Agricultural Subsistence labor among rural individuals in labor age occupied in any Subsistence labor. (n= 16124, ELMPS 2018) *

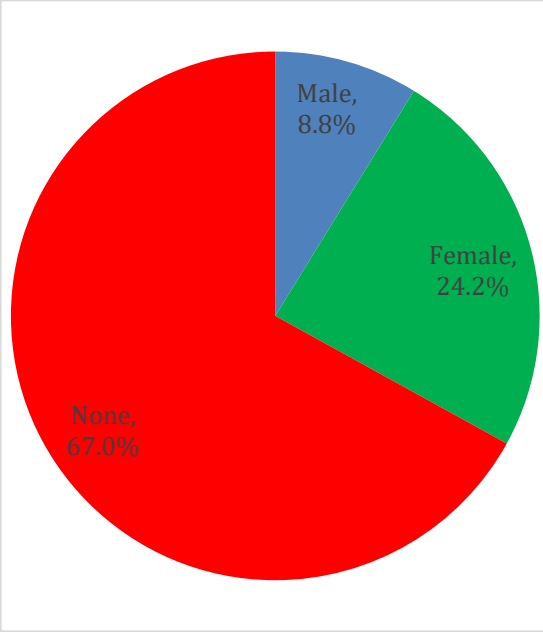
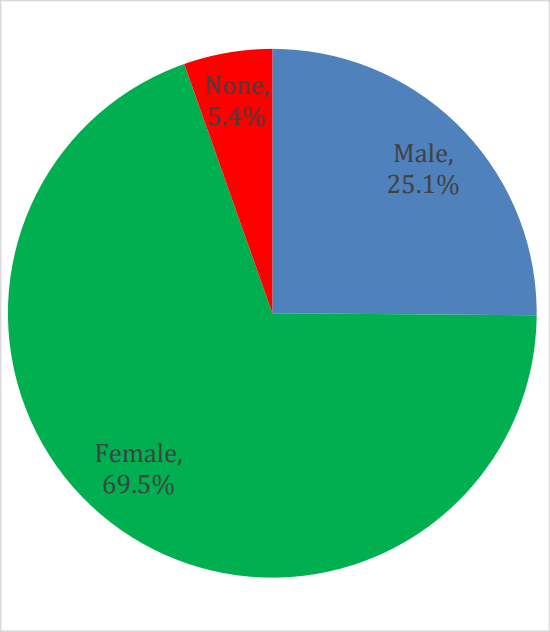


Figure 3.14: Gender distribution of Non-Agricultural Subsistence labor among rural individuals in labor age occupied in any Subsistence labor. (n= 16124, ELMPS 2018) *



* Significant difference between male and female rural residence using Chi-squared test of Association

The time dedicated to agricultural and non-agricultural subsistence labor was calculated excluding all those that do not participate in any of the listed Subsistence Labor tasks. The sample was limited to rural residents of labor age (6-64 yrs) taking part in at least one subsistence labor task (Observe table 3). Collectively rural females engaged in subsistence labor spend on average 3.44 hours a week (SD=9.45) on any subsistence agricultural labor, compared to 7.3 hours a week (SD=16.78) among rural males. This indicates that although more females partake in any subsistence agricultural labor,

males engaged in subsistence labor spend significantly more time in subsistence agriculture. Upon considering the average time spent on each task weekly; rural males spend almost 6 hours a week in agricultural work, 1.4 hours in raising livestock, and only a few minutes in dairy production. While females spend a little less than 3 hours tending to livestock, less than an hour in agricultural work or dairy production.

The differences observed in the time-survey shows that females spend on average significantly more time weekly in subsistence non-agricultural labor compared to their male counterparts. The analysis shows that rural females spend approximately 29 hours weekly (SD=23) in subsistence non-agricultural domestic tasks, while males spend only 4 hours weekly (SD=8). Rural females spend on average 10 hours a week cooking for their families, 5 hours washing dishes, 5 hours doing laundry, and 4 hours cleaning the household. Whereas the men spend on average only a few minutes to 2 hours on each subsistence non-agricultural task. Thus the analysis supports the claim that rural females are considerably occupied by subsistence non-agricultural labor, dedicating significantly more of their time in domestic work, which effectively limits their time for productive activities.

Table 3.22: Mean hours per week spent in each Subsistence Labor Tasks by gender among rural individuals in labor age occupied in any Subsistence labor (n=16124, ELMPS 2018)

Subsistence Labor Tasks	Male		Female		Total		Assumed Unequal Variance p-value
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	
Agricultural work **	5.89	14.13	0.67	4.85	2.24	9.07	0.000
Raise livestock **	1.37	5.09	2.55	6.21	2.20	5.92	0.000
Dairy production **	0.04	0.70	0.22	1.62	0.16	1.41	0.000
**Any Subsistence Agricultural Labor ** **	**7.30**	**16.78**	**3.44**	**9.45**	**4.60**	**12.26**	**0.000**
Making non-food (clothing, baskets)	0.01	0.28	0.02	0.63	0.02	0.55	0.088
Fetching wood or fuel	0.05	1.20	0.03	1.37	0.04	1.32	0.410
Collecting water	0.14	1.11	0.15	1.16	0.15	1.15	0.518
Cooking for family **	0.45	2.32	9.95	7.35	7.09	7.64	0.000
Washing dishes **	0.19	1.23	5.40	6.31	3.83	5.83	0.000

Doing laundry **	0.15	1.11	4.40	3.74	3.12	3.74	0.000
Managing family affairs (paying bills, recoding accounting, purchasing goods and services) **	0.27	1.33	0.08	0.67	0.13	0.92	0.000
Cleaning household **	0.22	2.75	5.41	5.62	3.85	5.48	0.000
Assisting in home construction **	0.19	2.14	0.03	0.83	0.08	1.37	0.000
Shopping for hh (buying food, clothing, and hh needs) **	2.17	3.41	1.48	2.74	1.69	2.98	0.000
Care for elder hh members	0.12	2.42	0.17	3.27	0.15	3.04	0.243
Care for children **	0.13	2.43	1.50	12.86	1.09	10.85	0.000
Any Subsistence Non-Agricultural Labor **	**4.10**	**8.23**	**28.62**	**22.51**	**21.23**	**22.39**	**0.000**
Any Subsistence Labor	**11.4**	**18.13**	**32.06**	**25.71**	**25.83**	**25.51**	**0.000**
Total Count	**4855**		**11269**		**16124**		

** Significant difference between male and female rural residence using Independent sample t-test (p-value < 0.05)

In summary, the above analysis provides sufficient evidence to deduce that rural women do have the capacity for food production. Rural women work longer hours than men in subsistence labor. The unpaid household duties that women shoulder limit their time for productive activities. Although more rural women are engaged in agricultural subsistence labor tasks compared to men; rural men that confirm their involvement in any subsistence labor spend significantly more time agricultural subsistence than women. While women spend significantly more time in non-agricultural subsistence labor than men. The following section will examine the impact of male versus female subsistence agricultural labor on the wellbeing of rural households, estimated by food security.

3.1.2. Impact of Female Subsistence Agricultural Labor on Rural Household Food Security

Under objective (A) the analysis aims to identify the significance of female subsistence agricultural labor on the odds of a rural household experiencing food insecurity. As such, the analysis seeks to highlight the difference between the effect of female and male subsistence agricultural labor on their households. This will identify whether females in rural households hold more potential in agriculture production.

The definition of Food Security used for the purpose of this research is as follows: “At the individual, household, national, regional and global levels is achieved, when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.” Hence, Food Insecurity “exists when people do not have adequate physical, social or economic access to food as defined above” (FAO, 2010). Based on the definition of Food Security four integral components are required to be fulfilled simultaneously Availability, Accessibility, Utilization, and Stability (FAO, 2008). The conceptual model developed by Drammeh, Hamid, and Rohana in their article reviewing the determinants of Household Food Insecurity in Sub-Saharan Africa (2019), specified several factors for each of the three main components Availability, Accessibility, and Utilization. The final component ‘Stability’ pertains to the consistency of the other three dimensions over time. The analysis will be conducted on the household level data, constructed by aggregating individual-level data on their respective households.

As previously mentioned, several assumptions cited in the literature will be tested to adequately analyze the impact of subsistence farming. Firstly, the analysis will explore the general conception that subsistence farming is peasant work thus widely associated with the lower levels of wealth. This is then followed by highlighting the impact of subsistence farming on the food scarcity of the poorest rural wealth quintiles. Secondly, the correlations between the independent variables specified in the conceptual framework for Objective (A) were investigated. Finally, the regression model will infer the significance of female subsistence agricultural labor on the food security of rural households.

Is Subsistence Agriculture peasant work? Is it more prevalent among the poor?

The data at hand corroborates that subsistence agriculture was significantly more prevalent among the poorer rural households. As presented in the figure below, subsistence agriculture was common among approximately 42% of the households categorized under the poorest rural wealth quintile. Whereas among the wealthiest quintile, subsistence agriculture was prevalent among only a third (33%).

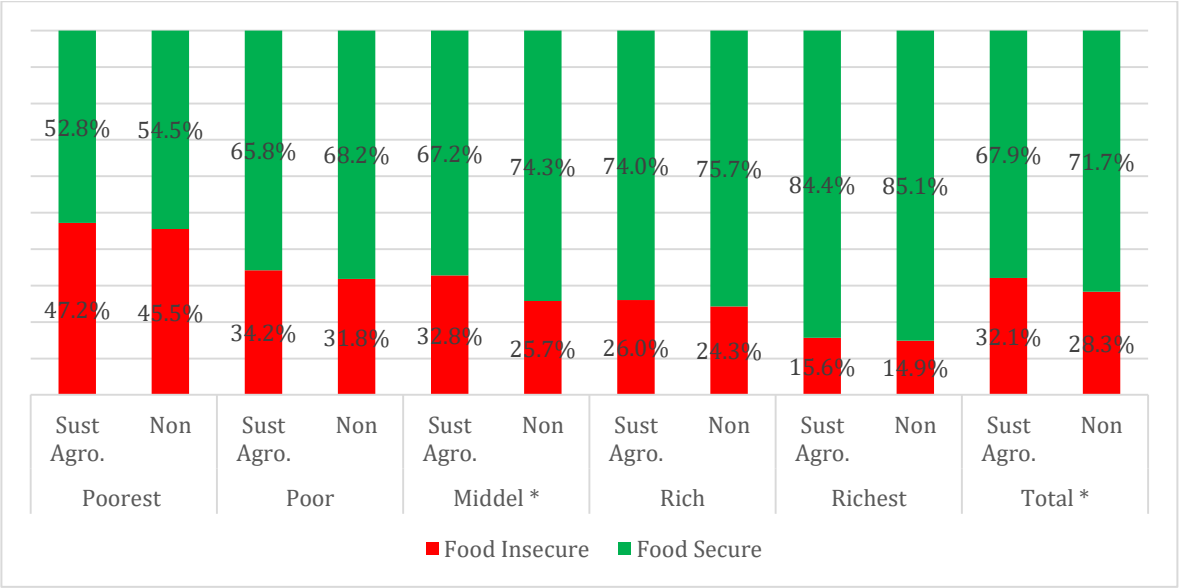
Figure 3.15: Subsistence Agriculture by Rural Wealth Quintile [1] (n=9613, ELMPS 2018)

* Significant difference between Subsistence agricultural labors by rural-wealth quintiles of respective HH using Chi-squared test of Association (p-value <0.05)

[1] 122 household's wealth category was missing in the data set.

The figure below provided evidence to the importance of subsistence agriculture, regardless of gender of subsistence laborers. The percentage of food insecurity among households is higher among those engaged in any subsistence agriculture compared to those not engaged in any subsistence agriculture (32% and 28% respectively). Therefore, the data substantiates that subsistence agriculture is particularly important among the most vulnerable wealth categories.

Figure 3.16: Household Food Insecurity by Subsistence Agriculture among each wealth category (n=9613, ELMPS 2018)



* Significant association between Subsistence Agricultural labor and food security using Chi-squared test of Association (p-value <0.05)

Correlations between determinants of household food insecurity (independent variables)

The purpose of the correlation analysis is to validate the absence of multicollinearity among independent variables to fit the assumptions of logistic regression. Thus the associations that show a strong and significant correlation coefficient (either inversely (-ve) or direct (+ve)) will be taken into consideration when building the logistic model. The results of the correlation analysis will also test the validity of some of the assumptions stated in literature.

The correlation between the identified independent variables (Observe Appendix Table A.22: Correlation Matrix) shows that strongest linear associations lie between the total number of household members in labor age and the household size (r=0.878). By differentiating between men and women in the labor age the data reveals a similar strong positive correlation with the household size (females r=0.712 and males r=0.710 respectively). This indicates the possibility of

multicollinearity, thus logistic modeling will prioritize household size over total number of household members in the labor age.

The correlation analysis substantiated the economic vulnerability of households with female heads. The gender of the household head was found to be moderately and inversely correlated with the number of household members (r= -0.294). A significant inverse moderate correlation was found between the gender of household head and the total number of household members in labor age (r=-0.252), as well as the number of male household members in labor age (r=-0.316). This meant that households with female heads, contained less household members able to work, which may increase their economic vulnerability. Additionally, the household head's level of education was found to be moderately and inversely correlated with their age, as older household heads had lower levels of education (r=-0.428).

Another finding from the correlation matrix is the moderate correlation between the total number of females in subsistence non-agricultural labor and the number of female household members in the labor age (r=0. 667). This further substantiated the finding that domestic duties are shouldered by able women in the household, which may limit their availability to take on productive activities.

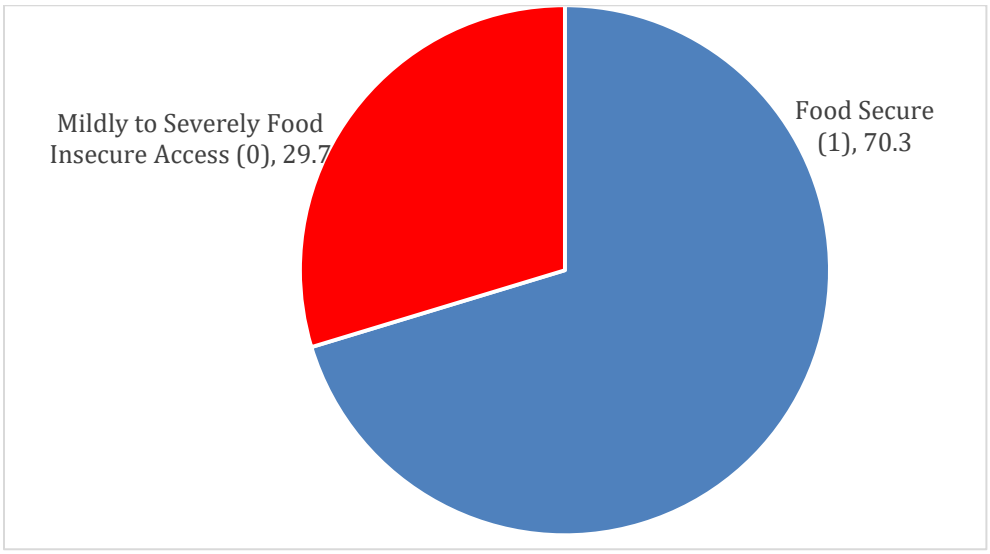
Predictably, the data also shows the strong correlation between the total numbers of males in the household in subsistence agricultural labor and the total number of hours males in the household spend in subsistence agricultural labor (r=0.738). The same applies for females in the household engaged in subsistence agricultural labor (r=0.499). Additionally, the same pattern was observed for the total number of males and females in the household and their respective total hours per week spent in subsistence non-agricultural labor (males r=0. 426 and females r=0.437). In other words, results of the correlation analysis show multicollinearity between total number -of males and females separately - in the household and their respective total hours per week spent in

subsistence agricultural and non-agricultural labor. Thus, the constructed logistic model will either use total number (male and female) household members or total number of hours weekly.

Logistic Regression Model to determine impact of Female Subsistence Agricultural Labor on Rural Household Food Security

Seventy percent of rural households were categorized as Food Secure. As such the percentage of households mildly, moderately, or severely Food Insecure reached 30%.

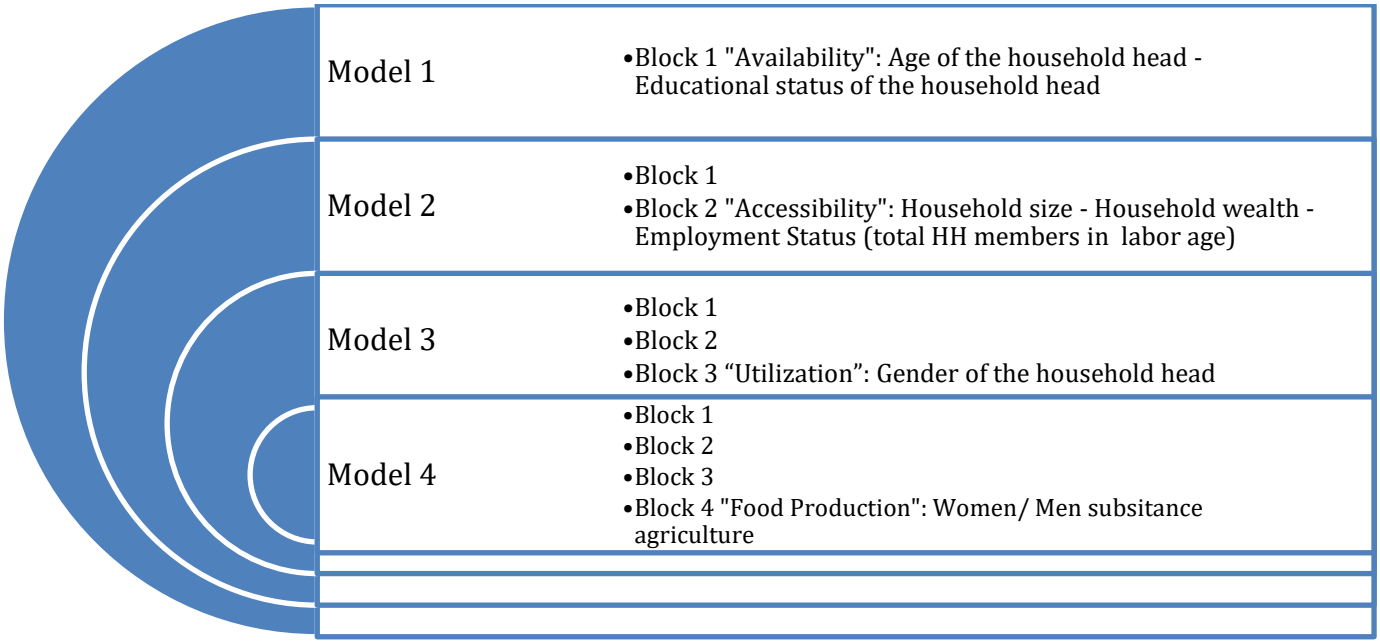
Figure 3.17: Household Food Insecurity Access Scale Score (n=9735, ELMPS 2018)



The first step in the regression analysis was to identify the significant variables pertaining to household properties and the household heads characteristics. The variables available in the 2018 ELMPS data did not cover all the identified variables in the theoretical conceptual framework. Figure 7 below presents the variables included in each block of the conceptual framework developed for Objective (A). A cumulative block method was applied in which all the variables identified for each block were entered in the logistic model in consecutive runs. Observe Appendix

Objective (A) for details on the significance and controlled impact of each variable in each consecutive run of Model 1, Model 2, and Model 3.

Figure 3.18: Variables included in each Logistic Regression Model Following Cumulative Block Method



After running model 1, model 2, and model 3, the analysis identified the significant variables from these consecutive model runs. Hence, the identified significant variables to distinguish the household heads characteristics were: education level, gender, and age. The household variables were size and wealth quintiles. The final form of Model 3, depicted in the table below, shows the effect of each of the significant variables on the odds of household food security.

The total number of households included in the logistic Model 3 were 9511 households, as by default SPSS logistic regression does a listwise deletion of missing data. The education level of the household head significantly affected the odds of a household falling into food security, controlling for the effect of the other independent variables. Compared to households with heads with a university degree, and holding all other variables constant, those with illiterate household heads are 77% less likely to be food secure; those with less than intermediate degree are 72% less

likely, and those with intermediate degree or above intermediate degree are 38% less likely. When the age of the household head increases by one year, the likelihood of food security increases by 0.8%. As household size increases by one member, odds of food security decreases by 8%. Understandably, compared to the richest rural households, and holding all other variables constant, the likelihood of food security decreases by (4.4) times among the poorest rural households; (2.7) times among the poor rural households; twice among the middle wealth rural households; and (1.7) times among the rich rural households. Finally, food security decreases by 13% when the household head is female compared to male household heads.

Table 3.23: Regressing Household Food Security on Independent Variables (household properties and household-head characteristics) in Final form of Logistic Model 3 (n=9511, ELMPS 2018) [1]

Independent Variables	Variable name	**Exp(B)**	**1/Exp(B)**
EDUC of household head (reference is university)			
	Illiterate	0.562 *	1.779359
	Less than Intermediate	0.581 *	1.72117
	Intermediate and Above Intermediate	0.723 *	1.383126
Age of household head		1.008 *	0.992063
Household size		0.92 *	1.086957
Household rural wealth quintile (reference is richest)			
	Poorest	0.227 *	4.405286
	Poor	0.423 *	2.364066
	Middle	0.499 *	2.004008
	Rich	0.593 *	1.686341
Gender of household head (reference is male)	Female HHH	0.878 **	1.138952
Constant		9.34 *	0.107066
Evaluating the Performance of the Model			
Model Chi-Squared		Chi-square	626.887
		Df	10
		Sig.	0
Percent Correct Prediction			70.70%
Pseudo R-squared :		Cox & Snell R Square	0.064
		Nagelkerke R Square	0.091

* Significant impact at 99% level of confidence (p-value <=0.01)
** Significant impact at 95% level of confidence (p-value <=0.05)
[1] Model 1 and Model 2 are in Appendix Objective (A) Table A.23 and Table A.24

Gender analyses in agriculture data requires the examination of the comparative behaviors of both men and women in agriculture, thus, the analysis will take into consideration the difference

between males and females engaged in subsistence labor in the final regression models. Additionally, since the literature cites the preoccupation of women in sustenance of non-agricultural labor, its effect should not be disregarded. In addition to the household properties and household head characteristics specified in Model 3 (table 4). Hence for the fourth Model, in order to assess the true impact of female subsistence agriculture on their respective households' food security, two variations for the independent variable 'food production' were examined separately in two versions of Model 4. The first version of Model 4 uses the number of females and males in the household engaged in subsistence labor (agricultural and non-agricultural). The second version of Model 4 uses the number of total hours all females in the households spend on subsistence labor in the week prior to the survey, and the same for males.

The evaluation of the resulting models including the different measures of household subsistence labor were both statistically significant. The difference between the strength of both models is presented in table 5.

Table 3.24: Evaluating the Performance of Model 4 version 1 and Model 4 version 2 (n= 9511, ELMPS 2018)

	Model Chi-Squared:			**Percent Correct Prediction**	**Pseudo R-squared:**	
	Chi-square	**Df**	**Sig.**		**Cox & Snell R Square**	**Nagelkerke R Square**
Model 4. version 1 : SUM Agro and Non-Agro	784.998	14	0.000	71.5%	0.079	0.112
Model 4. version 2: HOURS per Week Agro and Non-Agro	664.306	14	0.000	70.8%	0.067	0.096

- Model 4. Version 1: Testing the impact of the total number male and female (separate independent variables) household members engaged in subsistence agriculture, and the same for subsistence non-agriculture. In Model 4 version 1, the percent correct prediction was approximately 72%; indicating that the resulting model was able to correctly categorize 72% of the rural households. The Cox and Snell R-squared

indicated that approximately 8% of the variation in the dependent variable was explained by Model 4 version 1.

- Model 4. Version 2: Testing the impact of the total number of hours male and female (separate independent variables) household members spend in subsistence agriculture weekly and the same for subsistence non-agriculture. In Model 4 version 2, the percent correct prediction was approximately 71%; indicating that the resulting model was able to correctly categorize 71% of the rural households. The Cox and Snell R-squared indicated that approximately 7% of the variation in the dependent variable was explained by Model 4 version 2.

Table 3.25: Regressing Household Food Security on Independent variables Logistic Model 4 Version 1 (n= 9511, ELMPS 2018)

Independent Variables		**Exp(B)**	**1/Exp(B)**
EDUC of household head (reference is university)			
	Illiterate	0.545 *	1.835
	Less than Intermediate	0.586 *	1.706
	Intermediate and Above Intermediate	0.724 *	1.381
Gender of household head (reference is male)	Female HHH	0.889	1.125
Age of household head		1.01 *	0.990
Household size		0.98	1.020
Household rural wealth quintile (reference is richest)			
	Poorest	0.217 *	4.608
	Poor	0.411 *	2.433
	Middle	0.49 *	2.041
	Rich	0.577 *	1.733
Number of **Female** HH members engaged in **Sustin Agro** labor		1.051	0.951
Number of **Male** HH members engaged in **Sustin Agro** labor		1.092	0.916
Number of **Females** HH members engaged in **Sustin Non-Agro labor**		0.745 *	1.342
Number of **Males** HH members engaged in **Sustin Non-Agro labor**		0.69 *	1.449
Constant		10.182 *	0.098

* Significant impact at 99% level of confidence (p-value <=0.01)

The interpretation concluded from the Logistic Model 4 Version 1, regarding the impact of subsistence labor based on number of members (males and females) in the households on household food security, is as follows (observe table 25):

The impact of the number of females engaged in subsistence agricultural labor did not significantly impact the odds of household food security. The same was observed for males engaged in subsistence agricultural labor. On the other hand, the total number of all the women in the household engaged in subsistence non-agricultural labor and that of men were both found to be significant. As the number of women engaged in subsistence non-agricultural labor increases by one, the odds of household food security decreases by 34.2%. The same applies for men engaged in subsistence non-agricultural labor, as they increases by one, the odds of household food security decreases by 44.9%

Table 3.26: Regressing Household Food Security on Independent variables Logistic Model 4.Version 2 (n= 9511, ELMPS 2018)

Independent Variables		Exp(B)	1/Exp(B)
EDUC of household head (reference is university)			
	Illiterate	0.541 *	1.848
	Less than Intermediate	0.564 *	1.773
	Intermediate and Above Intermediate	0.719 *	1.391
Gender of household head (reference is male)	Female HHH	0.878 ***	1.139
Age of household head		1.007 *	1.007
Household size		0.903 *	0.903
Household rural wealth quintile (reference is richest) *			
	Poorest	0.222 *	4.505
	Poor	0.417 *	2.398
	Middle	0.493 *	2.028
	Rich	0.583 *	1.715
Number of hours **Females** in HH engaged in **Sustin Agro** labor		1.009 *	0.991
Number of hours **Males** in HH engaged in **Sustin Agro** labor		1.004 **	0.996
Number of hours **Females** in HH engaged in **Sustin Non-Agro** labor		0.997 *	1.003
Number of hours **Males** in HH engaged in **Sustin Non-Agro** labor		0.993 **	1.007
Constant		10.571	0.095

* Significant impact at 99% level of confidence (p-value <=0.01)
** Significant impact at 95% level of confidence (p-value <=0.05)
*** Significant impact at 90% level of confidence (p-value <=0.10)

The interpretation concluded from the Logistic Model 4 Version 2, estimating subsistence labor based on total hours per week, is as follows (observe table 26):

As the total number of hours in subsistence agricultural labor for all the women in the household increases by one hour per week, the odds of household food security increases by 0.9% (1.009) - holding all other variables constant, which is double that of males (0.4%). In contrast, as the total number of hours in subsistence non-agricultural labor for all the women in the household increases by one hour per week, the odds of household food security decreases by 0.3% - holding all other variables constant, which more than double that of males (0.7%).

In conclusion, the analysis presented above confirms that rural women do have the capacity for food production. More rural women work in subsistence labor both agricultural and non-agricultural. Even though rural men that confirm their involvement in any subsistence labor spend significantly more time agricultural subsistence than women. The resulting logistic regression shows that the time women spend in subsistence agriculture (total hours weekly) significantly protects their households from falling into food insecurity, more so than their male counterparts.

3.2. Objective (B): Determining the Profile of Formal and Informal Agricultural Labor

Women are disproportionately affected by informality, as unpaid reproductive work (goods and services) or care for the household responsibilities is mostly performed by women (Verschuur, 2019). This claim was substantiated in the analysis presented for Objective (A). The literature claims that agriculture is becoming increasingly feminized (Krall, 2015), this unequal sexual division of work will undoubtedly increase social, economic and political inequalities; such as access to the formal labor market (Verschuur, 2019). Thus the analysis under Objective (B) will attempt to determine the profile of formal and informal agricultural labor over two time periods 2012 and 2018 in order to statistically quantify these inequalities.

3.2.1. Gender Profile of Agricultural Labor

Agricultural labor is identified as all those categorized under agriculture, forestry, and fishing economic activity based on the ISIC-4 classification. The percentage of those engaged agricultural labor in the 3-months prior to each survey has increased from approximately 31% in 2012 to reach 36% in 2018. Moreover, the data at hand reveals the gender division of agricultural labor between 2012 and 2018 has become increasingly female. As presented in the figures below, the percentage of female agricultural labor has increased from approximately 50% of agricultural labor in 2012 to approximately 57% of agricultural labor in 2018.

Figure 3.19: Gender Division of Agricultural Labor in ELMPS 2012 (n=4718, ELMPS 2012)

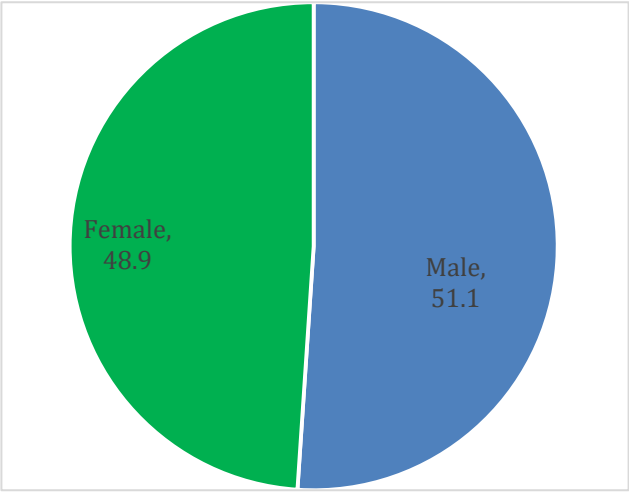
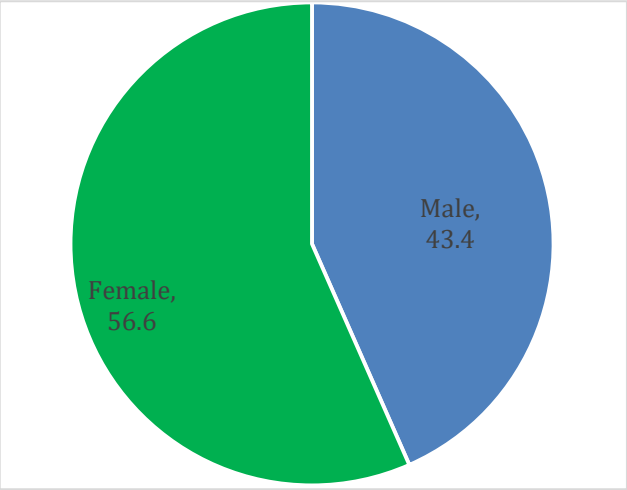


Figure 3.20: Gender Division of Agricultural Labor in ELMPS 2018 (n=7413, ELMPS 2018)



The following analysis divulged deeper into the main properties of male and female agricultural labor between 2012 and 2018. The analysis here seeks to highlight the change in the situation of Egyptian women in agriculture between the two time periods. Additionally, the contextual gender analysis stipulates the comparison between women in agriculture and their male counterparts.

Although agricultural labor is understandably more prevalent among rural residents, the analysis shows a notable increase of male and female agricultural labor in rural Upper Egypt in 2018; reaching 55% of male agricultural labor and 52% of female agricultural labor. On the other hand, female agricultural labor has decreased in rural Lower Egypt overtime; from 49% of female agricultural labor in 2012 to only 35% in 2018. In terms of household size the most obvious change overtime is the percentage of those with large households, where the percentage of female agricultural labor with a household of 7 or more members has decreased from 25% in 2012 to 18% in 2018. In this regard, a higher decrease can be observed among male agricultural labor; as those with households of 7 or more members have dropped from 30% in 2012 to 18% in 2018. Although agricultural labor appears to be associated with lower levels of wealth quintiles in both datasets, the results show a slight increase of the poorest wealth quintile among female agricultural labor; from 30% in 2012 to 32% in 2018.

Table 3.27: Household Properties of Agricultural Labor by Gender between 2012 and 2018 (n=7413, ELMPS 2018)

Categories		ELMPS 2012			ELMPS 2018		
		Male	Female	Total	Male	Female	Total
Region *	Gr. Cairo	0.2%	0.8%	0.5%	0.3%	0.8%	0.6%
	Alx. Sz C.	0.9%	0.9%	0.9%	0.6%	0.5%	0.5%
	Urb. Lwr.	3.2%	5.3%	4.2%	2.5%	3.8%	3.2%
	Urb. Upp.	8.1%	7.5%	7.8%	7.4%	7.4%	7.4%
	Rur. Lwr.	37.7%	48.6%	43.0%	34.5%	35.4%	35.0%
	Rur. Upp.	49.9%	36.9%	43.5%	54.6%	52.1%	53.2%
	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3217	4196	7413
Household size *	1	0.5%	0.8%	0.6%	1.1%	2.1%	1.7%
	2	8.1%	7.0%	7.6%	10.9%	10.6%	10.7%
	3	12.2%	13.2%	12.7%	15.1%	13.6%	14.3%
	4	17.5%	17.5%	17.5%	20.0%	18.8%	19.3%
	5	18.4%	20.6%	19.5%	20.0%	21.5%	20.9%
	6	13.1%	16.2%	14.6%	14.9%	15.5%	15.3%
	7 and higher	30.1%	24.7%	27.5%	18.0%	17.8%	17.9%

	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3217	4196	7413
Quintiles of household wealth ** *	Poorest	41.1%	29.7%	35.5%	37.6%	32.0%	34.4%
	Poor	29.2%	28.2%	28.7%	29.2%	26.9%	27.9%
	Middle	18.5%	23.0%	20.7%	19.1%	20.9%	20.1%
	Rich	8.1%	13.7%	10.9%	10.6%	13.3%	12.1%
	Richest	3.1%	5.4%	4.2%	3.6%	6.9%	5.5%
	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3217	4196	7413

** Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2018
* Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2012

With respect to household structure, in 2018 male agricultural labor were mainly the household heads (69%), while female agricultural labor were mainly their respective spouses (67%). These percentages show little change from 2012. The data also shows a slight increase in the percentage of female agricultural labor that are household heads; increasing from 9% in 2012 to 12% in 2018. In terms of marital status, most women engaged in agricultural labor were married in both datasets (78% in 2012 and 77% in 2018). Whereas a fifth of men in agricultural labor were never married compared to only 10% of women.

Table 3.28: Household Structure of Agricultural Labor by Gender between 2012 and 2018 (n=7413, ELMPS 2018)

Categories		ELMPS 2012			ELMPS 2018		
		Male	Female	Total	Male	Female	Total
Relation to the head of household ** *	Head	62.1%	9.1%	36.2%	69.2%	12.4%	37.1%
	Spouse	0.0%	65.2%	31.9%	0.2%	67.5%	38.3%
	Son/daughter	34.9%	14.8%	25.1%	28.8%	14.3%	20.6%
	Grandchild	0.7%	0.6%	0.7%	0.6%	0.4%	0.4%
	Parent	0.5%	0.8%	0.6%	0.3%	0.5%	0.4%
	Brother/sister	1.3%	0.8%	1.1%	0.4%	0.6%	0.5%
	Other relations	0.4%	8.6%	4.4%	0.4%	4.2%	2.5%
	Servants & others	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3217	4196	7413
Marital status ** *	Less than minimum age	9.5%	7.5%	8.5%	5.6%	4.7%	5.1%

	Never married	21.0%	7.2%	14.3%	21.3%	9.7%	14.8%
	Contractually married	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
	Married	68.0%	78.0%	72.9%	71.5%	77.3%	74.8%
	Divorced	0.2%	1.4%	0.8%	0.4%	1.5%	1.0%
	Widowed(er)	1.2%	5.8%	3.4%	1.1%	6.7%	4.3%
	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3205	4184	7389
Is the spouse present in the household ** *	Yes	99.9%	93.3%	96.5%	99.7%	92.0%	95.2%
	No	0.1%	6.7%	3.5%	0.3%	8.0%	4.8%
	Total %				100.0%	100.0%	100.0%
	Total Count	1638	1801	3439	2291	3234	5525

** Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2018
* Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2012

In terms of education level, most of the agricultural labor is illiterate or have acquired an intermediate level of education. However, illiteracy appears to be more prevalent among females than males (44% and 36% in 2018 respectively). Whereas, an intermediate level of education appears to be more prevalent among males than females (30% and 26% in 2018 respectively).

Close to half of male and female agricultural labor in 2018 were between 20 and 39 years of age.

Table 3.29: Characteristics of Agricultural Labor by Gender between 2012 and 2018 (n=7413, ELMPS 2018)

Categories		ELMPS 2012			ELMPS 2018		
		Male	Female	Total	Male	Female	Total
Educational Attainment ** *	Illiterate	40.3%	50.0%	45.0%	35.8%	44.4%	40.7%
	Reads & Writes	6.5%	4.2%	5.4%	9.3%	6.6%	7.8%
	Less than Intermediate	21.5%	18.0%	19.8%	20.4%	18.9%	19.5%
	Intermediate	27.7%	24.2%	26.0%	30.3%	25.9%	27.8%
	Above Intermediate	0.8%	0.9%	0.8%	0.7%	0.8%	0.8%
	University	3.3%	2.7%	3.0%	3.4%	3.4%	3.4%
	Total %				100.0%	100.0%	100.0%
	Total Count	2390	2297	4687	3178	4155	7333
Age groups ** *	6-11	1.6%	1.5%	1.6%	2.3%	2.1%	2.2%
	12-14	2.6%	2.8%	2.7%	3.3%	2.6%	2.9%
	15-19	9.6%	8.6%	9.1%	8.4%	7.7%	8.0%
	20-29	28.9%	29.3%	29.1%	23.0%	24.0%	23.6%

	30-39	19.1%	22.0%	20.6%	23.7%	26.6%	25.3%
	40-49	14.4%	17.7%	16.0%	14.2%	18.8%	16.8%
	50-59	11.7%	13.6%	12.7%	12.8%	12.9%	12.9%
	60-64	5.8%	4.0%	4.9%	5.9%	4.6%	5.2%
	65+	6.3%	0.5%	3.4%	6.3%	0.6%	3.1%
	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3217	4196	7413

** Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2018
* Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2012

The table below provides more information on the labor properties and specifics of agricultural labor. The data shows the persistent concentration of unpaid family workers among female agricultural labor in 2012 and 2018; 94% in 2012 and 94% in 2018. Whereas males in agricultural labor in 2018 were divided between irregular waged labors (30%), unpaid family workers (21%), and informal private waged (19%), and employers (18%).

Table 3.30: Labor Properties of Agricultural Labor by Gender between 2012 and 2018 (n=7413, ELMPS 2018)

Categories		ELMPS 2012			ELMPS 2018		
		Male	Female	Total	Male	Female	Total
Institutional Sector of Prim. Job (ref 3-month) ** *	Self-Employed Agri.	8.4%	1.8%	5.2%	9.6%	1.4%	5.0%
	Employer	30.6%	2.3%	16.7%	18.2%	1.2%	8.6%
	Unpaid Fam. Wrk. Agri.	21.8%	93.8%	57.1%	20.7%	94.1%	62.3%
	Irregular Wage	29.3%	1.6%	15.8%	29.8%	1.8%	13.9%
	Informal Private Regular Wage	8.9%	0.5%	4.8%	19.2%	1.1%	9.0%
	Formal Private Regular Wage	0.6%	0.0%	0.3%	0.8%	0.0%	0.4%
	Public Enterprises	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
	Government	0.3%	0.0%	0.2%	1.6%	0.3%	0.8%
	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3207	4192	7399 [1]

** Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2018
* Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2012
[1] 14 individuals in 2018 did not provide information on institutional sector (missing)

Finally, in the table below provides more information on the main type of agricultural labor carried by the analytical sample in the months prior to the survey. The growth of non-perennial

crops includes cultivating grains, legumes, oilseeds, rice, vegetables, melons, roots and tubers, sugar crops, tobacco, fiber crops, and other non-permanent crops. This type of agricultural production was the most common among men and women in 2018 (94% and 93 respectively). Additionally, the data shows an increase in this type of agricultural production among female agricultural labor between 2012 and 2018; from 89% in 2012 to 93% in 2018. The data also shows a relative decline in animal production dropping from 12% of female agricultural labor in 2012 to only 6% of female agricultural labor in 2018.

Table 3.31: Type of Agriculture Production (n=4718, ELMPS 2012; n=7413, ELMPS 2018)

Categories		ELMPS 2012			ELMPS 2018		
		Male	Female	Total	Male	Female	Total
Economic activity of prim. job (based on ISIC4, ref. 3-mnths) * **	Growing of non-perennial crops	92.6%	88.5%	90.6%	93.7%	93.4%	93.6%
	Growing of perennial crops	0.1%	0.0%	0.1%	0.2%	0.0%	0.1%
	Plant propagation	0.1%	0.0%	0.1%			
	Animal production	3.7%	11.5%	7.5%	2.8%	6.1%	4.7%
	Mixed farming				0.0%	0.0%	0.0%
	Support activities to agriculture and post-harvest crop activities	0.8%	0.0%	0.4%	1.2%	0.4%	0.7%
	Silviculture and other forestry activities				0.0%	0.0%	0.0%
	Logging	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Support services to forestry	0.0%	0.0%	0.0%			
	Fishing	2.5%	0.0%	1.3%	1.9%	0.0%	0.8%
	Aquaculture	0.2%	0.0%	0.1%	0.2%	0.0%	0.1%
	Total %				100.0%	100.0%	100.0%
	Total Count	2409	2309	4718	3217	4196	7413

** Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2018
* Significant difference between categories using Chi-squared test of association (p-value <= 0.05) in 2012

In conclusion, the analysis depicted in this section provides evidence to substantiate the hypothesis that agriculture is, in fact, becoming increasingly feminized within the Egyptian context. As the percentage of females in agricultural labor has increased over the examined time

periods; from approximately 50% of agricultural labor in 2012 to approximately 57% of agricultural labor in 2018. Moreover, the agricultural production of women and men appear to become more similar overtime; as 94% of men and 93% of women cultivated non-perennial crops in 2018. However, the analysis also indicates the continued disposition of females in agricultural labor; exemplified in the unchanged concentration of unpaid family workers among female agricultural labor in 2012 and 2018; 94% in 2012 and 94% in 2018.

3.3. Objective (C): Proxy to agricultural autonomy analyzing impact of household head gender on agricultural productivity and resource.

Patriarch of agricultural work has often masked the real capacities and contribution of women in agriculture. The biased division of labor, both in the households and on the farm, has reinforced inequalities and fails to acknowledge the real value of women in agriculture. In turn this biased division of power has also reinforced unequal opportunities and access to fundamental resources in agricultural production (Verschuur, 2019). Women in agriculture are often marginalized due to their devaluation; as such they lack visibility in agricultural development projects and policies, and lack representation in agricultural unions and syndicated. The purpose of Objective (C) is to assess the real capacity of autonomous women in agriculture compared to that of men (estimated by gender of household heads) by standardizing agricultural productivity (estimated in term of net earnings over 12 month period) from the two specified principal agricultural assets (cultivated crops and livestock production). Moreover, the research will look into the difference between agricultural inputs and resources to explain the differences in agricultural productivity (FAO, 2011). Therefor the analysis under objective (C) is divided into two main points of inquiry:

1. The average agricultural yield gap between male-headed households and female-headed households;

2. The agricultural resource gap between male-headed households and female-headed households.

Approximately 23% of all households in ELMPS 2018 cultivate crops or raise livestock, representing 3626 households (section 3.3.2). Among all the households that cultivate crops or raise livestock less than half (42.4%) reported an income generated from these assets in the past 12 months, representing 1537 households (section 3.3.1.). Since the data cannot tell us whether the remaining households did not achieve a profit or simply refuses to divulge the details of their earnings, these households will be omitted from analysis when estimating yield gap, but retained when analyzing resource gap. In the following sections the sample properties of each point of inquiry will be presented in terms of supplementary agricultural resources, household properties, and household-head characteristics. The yield gap between male-headed households and female-headed households will be estimated by calculating the difference in their respective average net earnings per unit generated from the principal agricultural assets.

3.3.1. Yield Gap between Male-Headed Households and Female-Headed Households:

The average yield of male-headed households and female-headed households is estimated in terms of net earnings (in EGP) per unit of the principal agricultural assets (cultivated land and/or livestock) during the 12 months prior to the survey. This method standardizes agricultural productivity in terms of monetary gains to compare the productivity of male-headed households versus female-headed households, regardless of size of agricultural land or variety of livestock. In other words, this method omits the impact of the assumed gender gap in critical agricultural resources. However, before measuring the gender gap in agricultural productivity, the analysis will depict the difference between male-headed and female-headed households in some of the most important factors that impact agricultural productivity. These factors represent the independent variables in the study. Firstly, the analysis will test the gender division of the aforementioned

supplementary agricultural resources. Secondly, the profile and contextual properties of households are examined through the main properties of the households and the household head. Finally, this section will test the impact of gender of household head on agricultural productivity, while controlling for the other factors.

Gender division of Supporting Agricultural Resources among Household That Generate Income from Principal Agricultural Resources (Crops and Livestock)

The literature has described the gender gap in agricultural productivity as the disparity between men and women in productivity resources. However, till recent studies did not follow a comprehensive systematic framework to fully account for the yield differences between male and female farmers. While the contextual details may differ across regions, the 2011 FAO report has categorized agricultural resources into seven main types; land, livestock, labor, education, information and extension, financing, and technology (FAO, 2011). The difference between male-headed households and female-headed households in supporting agricultural resources are depicted in Table 32 below.

1. **Agricultural Land**: The most important resources and main tie to agriculture production. Approximately 76% of all households in ELMPS 2018 that generated an income from the specified principal agricultural assets (crops on agricultural land in their tenure or livestock) cultivated agricultural land in the past 12 months. The average area of agricultural land cultivated[20] by male-headed households that reported earnings from crops or livestock was 1.8 feddans and that cultivated by female-headed households was 0.9

[20] The size of land cultivated for crop production was calculated by summing the total area for each crop cultivated over the past 12 months, accounting for each crop cultivated over different periods of time (seasons).

feddans. The difference between male-headed households and female-headed households for this agricultural resource was significant (p-value =0.000 unequal variance assumed).

2. **Livestock**: One of most important agricultural assets and important resistant to market shocks. In the sample 41% of the households that generated income from the principal agricultural assets raised any livestock. The average TLU maintained by male-headed households was 1.6 TLU[21], compared to 1.2 TLU among female-headed households. The difference between male-headed households and female-headed households for this agricultural resource was significant (p-value =0.010 unequal variance assumed).
3. **Agricultural tools and machinery:** Among the households that generate an income from crop cultivation or livestock, 40% of male-headed households owned any agricultural tools or machinery, while this percentage drops to approximately 28% of female-headed households. The categorical difference between male-headed households and female-headed households for this agricultural resource was significant (p-value =0.000, Pearson Chi-Square).
4. **Family Labor**: This includes family members in a household aged 15 and above. As such, only 2% of male-headed household that generate income from crops or livestock have one adult in labor age (over 15), compared to 23% of female-headed households. The categorical difference between male-headed households and female-headed households for this agricultural resource was significant (p-value =0.000, Pearson Chi-Square).
5. **Information and Extension**: The data shows that 29% of male-headed households include at least one person that uses the internet on mobile phones, tablets, or computers. On the other hand, this percentage increases to reach approximately 40% among female-headed

[21] Tropical Livestock Units (TLU) standardizes livestock by species mean live weight, in other words 1 TLU is equivalent to 250 kg live weight

households. The categorical difference between male-headed households and female-headed households for this agricultural resource was significant (p-value =0.002, Pearson Chi-Square).

6. **Financing**: The percentage of households that have any members with savings, loans, borrow money, or participated in gam`iya(s) reached 23% of male-headed households and 28% of female-headed households. The categorical difference between male-headed households and female-headed households for this agricultural resource was not significant (p-value =0.101, Pearson Chi-Square).
7. **Education**: The level of human capital available in a household was estimated by the education of the head of household. While the data at hand shows the prevalence of illiteracy and lower levels of education; illiteracy was higher among female-headed households (77%) compared to male-headed households (41%). The categorical difference between male-headed households and female-headed households for this agricultural resource was significant (p-value =0.000, Pearson Chi-Square).

Table 3.32: Supporting agricultural resources among households reporting net earnings by gender of household head (n=1537, ELMPS 2018)

Categories		Male-headed HH	Female-headed HH	Total
Area of Agricultural Land Cultivated over 12 months * (Feddan)	Mean	1.7843	0.9259	1.6675
	Std. Deviation	4.16942	1.57545	3.92955
	Minimum	0	0	0
	Maximum	72.13	14	72.13
	Count	1328	209	1537
TLU of Livestock *	Mean	1.6534	1.2350	1.5965
	Std. Deviation	4.58838	1.48497	4.30206
	Minimum	0.00	0.00	0.00
	Maximum	152.02	7.25	152.02
	Count	1328	209	1537
Variety of agricultural tools and machinery *	0	59.8%	72.2%	61.5%
	1	19.8%	17.7%	19.5%
	2	11.0%	5.3%	10.2%
	3+	9.4%	4.8%	8.8%
	Total %	100.0%	100.0%	100.0%

	Total count	1328	209	1537
Total number adult labor in household (15 yrs +) *	0	0.2%	0.5%	0.3%
	1	1.9%	23.0%	4.7%
	2	42.2%	25.4%	39.9%
	3	21.3%	28.2%	22.3%
	4	17.5%	12.0%	16.8%
	5	10.4%	7.2%	10.0%
	6 +	6.4%	3.8%	6.1%
	Total %	100.0%	100.0%	100.0%
	Total count	1328	209	1537
Internet *	No	71.0%	60.3%	69.6%
	Access to Internet	29.0%	39.7%	30.4%
	Total %	100.0%	100.0%	100.0%
	Total count	1328	209	1537
Finance	No	77.4%	72.2%	76.7%
	Access to Finance	22.6%	27.8%	23.3%
	Total %	100.0%	100.0%	100.0%
	Total count	1328	209	1537
Education of household head [1] *	Illiterate	41.1%	77.3%	46.0%
	Less than intermediate	23.4%	12.6%	21.9%
	Intermediate/ Above Intermediate	30.2%	9.2%	27.3%
	University	5.4%	1.0%	4.8%
	Total %	100.0%	100.0%	100.0%
	Total count	1320	207	1527

[1] 10 missing cases

* Significant difference observed between male-headed households and female-headed households using Chi-squared test of association (p-value <= 0.05)

Properties of Household That Generate Income from Principal Agricultural Resources (Crops and Livestock)

The contextual premise of each household are important factors to consider when investigating agricultural productivity. The main properties of the households and the main characteristics of the household head is presented in the table below. The data shows that male-household heads were significantly older than their female counterparts. As the percentage of males over 65 years of age was 15% compared to 22% of females. Similarly, the marital status of household heads was also significantly different. The majority of male-household heads were married (96%), compared to 29% of female-household heads. On the other hand, 65% of female- household heads were widows, compared to only 2% of male-household heads. With regard to their main economic

activity in the past 3 months based on ISIC Revison-4 classifications of economic activity, there does not appear to be a significant difference between males and females in agriculture, forestry or fishing. Where 61% of males and 63% of females reported agriculture, forestry or fishing as their main economic activity in the past 3 months.

Table 3.33: Demographic characteristics of household head among households reporting net earnings by gender of household head (n=1537, ELMPS 2018)

		Male-headed HH	Female-headed HH	Total
Age of household head [1] *	15-19	0.2%	1.4%	0.4%
	20-29	7.2%	6.3%	7.0%
	30-39	21.9%	14.9%	20.9%
	40-49	21.1%	16.3%	20.5%
	50-59	25.3%	29.8%	25.9%
	60-64	9.4%	9.6%	9.5%
	65+	14.9%	21.6%	15.8%
	Total %	100.0%	100.0%	100.0%
	Total count	1325	208	1533
Marital status [2] *	Less than minimum age (15 yrs)*	0.2%	0.5%	0.3%
	Never married	0.6%	2.4%	0.8%
	Married	96.4%	29.3%	87.3%
	Divorced	0.4%	2.4%	0.7%
	Widowed(er)	2.3%	65.4%	10.9%
	Total %	100.0%	100.0%	100.0%
	Total count	1323	208	1531
Agro. Economic activity of prim. job based on ISIC4 in ref. 3-mnths [1]	Agriculture, forestry and fishing	60.8%	62.2%	61.0%
	Not	39.2%	37.8%	39.0%
	Total %	100.0%	100.0%	100.0%
	Total count	1328	209	1537

[1] 4 household heads were below 15 years-of-age
[2] 6 missing cases
* Significant difference observed between male-headed households and female-headed households using Chi-squared test of association (p-value <= 0.05)

With respect to household structure, the data show a significant difference between male-headed households and female-headed households. Whereas approximately 1% of male-headed households were single households, the data shows that 13% of females lived alone. Additionally,

55% of male-headed households comprise three to five members, compared to 44% of female-headed households. Additionally, agriculture appears to be associated with lower levels of wealth quintiles regardless of gender of household head. As 34% and 35% of male-headed households and female-headed households, respectively, are in the poorest wealth quintile. Finally, agricultural labor is understandably more prevalent among rural residents regardless of gender of household head; where approximate 53% of male-headed households were in rural Upper Egypt and 68% of female-headed households.

Table 3.34: Household properties among households reporting net earnings by gender of household head (n=1537, ELMPS 2018)

Categories		Male-headed HH	Female-headed HH	Total
Household size *	1	1.4%	12.9%	3.0%
	2	13.4%	19.1%	14.2%
	3	14.8%	19.6%	15.5%
	4	19.1%	10.5%	17.9%
	5	21.4%	13.9%	20.4%
	6	14.1%	10.0%	13.5%
	7+	15.8%	13.9%	15.5%
	Total %	100.0%	100.0%	100.0%
	Total count	1328	209	1537
Quintiles of household wealth	Poorest	34.0%	35.9%	34.3%
	Poor	29.4%	31.6%	29.7%
	Middle	21.0%	18.2%	20.6%
	Rich	11.0%	9.1%	10.7%
	Richest	4.5%	5.3%	4.6%
	Total %	100.0%	100.0%	100.0%
	Total count	1328	209	1537
Region *	Alx. Sz C.	0.2%	1.0%	0.3%
	Urb. Lwr.	2.4%	1.9%	2.3%
	Urb. Upp.	7.7%	6.7%	7.5%
	Rur. Lwr.	37.2%	23.0%	35.3%
	Rur. Upp.	52.5%	67.5%	54.5%
	Total %	100.0%	100.0%	100.0%
	Total count	1328	209	1537

* Significant difference observed between male-headed households and female-headed households using Chi-squared test of association (p-value <= 0.05)

Gender Gap in Agricultural Productivity

In the analysis two principal agricultural assets are specified to compare the agricultural productivity (in terms of net earnings per unit) of male-headed households versus female-headed households. The first agricultural asset is the total crops cultivated from the agricultural land controlled by any member of the household in the 12 months prior to the ELMPS 2018 survey. The second agricultural asset is the livestock raised by the household or any member of the household. Approximately 9.8% of all households in ELMPS 2018 cultivate crops and/or raise livestock, and have income generated from these assets in the past 12 months, representing 1537 households. Among these households approximately 14% were female-headed households and the remaining 86% were male-headed households (Figure 10). By observing the variation of principal agricultural assets among male-headed households (Figure 11) and female-headed households (Figure 12), the data at hand shows that 17% of male-headed households controlled both types of agricultural assets compared to 14% of female-headed households.

Figure 3.21: Gender of Household Head among Households with reported earnings from Principal Agricultural Assets (n=1537, ELMPS 2018)

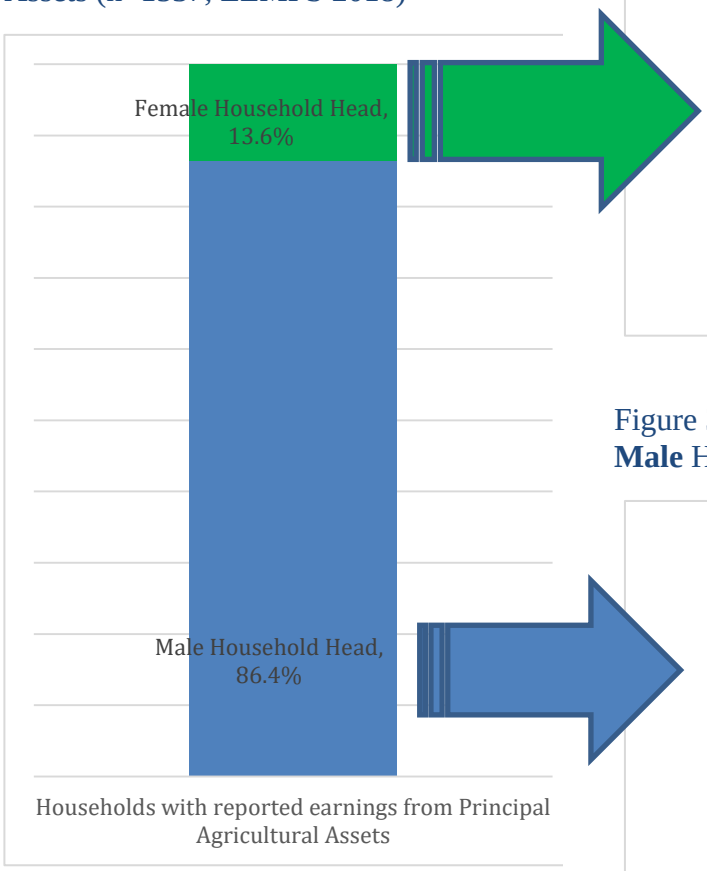


Figure 3.22: Principal Agricultural Assets among **Female** Household Heads (n=209, ELMPS 2018)

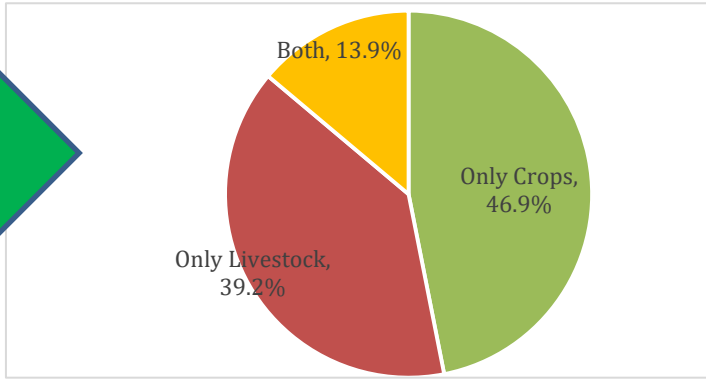
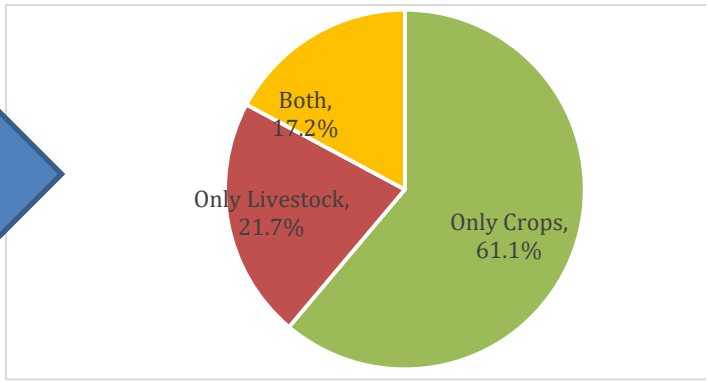


Figure 3.23: Principal Agricultural Assets among **Male** Household Heads (n=1328, ELMPS 2018)



The ELMPS 2018 data shows that 1520 households cultivated crops in the past 12 months, among which 23.3% neglected to report any net earnings. As such the number of households that cultivated crops and generated income was 1167 households. The difference between net earnings from crops per feddan of cultivated land in the past 12 months among male-headed (approximately 9500 EGP) and female-headed households (approximately 10000 EGP) was not significant. Additionally, 3270 households raise livestock, among which 80.8% did not report any net earnings from livestock sales or products (eggs, dairy products, and milk). As such the number of

households that raised livestock and generated income was 627 household[22]. Similar to the above, the difference between net earnings from livestock per TLU among male-headed households (approximately 2500 EGP) and female-headed households (approximately 2000 EGP) was also not significant. The total net earnings from both principal agricultural assets was calculated at approximately 8500 EGP among male-headed households and 7400 EGP among female-headed households, also statistically insignificant. Therefore the gap in agricultural productivity per unit was estimated at 1057EGP[23].

Table 3.35: Net earnings from principal agricultural assets (crops, livestock, and sum of both) by gender of household head (n=1167, n=627, n=1537, ELMPS 2018)

	Statistic	Male-headed HH	Female-headed HH	p-value Equal variances not assumed
Net Earnings from Crops per feddan	Mean	9,502.17	10,239.50	0.466
	Std. Deviation	10112.08	10804.11	
	N	1040	127	
Net Earnings from Livestock per TLU	Mean	2,549.99	2,169.53	0.502
	Std. Deviation	9502.23	4023.02	
	N	516	111	
Total Net Earnings (sum of both)	Mean	8,432.27	7,374.33	0.158
	Std. Deviation	11235.64	9856.04	
	N	1328	209	

Impact of Gender of Household Head on Agricultural Productivity controlling for other variables

In this section the analysis will identify the true impact of gender on the agricultural productivity of the sample's households, while controlling for the effect of other variables that can influence the outcome. Multiple Linear Regression was selected as the most appropriate statistical tool, as measures the linear relationship of multiple independent variables on a continuous

[22] It must be noted that 67 households reported only 1 EGP in net earnings from their livestock and 97 households reported less than 50 EGP in net earnings. Therefore the net earnings from livestock was capped at a minimum of 49 EGP for these 97 households.
[23] The gap in agricultural productivity per unit was estimated at approximately 900EGP by excluding outliers (13 case under 20 EGP and 1 case over 19000EGP) average

dependent variable. Here our dependent variable will be the net earnings from crops, livestock, and sum of both (calculated above in table 34). In addition to gender of household head, the other independent variables are the agricultural resources, household properties, and characteristics of household head (detailed above in table 31, 32, and 33).

As such, three separate models were conducted to identify the true impact of gender on household's agricultural productivity from *crops, livestock, and sum of both*:

- The first model: Identified independent valuables on net earnings from crops cultivated per unit of land (feddans). (n=1167 households)
- The second: Identified independent valuables on net earnings from livestock per Tropical Livestock Unit (TLU) (equivalent to 250kg of live weight). (n=627 households)
- The third: Identified independent valuables on net earnings from crops cultivated per unit of land (feddans) and from livestock per TLU. (n=1537 households)

In the three models the variable 'gender of household head' was always not significant for agricultural productivity from principal agricultural assets (corps and/or livestock). This finding reaffirms the finding that gender does not impact the agricultural productivity of households. The main difference between male-headed households and female-headed households were their access to fundamental agricultural resources. (Observe Appendix Objective C for Multiple Regression Models).

3.3.2. The agricultural resource gap between male-headed and females-headed households regardless of earnings:

The analytical sample for the second point of inquiry includes all the households that had any of the principal agricultural assets; cultivating crops and raising livestock, regardless if a reported income was generated from these assets. The gender gap is estimated by exemplifying the difference in all agricultural resources between female-headed households and male-headed

households, as well as testing the statistical significance of the difference (if any). Agricultural land for crop cultivation and livestock measured in Tropical Livestock Units were highlighted as the most important agricultural resources in this research and the literature (FAO, 2011). The following presents the gender differences between these two resources separately:

Agricultural Land; the most important resources and main tie to agriculture production. The size of land cultivated for crop production was calculated by summing the total area for each crop cultivated over the past 12 months. In total 9.7% of all households in ELMPS 2018 cultivated crops on agricultural land in their tenure, representing 1520 households. Among these households the average feddans of agricultural land cultivated by male-headed households was almost twice that of female-headed households (2 feddans and 1.4 feddans respectively), as presented in the table below.

Table 3.36: Size of agricultural land among households reporting crops cultivated in previous 12 months by gender of household head (n=1520, ELMPS 2018)

Categories		Male-headed HH	Female-headed HH	Total
Area of Agricultural Land Cultivated over 12 months (Feddan) *	Mean	2.0482	1.3780	1.9781
	Std. Deviation	4.37612	1.72366	4.18294
	Minimum	0.02	0.04	0.02
	Maximum	72.13	14.00	72.13
	Count	1361	159	1520

* Significant difference between male and females using Independent sample t-test, p-value= 0.000 equal; variance not assumed

Livestock; One of most important agricultural assets and important resistant to market shocks. As previously mentioned the literature regarding livestock productivity recommends using the Tropical Livestock Units (TLU) to standardize livestock by species mean live weight, in other words 1 TLU is equivalent to 250 kg live weight. In total 20.7% of all households in ELMPS 2018 raised livestock, representing 3270 households. Among these households the analysis did not show

a significant difference between male-headed households and female- headed households with respect to livestock TLU (1.2 TLU and 1.1 TLU respectively)

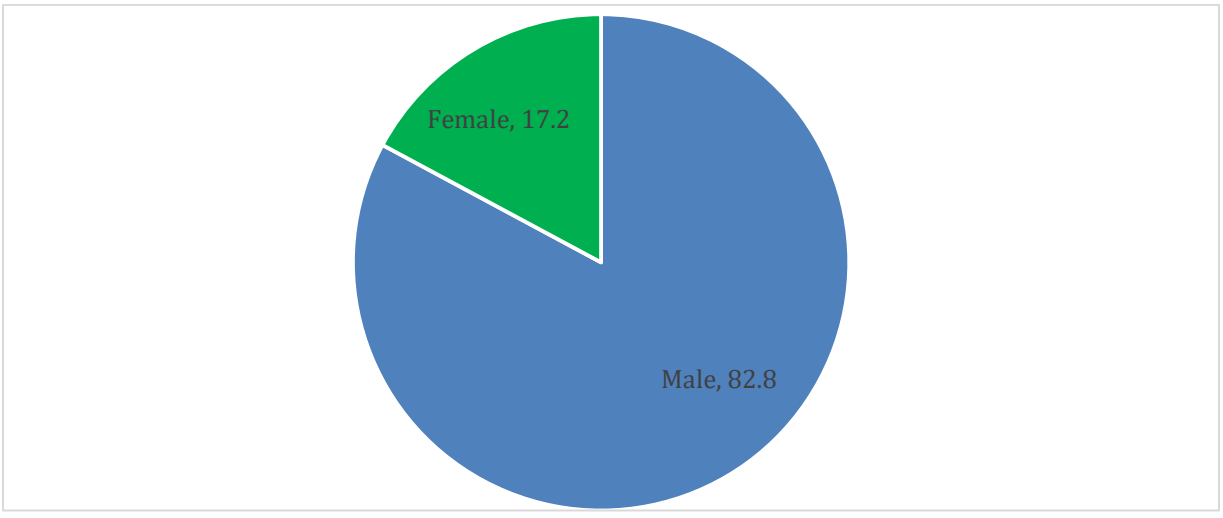
Table 3.37: Livestock TLU among households reporting livestock production in previous 12 months by gender of household head (n=3270, ELMPS 2018)

Categories		Male-headed HH	Female-headed HH	Total
TLU of Livestock *	Mean	1.2468	1.0500	1.2115
	Std. Deviation	3.91931	6.31956	4.44522
	Minimum	0.01	0.02	0.01
	Maximum	152.02	150.00	152.02
	Count	2684	586	3270

* NO Significant difference between male and females using Independent sample t-test, p-value= 0.469 equal; variance not assumed

Approximately 23% of all households in ELMPS 2018 cultivate crops or raise livestock, representing 3626 households. The distribution of principal agricultural assets between male-headed households and female- headed households is presented in the Figure below. As displayed the gender gap is obvious where only 17% of households controlled any of the aforementioned principal agricultural assets were female-headed.

Figure 3.24: Percentage Distribution Gender of Household-Head among households with any principal agricultural assets (n=3626, ELMPS 2018)



Noteworthy, less than half (42.4%) of all the households that cultivate crops and/or raise livestock reported an income generated from these assets in the past 12 months, representing 1537 households (previously discussed in section 2.3.3.1.). In this section of the analysis, the prevalence of each agricultural resource among all households that reported any of the principal agricultural assets in the 2018 ELMPS dataset is presented. Similar to the above, the analysis will also show the main properties of the households and the main characteristics of the household head representing the autonomous agricultural worker.

Gender division of Supporting Agricultural Assets among Household That Reported Any Principal Agricultural Resources (Crops and Livestock), Regardless of Earnings

The supporting agricultural resources cited in the literature (FAO, 2011) are depicted in the table below.

1. **Agricultural Land**; By observing the difference in land size between the male-headed household and female-headed household among the households that reported any crops cultivated in the past 12 months or livestock production, the gender gap is significant (p-value =0.000). The average area of agricultural land cultivated by male-headed households was approximately 1 feddan, whereas the land cultivated by female-headed households was less than 1 feddan.
2. **Livestock**; in the sample the average TLU among male-headed households was 1.1 TLU, and that among female-headed households was 1 TLU; as such the difference was found to be statistically not significant (p-value =0.625).
3. **Agricultural tools and machinery**; a total of 24% of male-headed households own any agricultural tools and machinery, compared to only 13% of female-headed households. The gender gap was significant with regard to this resource (p-value =0.000).

4. **Labor**; this resource was estimated by the total number of family labors available in a household aged 15 and above. Approximately, 85% of male-headed households had 2 to 4 adults over 15 years of age, compared to 54% of female-headed households. The gender gap was significant with regard to this resource (p-value =0.000).
5. **Information and Extension**; this resource was estimated by whether any member in the household has access to online information. Unlike the above agricultural resource, the data shows the relative improved state of female-headed households compared to male-headed households. As 42% of female-headed households include at least one person that uses the internet on mobile phones, tablets, or computers were male-headed households, compared to only 31% of male-headed households. The gender gap was significant with regard to this resource (p-value =0.000).
6. **Financing**: This variable combined multiple financing sources: internal sources (household saving), formal external sources (loans from formal institutions), and informal external sources (borrowing and ROSCA). The data shows an improved state of female-headed households. Where 31% of female-headed households in the sample reported any financing resources in the past 12 months, compared to 24% of male-headed households. The gender gap was significant with regard to this resource (p-value =0.000).The most prevalent source of financing for female-headed households household savings (confirmed by 16%), and most of the external financing resources were informal; borrowing money from individuals (12%), and participated in one or more ROSCA (gam`iya(s)) (7%). On the other hand only 6% of male-headed households had any saving and 12% borrowed money from individuals. Although only 5% of all households have acquired a loans from a formal institution, the data shows relative domination of male-headed households in this regard; as approximately

6% of male-headed households have acquired a loan compared to only 2% of female-headed households. (observe Table C.26 in appendix Objective (C))

7. **Education**: While the correlation between low level of education and agricultural work is apparent, illiteracy was higher among female household heads compared to male ones (68% and 35% respectively). The gender gap was significant with regard to this resource (p-value =0.000).

Table 3.38: Supporting agricultural resources among households with any principal agricultural assets (n=3626, ELMPS 2018)

Categories		Male-headed HH	Female-headed HH	Total
Area of Agricultural Land Cultivated over 12 months (Feddan) *	Mean	0.9280	0.3523	0.8292
	Std. Deviation	3.11653	1.05727	2.87833
	Minimum	0.00	0.00	0.00
	Maximum	72.13	14.00	72.13
	Count	3004	622	3626
TLU of Livestock	Mean	1.1140	0.9892	1.0926
	Std. Deviation	3.72453	6.13856	4.23667
	Minimum	0.00	0.00	0.00
	Maximum	152.02	150.00	152.02
	Count	3004	622	3626
Variety of agricultural tools and machinery *	0	76.4%	87.3%	78.2%
	1	12.4%	7.7%	11.6%
	2	6.1%	2.9%	5.6%
	3+	5.2%	2.1%	4.6%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626
Total number adult labor in household (15 yrs +) *	0	0.1%	0.2%	0.1%
	1	1.1%	37.1%	7.3%
	2	49.4%	24.0%	45.1%
	3	19.7%	19.9%	19.7%
	4	15.7%	9.8%	14.7%
	5	9.1%	6.3%	8.6%
	6 +	4.9%	2.7%	4.5%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626
Internet *	Access to Internet	30.9%	42.0%	32.8%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626
Finance *	Access to Finance	24.1%	31.4%	25.3%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626
	Illiterate	34.9%	68.2%	40.6%

Education of Household head *	Less than intermediate	24.3%	13.8%	22.5%
	Intermediate/ Above Intermediate	32.6%	15.3%	29.7%
	University	8.1%	2.8%	7.2%
	Total %	100.0%	100.0%	100.0%
	Total count	2985	616	3601

* Significant difference observed between male-headed households and female-headed households using Chi-squared test of association (p-value <= 0.05)

Properties of Household with Principal Agricultural Assets (Crops and Livestock), Regardless of Earnings

The main properties of the households and the main characteristics of the household head are presented to depict the contextual premise of households that control any principal agricultural assets. The data does not show much variation among these households compared to those that reported any net earnings from the principal agricultural assets. As such, 12% of the male household heads were over 65 years of age, compared to 20% of female household heads. The majority of male household heads were married (98%). Whereas 33% of female household heads were married and 61% were widows. In terms of economic activity, 62% of female household heads reported agriculture, forestry or fishing as their main economic activity in the past 3 months (based on ISIC Revision-4 classifications), compared to 42% of male households heads.

Table 3.39: Demographic characteristics of household head among households with any principal agricultural assets (n=3626, ELMPS 2018)

		Male-headed HH	Female-headed HH	Total
Age of household head [1] *	15-19	0.2%	1.4%	0.4%
	20-29	8.8%	11.0%	9.2%
	30-39	26.1%	16.7%	24.5%
	40-49	23.5%	17.2%	22.4%
	50-59	21.3%	23.0%	21.6%
	60-64	8.5%	10.3%	8.8%
	65+	11.5%	20.3%	13.0%
	Total %	100.0%	100.0%	100.0%
	Total count	2999	621	3620
Marital status [2] *	Less than minimum age (15 yrs)*	0.2%	0.2%	0.2%

	Never married	0.4%	2.6%	0.7%
	Married	97.8%	33.2%	86.7%
	Divorced	0.2%	3.1%	0.7%
	Widowed(er)	1.5%	61.0%	11.7%
	Total %	100.0%	100.0%	100.0%
	Total count	2994	620	3614
Agro. Economic activity of prim. job based on ISIC4 in ref. 3-mnths [1] *	Agriculture, forestry and fishing	42.3%	61.7%	45.7%
	Not	57.7%	38.3%	54.3%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626

[1] 6 household heads were reported below 15 years-of-age thus recoded as missing cases
[2] 12 missing cases
* Significant difference observed between male-headed households and female-headed households using Chi-squared test of association (p-value <= 0.05)

The household structures of the sample that controls any of the principal agricultural assets was also very similar to those that generated any earnings (section 2.3.3.1.). Only less than 1% of male-headed households were single households, compared to 13% of female-headed households. Additionally, 57% of male-headed households comprise three to five members, compared to 46% of female-headed households. A third of male-headed households and female-headed households were in the poorest wealth quintile (31% and 34% respectively). Finally, agricultural labor is understandably more prevalent among rural residents regardless of gender of household head; where approximate 87% of male-headed households were in rural areas and 89% of female-headed households.

Table 3.40: Household Properties among households with any principal agricultural assets (n=3626, ELMPS 2018)

Categories		Male-headed HH	Female-headed HH	Total
Household size *	1	0.8%	19.0%	3.9%
	2	13.3%	19.6%	14.4%
	3	14.0%	18.8%	14.9%
	4	19.6%	14.0%	18.7%
	5	23.0%	12.9%	21.2%
	6	15.0%	6.8%	13.6%
	7+	14.2%	9.0%	13.3%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626
Quintiles of household wealth	Poorest	31.1%	33.6%	31.5%
	Poor	27.6%	26.2%	27.4%
	Middle	21.3%	20.4%	21.2%
	Rich	13.1%	12.7%	13.1%
	Richest	6.8%	7.1%	6.9%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626
Region *	Gr. Cairo	0.2%		0.2%
	Alx. Sz C.	0.2%	0.3%	0.2%
	Urb. Lwr.	4.1%	3.9%	4.0%
	Urb. Upp.	8.1%	7.1%	7.9%
	Rur. Lwr.	38.0%	26.2%	36.0%
	Rur. Upp.	49.4%	62.5%	51.6%
	Total %	100.0%	100.0%	100.0%
	Total count	3004	622	3626

* Significant difference observed between male-headed households and female-headed households using Chi-squared test of association (p-value <= 0.05)

In conclusion, the analysis under objective C has provided evidence to validate the key messages articulated in the 2011 FAO report; women can produce just as efficiently as men and the only difference is in their access to fundamental agricultural resources and inputs. Evidence to support the hypothesis that female household heads (proxy to autonomous women) working in agricultural production are able to produce just as efficiently as their male counterparts is exemplified in the statistically insignificant difference between their net earnings per unit (land

feddans and livestock TLU) generated from the principal agricultural assets. The average gap in agricultural productivity per unit was estimated at only 1057EGP. However, the gap in agricultural resources has limited the capacity of female-headed households to produce as much as male-headed households. Only 17% of households that controlled any of the aforementioned principal agricultural assets (crops and/or livestock) were female-headed. The most notable differences appear in the the average size of agricultural land; as that cultivated by male-headed households was almost twice that of female-headed households (2 feddans and 1.4 feddans respectively).

The analysis of the three analytical objectives presented in this chapter provides evidence to support most of the claims cited in the body of literature dedicated to the topic of gender equity in agriculture production in developing countries. Therefore, the evidence-based findings concluded from the analysis, reveal the unsustainability of Egypt's agriculture and food supply system. Despite the enormity of women's contribution to agricultural production; in the form of subsistence, labor, or production, they continue to be marginalized socially and economically. Egyptian women working in agriculture require political agency to support their access to fundamental resources in agricultural production and their visibility in agricultural development projects and policies.

4. Discussion

Sustainability is the act of protecting and maximizing the benefit for people, planet, and profit. This concept is otherwise known as the Triple Bottom Line (Arowoshegbe & Emmanuel, 2016), which is widely associated with Sustainable Development. This study is situated in the field of sustainable development in which enticing change for the prosperity of people, protection of the planet, and increasing profits is the aim. Although agriculture has always been a vital part of life, research has established that some agricultural activities and cultural norms tied to agricultural work have proven their unsustainability. In short, our current primary food production systems threaten our sustainability and prosperity of future generations. Thus, the importance of sustainable agriculture is undeniable, and the entanglement of gender-equity in agriculture production is a cornerstone of sustainable agriculture.

Empirical studies on agricultural development and gender equity conducted worldwide have unanimously concluded that policy interventions to close the gender gap in agricultural resources are required for sustainable agricultural development (Quisumbing, et al., 2014). While many governments are investing in their rural development (ILO, 2017), agricultural research and rural community development programs in Egypt have yet to grasp the central role of gender issues in agriculture. However, the main purpose of this thesis is not limited to promoting a feminist view of women's rights to agricultural autonomy, but seeks to present quantified evidence to substantiate the capacity of this major fragment of the population in increasing national agricultural production. Therefore, this thesis provides evidence of the significant -and often undermined contribution of women in agriculture as capable food producers and as a sustainable solution for agricultural production in Egypt.

The aim of the discussion chapter is to interpret the contribution of Egyptian women in agricultural production (described in the three analytical objectives) in light of what empirical literature has reached. This will provide insights about the problems agricultural development in Egypt has yet to address through evidence-based interpretation of the findings. The statistical analysis presented in Chapter 3 provides nationally representative evidence on the importance of Egyptian women's agricultural contribution to the wellbeing of their household's food security, agricultural labor sector, and agricultural productivity. This chapter will reflect on the key points deducted from the analysis of each of the three objectives used to conceptualize the contribution of Egyptian women in agriculture:

(A) Impact of female subsistence agriculture on rural household food security.

(B) Determining the gender profile of agriculture labor.

(C) Proxy to agriculture autonomy analyzing impact of household head gender on agricultural productivity and agricultural resources.

4.1. Objective (A): Impact of Female Subsistence Agriculture Labor on Rural Household Food Security

The analysis corroborates that subsistence agriculture was significantly more prevalent among the poorer rural households in Egypt. As household engagement in subsistence agriculture gradually decreases with the increase of wealth; dropping from approximately 42% of the households categorized under the poorest rural wealth quintile to a third of the wealthiest quintile (33%). Additionally, the data provides evidence to the importance of subsistence agriculture for households categorized as food insecurity, regardless of gender of subsistence laborers. As the percentage of food insecurity among households is higher among those engaged in any subsistence agriculture compared to those not engaged in any subsistence agriculture (32% and 28%

respectively). Therefore, the findings have substantiated that subsistence agriculture is particularly important among the most vulnerable wealth categories.

The literature has suggested that rural women are the main subsistence farmers in most developing countries. Although the analysis has validated this hypothesis within the Egyptian rural context; as the analysis shows that more women than men perform any subsistence agriculture task for their households, these women spend significantly less time in agricultural tasks than their male counterparts. Collectively rural females engaged in subsistence labor spend on average 3.44 hours a week (SD=9.45) on any subsistence agricultural labor, compared to 7.3 hours a week (SD=16.78) among rural males. In turn, rural women perform most of the domestic non-agricultural labor, and spend a significant amount of their time in these tasks. The analysis shows that rural females spend on average approximately 29 hours weekly (SD=23) in subsistence non-agricultural domestic tasks, while males spend only 4 hours weekly (SD=8). Therefore, the gender profile of subsistence agriculture and non-agriculture labor provides evidence on the constraints for productivity women face, in the form of unpaid household duties, taking them away from productive agricultural activities (Huyer, 2016). With regards to rural household food security, the analysis shows that the impact of female subsistence agricultural labor is double that of males. As the total number of hours in subsistence agriculture labor for all the women in the household increases by one hour per week, the odds of their household Food Security increases by 0.9% (1.009) - holding all other factors constant, which is double that of males (0.4%).

In summary, the above analysis provides sufficient evidence to deduce that rural women do have the capacity for food production. Rural women work longer hours than men in subsistence labor. The unpaid household duties that women shoulder limit their time for productive agricultural activities. Although more rural women are engaged in agricultural subsistence labor

tasks compared to men; rural men that confirm their involvement in any subsistence labor spend significantly more time agricultural subsistence than women. However, the impact of hours spent in subsistence agriculture by females in the household on the probability of their household's food security was higher than that of men.

4.2. Objective (B): Determining the Gender Profile of Agriculture Labor

The findings of the research provide evidence to the increased engagement of females in agricultural labor. Effectively substantiating the hypothesis that agriculture is, in fact, becoming increasingly feminized within the Egyptian context. The percentage of female agriculture economic activity (based on the ISIC-4 classifications) has increased from approximately 50% of agricultural labor in ELMPS 2012 to approximately 57% of agricultural labor in ELMPS 2018. However, despite the increase of female agricultural labor, the most notable finding of the research shows the persistent concentration of female agricultural labor as unpaid family agricultural workers (94% in 2012 and 94% in 2018). Whereas males in agricultural labor in 2018 were divided between irregular waged labors (30%), unpaid family workers (21%), and informal private waged (19%), and employers (18%). Moreover, the agricultural production of women and men appear to become more similar overtime; as 94% of men and 93% of women cultivated non-perennial crops in 2018. These findings substantiated the prevalence of biased patriarchy of agricultural work and the devaluation of women in agriculture.

The properties of male and female agricultural labor identified (based on the ISIC-4 classifications) further alludes to important changes in the agricultural sector. Regionally, rural Lower Egypt has witnessed a decline in agricultural labor, particularly among women in this region (from 49% of female agriculture labor in 2012 to only 35% in 2018). In turn the analysis

shows a notable increase of agricultural labor in rural Upper Egypt in 2018, particularly evident among female agriculture labor (from 37% of female agriculture labor in 2012 to 52% in 2018). As previously mentioned in the literature, women in agriculture are especially vulnerable to environmental changes and natural resources. Thus, these findings could allude to the environmental changes these regions have witnessed over the past few years, such as the notable increased urban sprawl particularly post-2011, mismanagement of natural resources, and increased salinity of agricultural land particularly in the Delta region (Hammam & Mohamed, 2020).

The findings of the research also show changes in the household structure of the individuals identified as agricultural labor. These changes may reflect the increased migration patterns of households affiliated with agricultural labor. The percentage of large households has decreased among both male and female agricultural labor; female agricultural labor with a household of 7 or more members has decreased from 25% in 2012 to 18% in 2018; and males with household of 7 or more members has dropped from 30% in 2012 to 18% in 2018. Additionally, inheriting agricultural work has decreased between generations in the household; as the percentage of sons/daughters (title in the household) working in agriculture has decreased between 2012 and 2018, this was particularly evident among sons (dropping form 35% of agricultural labor in 2012 to 29% in 2018). On the other hand, the percentage of female household heads working in agriculture has increased over time (9% of female agricultural labor in 2012 to 12% in 2018).

In terms of education level, most agricultural labor are illiterate or have acquired an intermediate level of education. However, illiteracy appears to be more prevalent among females than males (44% and 36% in 2018 respectively). Whereas, an intermediate level of education appears to be more prevalent among males than females (30% and 26% in 2018 respectively). This finding reflects the disposition of women engaged in agricultural work compared to their male

counterparts. Educational attainment for women in the labor force significantly impacts their earnings and standards of living, economic autonomy and agency, as well as non-professional prosperity in terms of marriage and fertility, health, nutrition, and overall well-being (Wodon, Montenegror, Nguyen, & Onago, 2018).

Therefore, the analysis provides evidence of the unsustainability of the current agricultural labor sector. Despite their continued marginalization, more and more women are working in agricultural production, and are exceeding the labor participation of men. The disposition of females in agricultural labor is particularly evident in their institutional labor affiliations and education. These imposing forces will undoubtedly impact the capacity of the food production systems to meet the demands of the Egyptian population.

4.3. Objective (C): Proxy to agriculture autonomy analyzing impact of household head gender on agricultural productivity and agricultural resources.

The analysis under Objective C has provided evidence to validate the key messages articulated in the 2011 FAO report: "The vast majority of this literature confirms that women are just as efficient as men and would achieve the same yields if they had equal access to productive resources and services." (FAO, 2011; p.40). While the ELMPS dataset used in the investigation of this claim did not support the ideal definition of agricultural autonomy; as the sampling unit for agricultural assets was the household not the individual, the agricultural resource gap between types of headship (as a proxy to autonomy) was undeniable. As presented in the analysis only 17% of households that controlled any of the principal assets for agricultural production (crops cultivated or livestock) in the 12 months reference period were female-headed.

Land is the most important resource for agriculture (FAO, 2011), as such it is listed under the indicators of the fifth Sustainable Development Goal "Indicator 5A.1: (a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; (b) share of women among owners or rights-bearers of agricultural land, by type of tenure." (UN, 2015). Additionally, it is widely regarded as the most valued tie to Egyptian rural livelihoods. The gap between male-headed households and female ones in the total area of agricultural cultivated land was particularly obvious; as the average area of agricultural land cultivated by male-headed households was almost twice that of female-headed households (2 feddans and 1.4 feddans respectively). While livestock TLU did not show a substantial gap between male-headed households and female ones (1.2 and 1.1 respectively), the gender gap was evident and statistically significant in other agricultural resources. Male-headed households that operated any of the principal agricultural assets (crops and livestock) had access to any agricultural tools and machinery more than female-headed households (24% and 13% respectively). Male-headed households had more adult labor available in their households compared to female-headed households. Male household heads were better educated than their female counterparts. (Observe Chapter 4: Table 19).

On the other hand, female-headed households were able to mobilize other resources. The most notable finding in this regard was their access to informal financing. Female-headed households that controlled any of the principal agricultural assets were significantly better than their male counterparts in household savings and accessing informal external financing sources. Whereas male-headed households were comparatively better than female-headed households in acquiring loans from formal institutions. Additionally, 62% of female household heads reported agriculture,

forestry or fishing as their main economic activity in the past 3 months (based on ISIC Revision-4 classifications), compared to 42% of male household heads.

Finally, the most substantial finding of the study shows that despite the evidence of disparity in agricultural resources (in favor of male-headed households), female-headed households were able to produce just as efficiently as male-headed households. In other words, the estimated yield gap between male-headed households and female-headed households generated from the principal agricultural assets was found to be not significant. The evidence to support this finding is exemplified in the statistically insignificant difference between their net earnings per unit (land feddans and livestock TLU) generated from the principal agricultural assets. The average gap in agricultural productivity per unit was estimated at only 1057EGP. In short, the 2018 ELMPS data has substantiated that autonomous women working in agriculture can produce just as efficiently as men, and the only difference is in their access to fundamental agricultural resources and inputs.

To summarize the discussion above, despite the enormity of women's contribution to agricultural production; in the form of subsistence, labor, or production, they continue to be marginalized socially, economically, and politically. Egyptian women working in agriculture lack agency to support their access to fundamental resources in agricultural production, such as land, education, and formal financial loans. However, despite their disposition, the findings show the substantial capacity of Egyptian women working in agriculture. Whether in the form of subsistence agriculture for their household needs, or as part of the agricultural labor force, or as autonomous food producers with their own agricultural assets, women's performance in agriculture is just as efficient as men despite their comparative disposition and limitations in access to fundamental resources. Hence, investing in agricultural autonomy of Egyptian women, is in fact an important pillar central to the sustainability of the agriculture sector in Egypt.

5. Conclusion

The definition of Sustainable Development encompasses political, economic, and social directions for global progression "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Sustainable Development requires understanding the intertwining nature of the many issues and crises the global populace faces. The commonality of the issues we face was emphasized in the title of the United Nations' Report (1987) "The World Commission on Environment and Development: Our Common Future," which laid the groundwork for the international recognition of the concept of sustainability. This understanding of sustainability is particularly evident in the study of gender in agriculture. As the inequity many women working in agriculture face has resulted in the underperformance of agriculture production systems. The ripple effect of the marginalization of women in agriculture, centers on limiting women's economic and social autonomy, and reaches up to the unsustainability of national agriculture and food production systems (FAO, 2011). The agency of this topic was underlined by development-scholars when setting 2030 Agenda for Sustainable Development (UN, 2015). The 2030 Sustainable Development Goals (SDG) positions gender equity in economic development at the forefront of achieving sustainable development. The fifth goal "SDG 5: Gender equality and empower all women and girls" sets multiple targets promoting gender-equity to promote effective labor market participation, as well as opportunities for financial independence and prosperity. The topic of this thesis was specified in target 5.A "Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws" (UN, 2015).

However, the reality is women working in agriculture are particularly susceptible to the implications of climate change as they are heavily reliant on local natural resources for their livelihood (UNDP, 2019). Moreover, the gender-bias constraints the limit of women's control over resources such as land and credit, mobility, secure housing and freedom from violence (Brody, Demetriades, & Esplen, 2008). Nonetheless, one of the key messages of the 2019 Human Development Report highlight the need for more focus on the role female agricultures in natural resource management in sustainability policies and projects as "women are powerful agents of change" (UNDP, 2019).

The main argument of this thesis is not limited to a feminist view of women's rights to agricultural autonomy, but seeks to provide evidence of the capacity of this major fragment of the population has in increasing national agricultural production. Studies to demonstrate how the gender gap limits agricultural productivity bears on the contributions women make in agriculture. Hence, this chapter will present the main forms of agricultural contribution women make and the constraints they face, surveyed in the body of literature. Secondly, this chapter will highlight the lack of adequate focus on gender-equity in Egyptian national agendas for agriculture and development. Subsequently, the implications of the findings will be presented in the forms of recommendations to support gender-inclusive approaches for agricultural development, as a fundamental step towards sustainable agriculture. The limitations of the study will be presented to provide a critical appraisal of the findings interpretation. These limitations are primarily centered on the unavailability of detailed data on individual agricultural production, rather than household-level data. Finally, suggestions for further research in the topic of gender-equity in agricultural production will be discussed

5.1. Agricultural contribution of women in the literature

Patriarchy is a strong feature of agricultural work in developing countries, as is the patrilineal property and resources (Brody, Demetriades, & Esplen, 2008). Historically, evidence of the gendered struggle in agriculture production in developing countries can be traced to the commercialization of the agricultural sector in colonial times. In the colonial era land reforms were imposed based on European belief that cultivation was properly men's work. Hence, not only were the third-world colonies forced to produce commercial crops instead of food for national consumption and household subsistence, women were excluded from agriculture education and technical assistance on modern farming systems (Beneria & Sen, 1981; Boserup, 1970).

Nonetheless, the contributions of women in agriculture labor and food production are undeniable, despite their consistent confinement by colonists and in modern times by developers, to a gendered division of labor based on women's subordination to men. Women's agricultural labor is often in the form of unpaid labor to assist the household in the cultivation of commercial cash-crops or subsistence agriculture for their family needs. Therefore, women's agriculture activities are largely underestimated in labor force statistics; due to the fact that women are less likely to define their activities as agricultural work despite working longer hours than men (FAO, 2011). However, the analysis has validated that to this day women continue to support the autonomy of their households by taking on much of the subsistence farming. This highlights the strategic importance of rural women's access to land and agricultural resources for their communities, and the capitalist schemes of companies and governments by 'liberating' male labor (Federici, 2004). Constraints for productivity include the unpaid household duties that women shoulder; such as child care, and fetching fuelwood and water, taking them away from income-generating activities (Huyer, 2016).

Closing the gender gap in agriculture refers to women owning and controlling productive agricultural assets and resources (Quisumbing, et al., 2014). Empowerment in agriculture is synonymous with one's autonomy in making decisions related to agriculture and access to the inputs, material, and social resources required to carry out those decisions (Alkire et al., 2013). An empowered female in agriculture has access to needed inputs and resources, is able to make decisions on crops to cultivate on her plot and will be more productive in agriculture. An empowered and autonomous woman will also be able to ensure the health and well-being of her children, her community, and herself (Quisumbing, et al., 2014). Additionally, the 2011 edition of 'The State of Food and Agriculture 2010–11, Women in agriculture: Closing the gender gap for development' has deduced from the global analysis of women and men in agricultural farming systems in developing countries, that women farmers are just as good at farming as their male counterparts, however the gap in yield[24] is almost entirely due to differences in input quality and resources. Bringing yields would increase national agricultural output in developing countries between 2.5-4%[25], which could reduce the number of undernourished people in the world by 12–17% (FAO, 2011).

5.2. National Commitment

Developing agricultural areas and supporting agro-industry is one of the programs and projects for economic development set in the Egyptian Sustainable Development Strategy: Egypt Vision 2030 (Egypt Cabinet of Ministers, 2016) However, the lack of evidence to substantiate the

[24] The 2011 FAO report is based on a number of studies measuring productivity in a variety of ways, but the most common method is based on output per hectare of land, or yield.

[25] Based on calculations of women agricultural holders for 52 countries.

potential of closing the gender gap in agriculture particular to the Egyptian context has resulted in the inadequate implementation of gender-equity in agricultural development programs.

The Sustainable Agriculture Development Strategy (SADS) recognized the importance of strengthening the role of women in agricultural development through public campaigns, consolidating relevant entities, and stimulating institutional support. However, the sole national program particular to women proposed to achieve these objectives in the SADS appears less focused on agriculture production, rather centered on improving rural living conditions of rural women and their participation in the different activities (MALR, 2009).

In the National Strategy for the Empowerment of Egyptian Women 2030, under the economic empowerment pillar of the strategy, the vulnerability of rural women is expressed as their need for social insurance and income security. The strategy also emphasizes the role of women in agriculture in coping with environmental risks and climate change through promoting sustainable management of natural resources and organic agriculture (NCW, 2017).

5.3. Findings, Implication and Recommendations

The assessment of the contribution of Egyptian women in agricultural production has been conceptualized into three main form; subsistence agriculture, agricultural labor, and autonomous agriculture producers. Each form of agricultural contribution was addressed in the three analytical objectives respectively:

(A) Impact of female subsistence agriculture on rural household food security.

(B) Determining the gender profile of agriculture labor.

(C) Proxy to agriculture autonomy analyzing impact of household head gender on agricultural productivity and agricultural resources.

Objective (A) utilizes both descriptive and inferential analysis to assess the real impact of female subsistence agriculture in rural areas on their household's food security. The descriptive analysis for Objective (A) reveals that although more females in rural areas are engaged in subsistence agricultural labor (as well as non-agricultural), males that do preform any subsistence agricultural labor spend significantly more time. Whereas the inferential analysis reveals that the total number of hours females in a household spend in subsistence agriculture significantly increases the probability of household food security, moreover their impact was double that of males. This was identified through the logistic regression of household food security on determinates of household food security (Drammeh, Hamid, & Rohana, 2019; FAO, 2008).

Objective (B) provides evidence that agricultural labor is becoming increasingly feminized within the Egyptian context. This objective was studied by comparing descriptive analysis of agricultural labor in 2012 and 2018. Agricultural labor is identified as all those categorized under agriculture, forestry, and fishing economic activity based on the ISIC-4 classification (UN, 2008). The percentage of females in formal or informal agricultural labor has increased over the examined time periods; from approximately 50% of agricultural labor in 2012 to approximately 57% of agricultural labor in 2018. Whereas the agricultural production of women and men is becoming more similar overtime (with 94% of men and 93% of women is non-perennial crops in 2018), the analysis also indicates the continued institutional disposition of females in agricultural labor. This is exemplified in the unchanged concentration of unpaid family workers among female agricultural labor in 2012 and 2018; 94% in 2012 and 94% in 2018.

Objective (C) has provided evidence to validate the key messages articulated in the 2011 FAO report; women can produce just as efficiently as men and the only difference is in their access to fundamental agricultural resources and inputs. This objective relies on inferential analysis to

measure significance of gap between female-headed households head (proxy to autonomous women) and male-headed households in agricultural productivity (yield gap). Descriptive statistics were used to identify whether there exist a significant difference in essential agricultural inputs (resource gap). As for the yield gap, the difference in the net earnings per unit (land feddans and livestock TLU) generated from the principal agricultural assets was not statistically significate. The average gap in agricultural productivity per unit was estimated at only 1057EGP. However, the gap in agricultural resources has limited the capacity of female-headed households to produce as much as male-headed households. Only 17% of households that controlled any of the aforementioned principal agricultural assets (crops and/or livestock) were female-headed. The most notable differences appear in the average size of agricultural land; as that cultivated by male-headed households was almost twice that of female-headed households (2 feddans and 1.4 feddans respectively).

The findings of this study has substantiated that autonomous women working in agriculture can produce just as efficiently as men, and the only difference is in their access to fundamental agricultural resources and inputs. Hence, directing public investment from governments, civil society, the private sector, and individuals to support gender equality in agricultural and rural areas is good for agriculture, food security and society (FAO, 2011). Despite the national recognition of the importance of Egyptian women working in agriculture, reiterated in national government strategies, women working in agriculture lack support for their access to fundamental resources in agricultural production, such as land, education, and formal financial loans. The implantation of gender-equity in sustainable agricultural development entails applying basic principles for an integrated, long-term and multi-stakeholder approach:

- **Eliminate Discrimination against Women in Legislation and Regulations:** Given evidence provided in this study about the inequities women face in agriculture, gender-neutral policies and laws are not sufficient. Institutional reforms aimed at eliminating discrimination and promoting equitable access to productive resources will enable women –and men- to achieve their full potential (FAO, 2011).
- **Planning and Designing Gender Sensitive Interventions**: Many of the constraints women face are social; as it is very difficult to separate women's economic activities from her household responsibilities and role in the community. Gender-constraints are reflections of the power dynamic within a household or community. The broader social contexts undoubtedly affect her ability for productive economic engagement in any sector, particularly in the agricultural sector in which patriarchy is a strong feature. Some literature has suggested building interventions and programs that include men in the process to ensure that gender equality is broadly beneficial and sustainable (FAO, 2011).

- **Mobilizing Locality by Strengthening Gender-Inclusive Rural Institutions**: Strong rural institutions are essential for national sustainable development. However, Egyptian women lack sufficient visibility in formal decision-making structures (Bush, 2004). Hence, efforts are needed to ensure equal representation for both women and men working in agriculture. Extension service providers that operate in agricultural production or in rural areas, such as agriculture extension services, veterinarian services, and microfinance organizations, must service the different needs of men and women to ensure that they are equally advantaged.
- **Interdependency of Basic Infrastructure and Public Service:** Investments in basic infrastructure for essential public services can liberate women from time consuming drudgery; such as fetching water and processing food by hand. Additionally, investing in women and girls' access to quality public service, such as general education and health services will build

their capacity. This will generate better agriculture producers and higher yields. The expected environmental challenges the agricultural terrain will face in the near future requires an educated farmer able to retain information and facilitate the transfer of knowledge and practical skills.

- **Monitoring Progress by Improving Sex-Disaggregated Agricultural Data:** Improving gender-equity starts with understanding the prevailing issues women face in agricultural production. Thus, the collection and analysis of sex-disaggregated data on crop cultivation, livestock, fisheries and other forms of agricultural production, is essential to the development process. Additionally, gender-biased concepts and definitions should be put into consideration when collecting sex-disaggregated data collection; such as data on ownership and control over productive resources such as land, and information on credit collateral and control.

5.4. Study Limitations

Generally, the scarcity of updated agriculture data disaggregated by gender has hindered regional estimates on the autonomy of females in agriculture (FAO, 2011). While household surveys are widely used in many research areas, the unitary model of the household renders the role of women in male-headed households invisible to the overall measure of women's contribution. Ideally, studies to measure the gender gap in agriculture should survey plot-specific ownership variables rather than household-level data. Additionally, patriarchy is highly prevalent in Egypt, thus the respondents tend to cite the oldest male in the household as the household head, as a sign of respect or in adherence to the customary conservative culture, regardless of their actual role within the household. This is particularly common in rural areas well known for their conservative cultures. Hence, this suggests that despite the positive findings, the real contribution of women in agriculture might be underestimated in the analysis concluded in this study.

The time frame dedicated to carrying out this study was during the global COVID-19 pandemic, thus the researcher was unable to conduct qualitative surveys during the timeframe allocated for research. Measuring the gender gap in agriculture requires a mixed-method approach, utilizing different information and data beyond quantitative indicators typically gathered in qualitative household surveys. Quantitative data in agriculture is also required to move beyond the unitary models of households and to divulge into the individual rather than just the household or the farm (Alderman et al., 1995).

An additional criteria to accurately measure of impact on sustainability of household food security would require looking in the longitudinal changes over time. Hence, it would have been interesting to utilize the quantitative panel survey data to observe the impact of subsistence agriculture labor on household food security over time.

5.5. Direction for Further Research

Research dedicated to the topic of women autonomy in agriculture has suggested considering both relative and absolute levels of power for women. In other words, assessing the extent to which women can take control over critical parts of their life, households, communities and the wider economy. The Women's Empowerment in Agriculture Index (WEAI) is an inclusive and standardized measure to directly estimate and quantify women's empowerment in rural areas. Whether they are working as farmers, wage workers, or engaged in non- agricultural businesses (Alkire, et al., 2013). The index was jointly developed by the United States Agency for International Development (USAID), International Food Policy Research Institute (IFPRI), and Oxford Poverty and Human Development Initiative (OPHI). WEAI is a survey-based index reported at the national or regional level. The computations are based on individual-level data collected from men and women within the same households. It seeks to identify the obstacles women face in agriculture, track gender equity and measure empowerment,

agency, and women's inclusion in the agricultural sector (IFPRI, 2020). The WEAI is composed of two sub-indices. The first measures women's control over five specific domains of empowerment, namely, control over Production, Income, Resources, Leadership, and Time. The other measures the intra-household Gender Parity Index by comparing gender inequity and empowerment gap between the primary male and female in each household (Alkire, et al., 2013).

Another area of interest would be to trace the importance of female and male subsistence agriculture labor on the 'Stability' of rural household food security. The 'Stability' component pertains to the consistency of the other three dimensions of food security over time; Availability, Accessibility, and Utilization (FAO, 2008). Under the 'Stability' component, one is considered food insecure even if food intake is adequate today, but inadequate on a periodic basis, thus risking nutritional and health deterioration. Hence, adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) can be detrimental to food security. Thus, 'Stability' reflects the continuity and sustainability of household food security. Ideally, this component would require longitudinal panel analysis which traces the changes in behaviors of the sampling units over time. Another interesting area of research pertaining to the topic of household food security, would be to identify the controlled impact of male and female subsistence agriculture labor on the four categories of household food security (Sever, Mild, Moderate, and Secure) simultaneously. In this thesis the categories of household food security were regrouped into a dichotomous variable in order to focus the discussion on the importance of female subsistence labor, as such a binary logistic model was employed. However, simultaneous analysis of the four categories of household food security would require an ordinal logistic regression to predict the ordinal dependent variable given the listed determinates of household food security.

In conclusion, this thesis is not limited to a feminist view for women's rights to agricultural autonomy, but seeks to provide evidence of the capacity women have in increasing national agricultural production. Whether in the form of subsistence agriculture for their household needs, or as part of the agricultural labor force, or as autonomous food producers with their own agricultural assets, women's performance in agriculture is just as efficient as men despite their comparative disposition and limitations in access to fundamental resources. It is obvious that bridging the gender gap in any economic sector would be beneficial for nation sustainability. The evidence of the increasing female contribution in the agricultural sector confirms the detrimental impact of their continued marginalization on their households, communities, and a national economy. In short, the gender gap limits agricultural productivity, economic development and human well-being, effectively the main pillars of sustainable development. Egyptian national government strategies and frameworks recognize the importance of women in agriculture, but lack practical implementation. Hence, investing in agricultural autonomy of Egyptian women, is in fact an important pillar central to the sustainability of the agriculture sector in Egypt.

6. References

Alderman, H., Chiappori, P.A., Haddad, L., Hoddinott, J., Kanbur, R. (1995). Unitary Versus Collective Models Of The Household: Is It Time To Shift The Burden Of Proof? *The World Bank Research Observer*, Volume 10, Issue 1, 1:19, https://doi.org/10.1093/wbro/10.1.1

Akter, S., Rutsaert, P., Luis, J., Htwe, N. M., San, S. S., Raharjo, B., & Pustika, A. (2017). Women's empowerment and gender equity in agriculture: A different perspective from Southeast Asia. *Food Policy 69*, 270–279.

Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., & Vaz, A. (2013). The Women's Empowerment in Agriculture Index. *World Development Vol. 52*, 71-91.

Arowoshegbe, A. O., & Emmanuel, U. (2016). Sustainability And Triple Bottom Line: An Overview Of Two Interrelated Concepts. *Igbinedion University Journal of Accounting, Vol. 2*, 88-126.

Asian Development Bank (ADB) and Food and Agriculture Organization (FAO). (2013). *Gender Equality and Food Security Women's Empowerment as a Tool against Hunger*. Mandaluyong City, Philippines. Asian Development Bank

Behrman, J. A., Meinzen-Dick, R., & Quisumbing, A. R. (2014). Chapter 2: Understanding Gender and Culture in Agriculture: The Role of Qualitative and Quantitative Approaches. In A. R. Quisumbing, R. Meinzen-Dick, T. L. Raney, A. Croppenstedt, J. A. Behrman, & A. Peterman, *Gender in Agriculture: Closing the Gender Gap* (pp. 31-54). Dordrecht: The Food and Agriculture Organization of the United Nations, Springer Science + Business Media B.V.

Beneria, L., & Sen, G. (1981). Accumulation, Reproduction, and "Women's Role in Economic Development": Boserup Revisited. *Signs: Journal of Women in Culture and Society, Vol. 7, No. 2, Development and the Sexual Division of Labor,The University of Chicago Press*, 279-298.

Boserup, E. (1970). *Woman's Role in Economic Development.* London: George Allen & Unwin.

Britannica, E. o. (2020, 3 22). *Subsistence farming*. Retrieved from Encyclopaedia Britannica: https://www.britannica.com/topic/enclosure

Brody, A., Demetriades, J., & Esplen, E. (2008). *Gender and Climate Change: Mapping the Linkages – A Scoping Study on Knowledge and Gaps.* Brighton: BRIDGE, Institute of Development Studies.

Bruni, M. (2017). *Egypt Labour Market Report: Demographic Trends, Labour Market Evolution and Scenarios for the Period 2015–2030.* Cairo: International Organization for Migration, Central Agency for Public Mobilization and Statistics.

Brundtland, G. (1987). *Report of the World Commission on Environment and Development: Our Common Future.* United Nations General Assembly document A/42/427.

Bush, R. (2004). *Civil Society and the Uncivil State Land Tenure Reform in Egypt and the Crisis of Rural Livelihoods.* United Nations Research Institute for Social Development (UNRISD).

Central Agency for Public Mobilization and Statistics (CAPMAS). (2016). *Egypt 2015 Labor Statistics - Aggregated Bulletin 2000-2015 (Arabic).* Central Agency for Public Mobilization and Statistics (CAPMS).

Central Agency for Public Mobilization and Statistics (CAPMAS). (2016). *Egypt 2015 Labor Statistics - Annual Aggregated Bulletin (Arabic).* Central Agency for Public Mobilization and Statistics (CAPMS).

Central Agency for Public Mobilization and Statistics (CAPMAS). (2016). *Egypt 2015 Labor Statistics - Press release April, 2016 (Arabic).* Central Agency for Public Mobilization and Statistics (CAPMS).

Central Agency for Public Mobilization and Statistics (CAPMAS). (2018). *Quarterly (Q4 2017) labour force survey report (Arabic)*. Cairo, Egypt: Central Agency for Public Mobilization and Statistics (CAPMS).

Consultative Group on International Agricultural Research (CGIAR). (2020). *System Annual Performance Report 2019: Summarized Report*. The Gender and Agriculture Research Network of the Consultative Group of International Agricultural Research (CGIAR) System Organization: Montpellier, France.

Coates, J., Swindale, A., & Bilinsky, P. (2007). Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide VERSION 3. Washington: Food and Nutrition Technical Assistance Project (FANTA).

Doss, C., Meinzen-Dick, R., Quisumbing, A., & Theis, S. (2018). Women in agriculture: Four myths. Global Food Security 16, 69–74.

Doss, C. (2014). Chapter 3: Data Needs for Gender Analysis in Agriculture. In Gender in Agriculture closing the knowledge gap (p. 55-68). Dordrecht: The Food and Agriculture Organization of the United Nations and Springer Science + Business Media B.V.

Drammeh, W., Hamid, N., & Rohana, A. (2019). Determinants of Household Food Insecurity and Its Association with Child Malnutrition in Sub-Saharan Africa: A Review of the Literature. *Current Research in Nutrition and Food Science Vol. 7(3)*, 610-623.

Egypt Cabinet of Ministers. (2016). *Sustainable Development Strategy (SDS): Egypt Vision 2030.*

FAO. (2008). *Food Security Information for Action Practical Guides: An Introduction to the Basic Concepts of Food Security.* European Union Food Security Programme.

FAO. (2011). *The State of Food and Agriculture; Women in Agriculture, closing the gender gap* . Rome: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS.

FAO. (2019). *Main results and metadata by country (2006–2015). World Programme for the Census of Agriculture 2010.* FAO Statistical, Development Series No. 17. Rome.

FAO. (2020). *Gender-related agricultural statistics: problems and significant activities.* Retrieved from FAO: http://www.fao.org/3/x2785e/X2785e09.htm

Farnworth, C. R. (2010). *Gender Aware Approaches in Agricultural Programmes: A Study of Sida-supported Agricultural Programmes.* Stockholm: Sida Evaluation, Swedish International Development Cooperation Agency, Department for Economic Opportunities, Team for Agriculture, Forestry.

Fávero, L. P., & Belfiore, P. (2019). Chapter 13: Simple and Multiple Regression Models. In L. P. Fávero, & P. Belfiore, *Data Science for Business and Decision Making.* (pp. 443-538). Academic Press.

Fávero, L. P., & Belfiore, P. (2019). Chapter 14: Binary andMultinomial Logistic Regression Models. In L. P. Fávero, & P. Belfiore, *Data Science for Business and Decision Making.* (pp. 539-615). Academic Press.

Federici, S. (2004). Women, Land-Struggles and Globalization: An International Perspective. *Journal of Asian and African Studies*, 39-47.

Grabska, K. (2013). The Return of Displaced Nuer in Southern Sudan Women Becoming Men? *Development and Change 44(5), International Institute of Social Studies*, 1135–1157.

Hammam, A. A., & Mohamed, E. S. (2020). Mapping soil salinity in the East Nile Delta using several methodological approaches of salinity assessment. *The Egyptian Journal of Remote Sensing and Space Science, Volume 23, Issue 2*, 125-131.

Huyer, S. (2016). Closing the Gender Gap in Agriculture. *Gender, Technology and Development 20(2)*, 105-116.

International Food Policy Research Institute (IFPRI). (2020, June 22). About WEAI. Retrieved from WEAI: http://weai.ifpri.info/about-weai/

International Labor Organization (ILO). (2017). Outcome 5: Decent work in the rural economy. *329th Session, 9–24 March.* Geneva

Kassim, Y., Mahmoud, M., Kurdi, S., & Breisinger, C. (2018). *An Agricultural Policy Review of Egypt: First Steps Towards a New Strategy*. Cairo: International Food Policy Research Institute (IFPRI).

Krafft, C., Assaad, R., & Wahe, K. (2019). *Introducing the Egypt Labor Market Panel Survey 2018; Working Paper No. 1360.* Giza: The Economic Research Forum (ERF).

Krall, S. (2015). *What is sustainable agriculture?* Bonn and Eschborn, Germany: Federal Ministry for Economic Cooperation and Development (BMZ) Division Rural Development and Global Food Security, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

MDG monitor. (2016, November 15). *MDG 3: Promote gender equality and empower women*. Retrieved from Millennium Development Goals monitor:

Ministry of Agriculture and Land Reclamation (MALR). (1999). *The Seventh Agricultural Census In Egypt 1999/2000*. Ministry of Agriculture and Land Reclamation (MALR) of Arab Republic of Egypt, Economic Affairs Sector, Central Administration for Agricultural Economics, General Department of Agricultural Census

Ministry of Agriculture and Land Reclamation (MALR). (2009). *The Eighth Agricultural Census In Egypt 2009/2010*. Ministry of Agriculture and Land Reclamation (MALR) of Arab Republic of Egypt, Economic Affairs Sector, Central Administration for Agricultural Economics, General Department of Agricultural Census

Ministry of Agriculture and Land Reclamation (MALR). (2009). *The Sustainable Agriculture Development Strategy Towards 2030*. Ministry of Agriculture and Land Reclamation (MALR) of Arab Republic of Egypt, Cairo

Mitchell, T., Tanner, T., & Lussier, K. (2007). *We know what we need; South Asian women speak out on climate change adaptation.* London: Action Aid International and the Institute of Development Studies (IDS).

National Council for Women (NCW). (2017). *National Strategy for the Empowerment of Egyptian Women 2030: Vision and Pillars.* First edition, March 2017

Peden, D., Freeman, A., Astatke, A., & Notenbaert , A. (2006). *Investment options for integrated water-livestockcrop production in sub-Saharan Africa*. International Livestock Research Institute, ISBN 92-9146-183-0.

Pentland, W. E., Harvey, A. S., Lawton, M. P., & McColl, M. (2002). *Time Use Research in the.* Kluwer Academic Publishers.

Peterman, A., Quisumbing, A., Behrman, J., & Nkonya, E. (2010). Understanding Gender Differences in Agricultural Productivity in Uganda and Nigeria. *International Food Policy Research Institute (IFPRI).*

Project INDDEX. (2018). *Data4Diets: Building Blocks for Diet-related Food Security Analysis.* Retrieved from Tufts University, Boston, MA: https://inddex.nutrition.tufts.edu/data4diets. Accessed on 15 September 2020.

Quisumbing, A. R., Meinzen-Dick, R., Raney, T. L., Croppenstedt, A., Behrman, J. A., & Peterman, A. (2014). *Gender in Agriculture: Closing the Knowledge Gap. Chapter 1: Closing the Knowledge Gap on Gender in Agriculture.* Dordrecht: The Food and Agriculture Organization of the United Nations and Springer Science + Business Media B.V.

Siegle, D. (2002). Educational Research Basics: An Introduction to t tests. Retrieved from University of Connecticut - Neag School of Education: https://researchbasics.education.uconn.edu/t-test/#

Sieverding , M., & Hassan, R. (2019). Associations Between Economic Vulnerability And Health And Wellbeing In Egypt; Working Paper No. 1364. Giza: The Economic Research Forum (ERF).

Solutions, S. (2020, September 29). Pearson's Correlation Coefficient. Retrieved from Statistics Solutions: https://www.statisticssolutions.com/pearsons-correlation-coefficient/

Thukral, E. G. (1996). Development, Displacement and Rehabilitation Locating Gender. *Economic and Political Weekly, Vol. 31, No. 24 (June 15, 1996),* 1500-153.

United Nations Development Program (UNDP). (2019). *Human Development Report 2019; beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century.* New York: United Nations Development Programme.

United Nations General Assembly. (2015). *Transforming Our World: the 2030 Agenda for Sustainable Development*, 21 October 2015, A/RES/70/1, available at: https://www.refworld.org/docid/57b6e3e44.html [accessed 29 September 2020]

United Nations (2008). *International Standard Industrial Classification of All Economic Activities Series M No. 4/Rev.4*. New York: Department of Economic and Social Affairs, Statistics Division. https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf.

Verschuur, C. (2019). From the Centre to the Margins and Back Again: Women in Agriculture at the ILO. *International Development Policy | Revue internationale de politique de développement, 11*, 152-176, https://doi.org/10.4000/poldev.3068.

Wodon, Q., Montenegror, C., Nguyen, H., & Onago, A. (2018). *Missed Opportunities: The High Cost of Not Educating Girls. The Cost of Not Educating Girls Notes Series.* Washington, DC: The World Bank.

World Bank. (2014). Program-For-Results Information Document (PID) Concept Stage, Report No.: 91426. Finance for Rural Egypt Program. Middle East and North Africa, Egypt.

Secondary Datasets:

Economic Research Forum and Central Agency For Public Mobilization & Statistics (CAPMAS), Egypt labor Market Panel Survey, ELMPS (2018), Version 2.0 of the Licensed data files (October, 2019), provided by the Economic Research Forum. http://www.erfdataportal.com/index.php/catalog

Economic Research Forum and Central Agency For Public Mobilization & Statistics (CAPMAS), Egypt labor Market Panel Survey, ELMPS (2012), Version 3.0 of the Licensed data files (November, 2013), provided by the Economic Research Forum. http://www.erfdataportal.com/index.php/catalog

7. Appendices

Appendix Objective (A)

Table A.41: Correlation Matrix between determinants of household food insecurity (independent variables)

		Rural HH Wealth	Sustin Agro females in HH	Sustin Agro males in HH	Total hr/week Sustin Agro females in HH	Total hr/week Sustin Agro males in HH	Sustin Non-Agro females in HH	Sustin Non-Agro males in HH	Total hr/week Sustin Non-Agro females in HH	Total hr/week Sustin Non-Agro male in HH	HH size	Total in HH in Labor Age	Total in males HH in Labor Age	Total in females HH in Labor Age	Sex of HHH	Age of HHH	Educ gr. of HHH
Rural HH Wealth	Pearson Correlation	1	-.069**	-.048**	-.055**	-.042**	-0.013	.023*	.078**	0.003	-0.005	0.002	-0.01	0.015	-.055**	-.200**	.403**
	Sig. (2-tailed)		0	0	0	0	0.191	0.027	0	0.762	0.647	0.809	0.339	0.139	0	0	0
	N		9613	9613	9613	9613	9613	9613	9613	9613	9613	9613	9613	9613	9613	9601	9513
Sustin Agro females in HH	Pearson Correlation		1	.333**	.499**	.245**	.394**	.127**	.219**	.066**	.260**	.288**	.181**	.292**	0.006	.099**	-.117**
	Sig. (2-tailed)			0	0	0	0	0	0	0	0	0	0	0	0.539	0	0
	N			9735	9735	9735	9735	9735	9735	9735	9735	9735	9735	9735	9735	9723	9633
Sustin Agro males in HH	Pearson Correlation			1	.316**	.738**	.160**	.181**	.131**	.124**	.188**	.207**	.216**	.113**	-.098**	.097**	-.094**
	Sig. (2-tailed)				0	0	0	0	0	0	0	0	0	0	0	0	0
	N				9735	9735	9735	9735	9735	9735	9735	9735	9735	9735	9735	9723	9633
Total hr/week Sustin Agro females in HH	Pearson Correlation				1	.389**	.198**	.043**	.238**	.054**	.196**	.202**	.136**	.194**	-0.016	.038**	-.078**
	Sig. (2-tailed)					0	0	0	0	0	0	0	0	0	0.125	0	0
	N					9735	9735	9735	9735	9735	9735	9735	9735	9735	9735	9723	9633
Total hr/week Sustin Agro males in HH	Pearson Correlation					1	.128**	.074**	.132**	.067**	.160**	.175**	.171**	.109**	-.070**	.038**	-.074**
	Sig. (2-tailed)						0	0	0	0	0	0	0	0	0	0	0
	N						9735	9735	9735	9735	9735	9735	9735	9735	9735	9723	9633
Sustin Non-Agro females in HH	Pearson Correlation						1	.184**	.437**	.065**	.531**	.563**	.267**	.667**	-0.013	.068**	-.021*
	Sig. (2-tailed)							0	0	0	0	0	0	0	0.187	0	0.036
	N							9735	9735	9735	9735	9735	9735	9735	9735	9723	9633
Sustin Non-Agro males in HH	Pearson Correlation							1	.108**	.426**	.251**	.261**	.312**	.098**	-.217**	0.015	.064**
	Sig. (2-tailed)								0	0	0	0	0	0	0	0.141	0
	N								9735	9735	9735	9735	9735	9735	9735	9723	9633
Total hr/week Sustin Non- Agro females in HH	Pearson Correlation								1	.182**	.387**	.387**	.248**	.386**	-.112**	-.127**	.095**
	Sig. (2-tailed)									0	0	0	0	0	0	0	0
	N									9735	9735	9735	9735	9735	9735	9723	9633
Total hr/week Sustin Non-Agro male in HH	Pearson Correlation									1	.118**	.122**	.141**	.051**	-.096**	-.021*	.035**
	Sig. (2-tailed)										0	0	0	0	0	0.039	0.001
	N										9735	9735	9735	9735	9735	9723	9633
HH size	Pearson Correlation										1	.878**	.710**	.712**	-.294**	-.078**	.104**
	Sig. (2-tailed)											0	0	0	0	0	0

	N											9735	9735	9735	9735	9723	9633
Total in HH in Labor Age	Pearson Correlation											1	.832**	.785**	-.252**	-.021*	.068**
	Sig. (2-tailed)												0	0	0	0.035	0
	N												9735	9735	9735	9723	9633
Total in males HH in Labor Age	Pearson Correlation												1	.309**	-.316**	-0.003	.059**
	Sig. (2-tailed)													0	0	0.732	0
	N													9735	9735	9723	9633
Total in females HH in Labor Age	Pearson Correlation													1	-.079**	-.033**	.050**
	Sig. (2-tailed)														0	0.001	0
	N														9735	9723	9633
Sex of HHH	Pearson Correlation														1	.198**	-.260**
	Sig. (2-tailed)															0	0
	N															9723	9633
Age of HHH	Pearson Correlation															1	-.428**
	Sig. (2-tailed)																0
	N																9631
Educ gr. of HHH	Pearson Correlation																1
	Sig. (2-tailed)																
	N																

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table A.42: Logistic Regression Model 1: Household food security on Block 1 "Availability"

		Exp(B)
EDUC of household head (reference is university) *		
	Illiterate	0.328 *
	Less than Intermediate	0.377 *
	Intermediate and Above Intermediate	0.535 *
Age of household head		1.007 *
Constant		3.940 *
Evaluating the Performance of the Model		
Model Chi-Squared	Chi-square	184.991
	Df	4
	Sig.	0
Percent Correct Prediction		70.30%
Pseudo R-squared :	Cox & Snell R Square	0.019
	Nagelkerke R Square	0.027

* Significant impact at 99% level of confidence (p-value <=0.01)
** Significant impact at 95% level of confidence (p-value <=0.05)

Table A.43: Logistic Regression Model 2: Household food security Block 1 "Availability" and Block 2 "Access"

		Exp(B)
EDUC of household head (reference is university)		
	Illiterate	0.577 *
	Less than Intermediate	0.583 *
	Intermediate and Above Intermediate	0.725 *
Age of household head		1.008 *
Household size		0.914 *
Household rural wealth quintile (reference is richest)		
	Poorest	0.227 *
	Poor	0.419 *
	Middle	0.496 *
	Rich	0.590 *
Total number of adults in the labor age in the HH		0.975
Constant		8.443 *
Evaluating the Performance of the Model		
Model Chi-Squared	Chi-square	623.830
	Df	10
	Sig.	0.000
Percent Correct Prediction		70.70%
Pseudo R-squared :	Cox & Snell R Square	0.063
	Nagelkerke R Square	0.090

* Significant impact at 99% level of confidence (p-value <=0.01)
** Significant impact at 95% level of confidence (p-value <=0.05)

Table A.44: Logistic Regression Model 3: Household food security Block 1 "Availability," Block 2 "Access," and Block 3 "Utilization"

		Exp(B)
EDUC of household head (reference is university)		
	Illiterate	0.562 *
	Less than Intermediate	0.581 *
	Intermediate and Above Intermediate	0.723 *
Age of household head		1.008 *
Household size		0.920 *
Household rural wealth quintile (reference is richest)		
	Poorest	0.227 *
	Poor	0.423 *
	Middle	0.499 *
	Rich	0.593 *
Total number of adults in the labor age in the HH		0.975
Gender of household head (reference is male)	Female HHH	0.878 **
Constant		9.340
Evaluating the Performance of the Model		
Model Chi-Squared	Chi-square	627.745
	Df	11
	Sig.	0.000
Percent Correct Prediction		70.70%
Pseudo R-squared :	Cox & Snell R Square	0.064
	Nagelkerke R Square	0.091

* Significant impact at 99% level of confidence (p-value <=0.01)

** Significant impact at 95% level of confidence (p-value <=0.05)

Appendix Objective (C)

Table C.45: Multiple Regression (Enter Method) of Total Net earnings from Principal Agricultural Assets (per unit) on Agricultural Resources, Household properties, and Household head characteristics (n=1521, ELMPS 2018)

	Unstandardized Coefficients Beta	Significance (p-value)
Gender of HHH (reference is male)	1572.576	0.166
Area of Agricultural Land Cultivated over 12 months (Feddan)	-203.869 *	0.006
TLU of Livestock	-133.160 *	0.048
Variety of agricultural tools and machinery	792.121 *	0.001
Total number adult labor in household (15 yrs +)	-400.509	0.209
Internet	50.062	0.942

Finance	-149.754	0.826
Education level of household head	986.786 *	0.005
Age of household head	24.843	0.329
Economic activity of prim. job based on ISIC4 in ref. 3-mnths	2375.509 *	0.000
Marital Status of household head	1028.622 **	0.082
Household size	564.813 *	0.004
Quintiles of household wealth (reference is richest)	-65.402	0.810
Region	-34.294	0.928
Constant	-2993.981	0.462
Evaluating the Performance of the Model		
Model Regression ANOVA	F	3.654
	Df	14
	Sig.	0
Model Summary	R Square	0.033
	Adjusted R Square	0.024

* Significant impact at 99% level of confidence (p-value <=0.01)

** Significant impact at 95% level of confidence (p-value <=0.05)

Table C.46: Multiple Regression (Best Fit) of Total Net earnings from Principal Agricultural Assets (per unit) on Agricultural Resources, Household properties, and Household head characteristics (n=1521, ELMPS 2018)

	Unstandardized Coefficients Beta	Significance (p-value)
Constant	-3109.566	0.339
Gender of HHH (reference is male)	1657.573	0.128
Area of Agricultural Land Cultivated over 12 months (Feddan) * (Land_size)	-201.062	0.006
TLU of Livestock (Animal_TLU) **	-131.456	0.050
Variety of agricultural tools and machinery *	781.806	0.001
Education level of household head *	927.794	0.003
Economic activity of prim. job based on ISIC4 in ref. 3-mnths *	2342.575	0.000
Marital Status of HHH **	1187.180	0.034
Household size *	379.157	0.004
Evaluating the Performance of the Model		
Model Regression ANOVA	F	6.152
	Df	8
	Sig.	0
Model Summary	R Square	0.032
	Adjusted R Square	0.026

* Significant impact at 99% level of confidence (p-value <=0.01)

** Significant impact at 95% level of confidence (p-value <=0.05)

*** Significant impact at 90% level of confidence (p-value <=0.10)

Table C.47: Multiple Regression (Enter Method) of Net earnings from Crops per feddan of cultivated land in previous 12 months on Agricultural Resources, Household properties, and Household head characteristics (n=1155, ELMPS 2018)

	Unstandardized Coefficients Beta	Significance (p-value)
Gender of HHH (reference in male)	954.867	0.498
Area of Agricultural Land Cultivated over 12 months (Feddan)	-357.431 *	0.000
TLU of Livestock	-422.086 *	0.018
Variety of agricultural tools and machinery	-28.845	0.903
Total number adult labor in household (15 yrs +)	-442.356	0.192
Internet	185.010	0.802
Finance	-247.879	0.732
EDUC_hhh	90.348	0.809
Age of household head	-25.616	0.358
Economic activity of prim. job based on ISIC4 in ref. 3-mnths	1662.368 *	0.012
Marital Status of HHH	1096.115	0.117
Household size	415.188 ***	0.054
Quintiles of household wealth	232.030	0.410
Region	443.140	0.283
Constant	2137.742	0.656
Evaluating the Performance of the Model		
Model Regression ANOVA	F	3.595
	df	14
	Sig.	0.000
Model Summary	R Square	0.030
	Adjusted R Square	0.042

* Significant impact at 99% level of confidence (p-value <=0.01)
** Significant impact at 95% level of confidence (p-value <=0.05)

Table C.48: Multiple Regression (Best Fit) of et earnings from Crops per feddan of cultivated land in previous 12 months on Agricultural Resources, Household properties, and Household head characteristics (n=1166, ELMPS 2018)

	Unstandardized Coefficients Beta	Significance (p-value)
Constant	9247.959	0.000
Gender of HHH (reference is male)	-530.390	0.575
Area of Agricultural Land Cultivated over 12 months (Feddan) * (Land_size)	-354.747	0.000
TLU of Livestock (Animal_TLU) **	-416.472	0.010

Economic activity of prim. job based on ISIC4 in ref. 3-mnths *	1635.462	0.009
Household size ***	234.952	0.088
Evaluating the Performance of the Model		
Model Regression ANOVA	F	8.299
	Df	5
	Sig.	0.000
Model Summary	R Square	0.035
	Adjusted R Square	0.030

* Significant impact at 99% level of confidence (p-value <=0.01)
** Significant impact at 95% level of confidence (p-value <=0.05)
*** Significant impact at 90% level of confidence (p-value <=0.10)

Table C.49: Multiple Regression (Enter Method) of Net earnings from Livestock per TLU in previous 12 months on Agricultural Resources, Household properties, and Household head characteristics (n=621, ELMPS 2018) [1]

	Unstandardized Coefficients Beta	Significance (p-value)
Gender of HHH (reference in male)	-206.695	0.870
Area of Agricultural Land Cultivated over 12 months (Feddan)	116.496	0.376
TLU of Livestock	-52.444	0.357
Variety of agricultural tools and machinery	850.613 *	0.002
Total number adult labor in household (15 yrs +)	-340.520	0.403
Internet	424.224	0.618
Finance	411.698	0.618
Education level of HHH	524.890	0.274
Age of household head	-16.541	0.615
Economic activity of prim. job based on ISIC4 in ref. 3-mnths	-250.088	0.744
Marital Status of HHH	64.604	0.926
Household size	154.809	0.504
Quintiles of household wealth	-273.918	0.440
Region	-69.258	0.884
Constant	2671.374	0.577
Evaluating the Performance of the Model		
Model Regression ANOVA	F	1.38
	df	14
	Sig. [1]	**0.157**
Model Summary	R Square	0.031
	Adjusted R Square	0.008

* Significant impact at 99% level of confidence (p-value <=0.01)
[1] Model was found to be not significant.

Table C.50: Financial Sources among all households that reported any principle agricultural assets [1] (n=3584, ELMPS 2018)

		Male-headed HH	Female-headed HH	Total
Internal	Any Savings *	6.4%	16.4%	8.1%
	Total %	100.0%	100.0%	100.0%
	Total count	2967	617	3584
External Formal loans during the past 12 months*	Acquired Loan	5.8%	2.4%	5.2%
	Loan Rejected	0.1%	0.2%	0.1%
	Loan Application pending	0.2%	0.0%	0.1%
	Not applied for Loan	94.0%	97.4%	94.6%
	Total %	100.0%	100.0%	100.0%
	Total count	2967	617	3584
External Informal borrow money from any individuals in the past 12 months	Yes	12.0%	11.8%	11.9%
	Total %	100.0%	100.0%	100.0%
	Total count	2967	617	3584
External Informal ROSCA participate in one or more (gam`iya(s)) in the past 12 months	Yes	5.5%	6.8%	5.7%
	Total %	100.0%	100.0%	100.0%
	Total count	2967	617	3584

[1] 42 households refused to answer these question (missing cases)