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## Economic Analysis of Women Empowerment in Agriculture Index (WEAI), a Comparative Study between some Egyptian Regions

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### ABSTRACT

This paper aims to analyze Women Empowerment in Agriculture Index (WEAI) for 3 simple random samples of beneficiaries utilized from agricultural development projects: MARSDEV in Matrouh, North coast of Egypt region, and WEE in Sohag and Aswan, South of Upper Egypt region through (1) calculating (WEAI) and its sub-indices : 5DE( 5 dimensions of empowerment: Production , resources, income control, leadership and time) and GPI (gender parity index) , monitoring changes between 2017 (project terminal) and 2022 (current situation), and highlighting differences of (WEAI) between regions, (2) econometric estimating of the impact of socioeconomic characteristics on the latent variable “women empowerment status” by Multiple Indicator Multiple Causes (MIMIC) model in 2022. The results explain that the majority of disempowered women are young, illiterate, and low income. The poorest situation of WEAI is in the North Coast, as WEAI score in 2017 is only 26.6%, depicts irrelevant accomplishments in 5DE and GPI. In 2022, WEAI scores improve in all samples due to agricultural development projects. MIMIC model results prove that age is the only exogenous variable affecting women’s empowerment as power source in extended Bedouin households in North coast, while age, education, and income have significant collective impact on empowerment in South of Upper Egypt. It also displays that as empowerment changes by one SD, all indicators change directly by one SD except workload change inversely. Recommendations are: give more priority for women empowerment in North Coast of Egypt and to implement national observatory to provide annual WEAI status.

**Keywords:** Women Empowerment, MIMIC Model, Egypt.

### INTRODUCTION

The women empowerment and gender parity concepts become a vital issue of international organizations as the 3<sup>rd</sup> Millennium Development Goal (MDG3) aims to promote gender equality and empower women for improving productivity and increasing efficiency (United Nations Millennium Summit, 2000). Food and Agriculture Organization (2011) declared that closing gender gap in agriculture is essential to increasing productivity, food security, and reducing hunger. The World Bank (2012) identified the significant effects of women’s empowerment on the efficiency and welfare results of policy interferences. The empowerment is defined as expansion of people’s ability to make strategic life choices particularly if this ability is denied to them (Kabeer, 2001). It is also defined as “a group’s or individual’s capability to make effective choices and then to convert those choices into preferred actions and outcomes” (Alsop, Bertelsen, and Holland, 2006). Furthermore, it is described as “the development of assets and capabilities of poor individuals to contribute in, negotiate with, influence, control, and hold accountable institutions that affect their lives”, emphasizing on four main components of empowerment: access to information, inclusion and participation, accountability, and local organizational capacity (Narayan 2002; 2005).

Today, Women’s Empowerment in Agriculture Index (WEAI) is survey-based index designed to measure the empowerment in the agricultural sector based on the Alkire-Foster methodology (Alkire and Foster 2011). the WEAI is an aggregate index, described at the country or regional level, concerning with individual- level data collected by interviewing men and women within the same households. The WEAI

involves two sub-indices. The first reflects the percentage of women who are empowered in five domains of empowerment (5DE): (1) decision about agricultural production, (2) access to and decision –making power about productive resources, (3) income control, (4) community’s leadership, (5) time allocation. The second sub index – the Gender Parity Index (GPI) measures gender parity. The GPI reflects the percentage of women who are empowered or whose empowerment score meets or exceeds that of the men in their households. For those households that have not achieved gender parity, the GPI shows the empowerment gap that needs to be closed for women to reach the same level of empowerment as men. (Alkire *et al.*, 2013).

In Egypt, Several international and national agricultural development projects and pilot initiatives are implemented to cover rural communities in all rural Egyptian regions from North Coast of Egypt to South of Upper Egypt within the framework of Agricultural Development Strategy 2030 which considers the role of women in agricultural development issues (the 2<sup>nd</sup> goal of rural livelihood improvement policy). The problem is that despite the importance reflection of impacts and results of these projects on progress of women’s empowerment level over time according to beneficiaries’ characteristics and their societies’ features, unfortunately, these reflection may be ignored unintentionally. In the framework of the mentioned problem, this paper aims to analyze the economic aspect of Women Empowerment in Agriculture Index (WEAI) which is developed by Alkire, *et al.* 2013 for 3 different simple random samples of beneficiaries’ households who utilize from specified international agricultural development projects which are assigned entirely or partially for women empowerment. The first sample are from beneficiaries’

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households of Matrouh Rural Sustainable Development “MARSDEV” project to represent North Coast Region and the second and the third samples are from beneficiaries’ households of Women Economic Empowerment “WEE” project in Sohag and Aswan governorates represent South of Upper Egypt. The sub-objectives are: (1) calculating (WEAI) for the 3 samples, monitoring its development between 2017 (the terminal of each project) and 2022 (the current situation), and highlighting the main differences of the five domains which are constituting (WEAI) between regions, (2) econometric estimating of the impact of some socioeconomic on the women empowerment status in 2022.

### Methodology

This paper applies the approach of Alkire and Foster, 2011 in calculating Women Empowerment in Agriculture (WEAI) which consists of two sub-indices: the five Domains of Empowerment Index (5DE) and the Gender Parity Index (GPI). Moreover, the Multiple Indicators Multiple Causes (MIMIC) Model for Jöreskog and Gold Berger, 1975 is applied to link the multiple dependent variables (5 DE indicators of empowerment) with multiple independent variables (socioeconomic characteristics of the respondents) through a latent variable (Women empowerment status).

### Women Empowerment in Agriculture (WEAI)

WEAI is calculated as weighted sum of two sub-indices: (5DE) with a weight of 90%, and (GPI), with a weight of 10%. The weights are slightly subjective which are assigning greater importance for the 5DE while still considering the importance of gender equality as an empowerment feature. Improvement in either 5DE or GPI will increase WEAI scores (Alkire *et al.*, 2013; Malpit *et al.*, 2019).  $WEAI = \alpha * (5DE) + (1 - \alpha) * (GPI)$ ,  $\alpha = 0.9$ . The steps of calculating WEAI are:

#### First: Identifying and calculating the five Domains of Empowerment in Agriculture (5DE)

**1-Production (weight =1/5) :** this domain consists of two indicators, the first indicator is: input in production decision making (weight =1/10) which considers decision-making about 4 agricultural areas (crop type, purchase resources, marketing and livestock raising).The 5scales inputs are: (1=no input), (2=input into very few decisions), (3=input into some decisions), (4=input into most decisions, and (5=input into all decisions). The respondent is adequate if he or she has (some) inputs in at least two types of decisions. The second indicator is relative autonomy indicator (RAI) (weight =1/10) in production which considers motivation for decisions in the 4 areas of decision – making. The previous scales are multiplied by (-2) for external coerced motivation and (-1) for introjected motivation and (3) for intrinsic values and motivations. The respondent is adequate if RAI is greater than one in at least one of the 4 area of decision- making.

**2-Resources (weight =1/5):** this domain consists of three indicators, the first indicator is ownership of assets( weight=1/15) (agricultural farm, large livestock, mechanized-farm equipment, house, nonagricultural land, and transportation means are considered major assets ,while cell phone, small livestock, small consumer durables and non-mechanized farm equipment are considered minor assets. the indicator equal 1 if the person own the asset, then all answers are summed to create the ownership indicator. The respondent is adequate if he or she owns **at least one major asset**. The second indicator is decisions regarding purchase, sale or transfer assets (Weight=1/15). The respondent is adequate if

he or she owns **any of the asset** and participates in decisions. The third indicator is Access to and decision about credit (weight=1/15). The indicator equal 1 if the household has access to credit from (banks, governmental organizations, informal lenders, rotating saving, friends and relatives).The respondent is adequate if he or she participates in **at least one decision** about credit.

**3-Income (weight =1/5):** this domain concentrates on control over the use of income resulted from crops and livestock. The 5 scales inputs ranges between (1= no input to 5=input into all decisions). The respondent is adequate if he or she has (**some**) inputs in at least two types of decisions.

**4-Leadership (weight =1/5):** this domain consists of two indicators: the first indicator is socioeconomic group memberships (weight =1/10) (cooperative associations, local development association, local committees, religious and charitable associations, national women council and business groups).The respondent is adequate if he or she is active member in **at least one** group. The second indicator is feeling comfortable to speak in public (weight =1/10) in building infrastructure, ensuring proper wages and Protesting against officials’ misbehavior. The 5 scales responses are: (1=no, not at all comfortable), (2=yes, with great difficulty), (3=yes, with little difficulty), (4=yes, fairly comfortable), and (5=yes, very comfortable).The respondent is adequate if he or she feel comfortable with great difficulty (score=2) for at least one from the 3 mentioned disputes (in this paper, the item of intervention to reconcile family and neighbors disputes is listed).

**5-Time (weight =1/5):** this domain consists of two indicators: the first indicator is the workload (weight =1/10), concentrates on the allocation of time to productive and domestic tasks at last 24 hours in the following tasks: wage and salary employment, own business work, farming, shopping, weaving and sewing, cooking, domestic work, caring children and elderly, commuting and traveling. The person is adequate if he or she works less than the time poverty line of 10.5 hours (Bardasi and Wodon 2006). The second indicator is satisfaction of leisure (weight =1/10) during visiting neighbors, TV watching, listening radio and sports. The 9 scales answers are: (1=strongly no satisfaction), (2=dissatisfied), (3=moderately dissatisfied), (4 =slightly dissatisfied), (5=indifferent), = (6=slightly satisfied), (7= moderately satisfied), (8= satisfied), (9=completely satisfied). The respondent is adequate if his or her satisfaction of leisure time is > 5.

To analyze empowerment situation, the critical index of disempowerment  $M_0$  that must be eliminated are identified (Alkire and Foster, 2011). This index calculates the percentage of women who are disempowered, varies between 0 (no one is disempowered), and one (everyone is disempowered and inadequate in all indicators). The 5 DE is defined as  $(1 - M_0)$ .  $M_0$  consists of two components: (1) the proportion of individuals whose weighted inadequacy are more than cut off (disempowered headcount ratio  $H_p$  ).(2) the intensity of their inadequacies- the average proportion of weighted inadequacies they experience. The steps of calculating 5DE and  $M_0$  are as follow:

1-Identify inadequacies for each of the 10 indicators described in the previous section. Person  $i$  is inadequate in indicator  $j$  if his or her level of achievement  $x_{ij}$  is below the adequacy cut-off  $z_j$ . The inadequacy situation  $g_{ij} = 1$  if  $x_{ij} < z_j$  , and  $g_{ij} = 0$  otherwise for each individual.

- 2- Calculate the *inadequacy score* for each individual  $c_i$ , by summing the inadequacy situation of all indicators, each multiplied by their corresponding weight ( $w_j$ ).  $c_i = \sum_{j=1}^{10} w_j g_{ij}$
- 3- Identify the disempowerment by comparing a person's inadequacy score  $c_i$  with the disempowerment cut-off  $k$ . A person is identified as disempowered if  $c_i > k$ , and empowered otherwise. Alkire and Foster (2011) set the disempowerment cut-off of 0.20, i.e. the individual is disempowered if his or her inadequacy score is greater than 20 percent or in other words he or she is empowered if his or her adequacy score is  $\geq 80\%$ , i.e. he or she has achievements in at least 4 of the 5 domains.
- 4- Compute the disempowerment headcount ratio or the percentage of individuals who are disempowered,  $H_p = q/n$ , where  $q$  is the number of individuals identified as disempowered and  $n$  is the total number of individuals.
- 5- Compute the intensity (breadth) of disempowerment  $A_p$ . It is the average inadequacy score of disempowered individuals and can be expressed as follows:  $A_p = \frac{\sum_{i=1}^n c_i(k)}{q}$ , where  $c_i(k)$  represents censored inadequacy score of individual  $i$  and  $q$  is the number of disempowered individuals. The censored inadequacy score,  $c_i(k)$  is equal to the inadequacy score if the individual is disempowered (i.e. if  $c_i > k$ , then  $c_i(k) = c_i$ ). The censored inadequacy score,  $c_i(k)$  is equal to zero if the individual is empowered (i.e. if  $c_i \leq k$ , then  $c_i(k) = 0$ ).
- 6- Compute the index of disempowerment  $M_0$  and the 5 DE.  $M_0$  is calculated as the product of headcount ratio and the intensity of disempowerment.  $M_0 = H_p \times A_p$ . 5DE is then:  $5DE = 1 - M_0 = 1 - (H_p \times A_p)$ .

**Second: Identifying and calculating Gender Parity Index (GPI)**

The GPI concentrates on the difference between the inadequacy scores of the surveyed woman and her spouse within each household. GPI involves the calculation of inadequacy scores for men and women and is based on the sample of adult- adult households, i.e., the sample involves at least one woman and one man. GPI is constructed as follows:

- 1- Censor the inadequacy scores i.e., the score of those whose inadequacy score is less than or equal to the disempowerment cut-off  $k$ , is replaced by the value of  $k$ , which is 20 % (rather than zero as in the computation of the 5DE). The new censored inadequacy score, denoted as  $\dot{c}_i(k)$  to differentiate it from the 5DE, is defined as follows:  $\dot{c}_i(k) = c_i$  if  $c_i > k$ ,  $\dot{c}_i(k) = k$  if  $c_i \leq k$
- 2- Identify households lacking gender parity. A household lacks gender parity if the women is disempowered and her new censored inadequacy score is higher than new censored inadequacy score of her male counterpart. Formally, household lacks gender parity if  $\dot{c}_j(k)^W > k$  and  $\dot{c}_j(k)^W > \dot{c}_j(k)^M$ , where  $\dot{c}_j(k)^W$  and  $\dot{c}_j(k)^M$  are the censored inadequacy scores of the eligible woman and spouse, respectively. In other words, a household is known by gender parity if the woman is empowered or, if she is not empowered, her inadequacy score is equal or lower than that of the man in her household.
- 3- Calculate the percentage of households needing gender parity. The percentage of households where females lack gender parity relative to their corresponding males, ( $H_{GPI}$ ) is  $r/m$ , where  $r$  is the number of households classified as lacking gender parity and  $m$  is the total number of dual-adult households in the sample.

4- Compute the average empowerment gap. The empowerment gap describes the extent of the disparity between women's and men's inadequacy scores in households that lack gender parity. It is calculated as the average relative gap in the censored inadequacy scores between women and men living in households that lack

$$\text{gender parity: } I_{GPI} = \frac{1}{r} \sum_{i=1}^r \frac{\dot{c}_j(k)^W - \dot{c}_j(k)^M}{1 - \dot{c}_j(k)^M}$$

5- Computing the GPI. The GPI combines the two last figures: the percentage of women who lack gender parity and the average empowerment gap:  $GPI = 1 - (H_{GPI} \times I_{GPI})$

**Multiple Indicators Multiple Causes Model**

Multiple Indicators Multiple Causes (MIMIC) Model is applied as a distinctive approach of Structural Equation Modeling (SEM). SEM is a combination of two statistical methods: confirmatory factor analysis and path analysis. Confirmatory factor analysis has an objective to estimate the latent variables. Path analysis, on the other hand aimed to find the causal relationship among variables by creating a path diagram (Wright, 1921).

In this paper, MIMIC model is suitable because it links multiple dependent variables (indicators of empowerment) with multiple independent variables (socioeconomic characteristics of the respondents) through a latent variable (Women empowerment status). Figure (1) explains the path diagram of the model (Bollen, 1989; Zereyesus, Y.A., et. al, 2017). Equation (1) describes the structural relationship between a vector of observable exogenous causal variables,  $X = (x_1, \dots, x_n)$  and the latent women empowerment status  $Y^*$  as follow:

$$Y^* = \alpha X + \varepsilon \quad (1)$$

Where  $\varepsilon$  is the error term, assumed to have a zero mean and a unity standard deviation, and  $\alpha = (\alpha_1, \dots, \alpha_n)$  is the vector of the parameters to be estimated. In equation (2), the latent variable, women empowerment status, is assumed to determine the 10 observable empowerment indicators,  $Y$ , the measurement component of the SEM, as follow:

$$Y = \beta Y^* + v \quad (2)$$

Where  $Y = (y_1, \dots, y_n)$  represents a vector of observable endogenous variables,  $\beta = (\beta_1, \dots, \beta_n)$  is the vector of the parameters to be estimated,  $v = (v_1, \dots, v_n)$  is a vector of mutually independent error terms. It is assumed that  $E(\varepsilon v) = 0$ ,  $E(\varepsilon^2) = \sigma^2$  and  $E(v v) = \theta^2$ ,  $\theta$  is  $m \times m$  diagonal matrix. By substituting equation (1) into equation (2), the MIMIC model is created which is presents the 10 observable indicators as a function of the observable exogenous variables  $X$  as follow:

$$Y = \beta(\alpha X + \varepsilon) + v \quad (3)$$

$$Y = \pi X + v \quad (4)$$

Where  $\pi = \beta\alpha$  and  $v = \beta\varepsilon + v$ . To ensure that the model is identified, minimum following requirements should be verified: (1) one of the factor loadings of the observable indicators is set to unity to provide a scale for the latent variable, (2) there are at least two observable indicators, and (3) there are at least one exogenous variable. Maximum Likelihood (ML) method is applied to estimate the MIMIC model. Because the exogenous variables have different units, the comparisons between the estimated coefficients will not be reasonable. Standardization procedure will be useful for two reasons: (1) comparing between the estimated parameters which have different units (Bollen, 1989), (2) rather than elasticity coefficients, which is meaningless when its value goes to infinity if the coefficient near to zero, the standardized parameters explain the change in standard deviation units of dependent variable as the standard deviation of explanatory variable changes by one unit.

As few papers applied MIMIC Model to assess the (WEAI) reducing the numbers of the 10 indicators (Contreras

SM, 2018) to increase the degrees of freedom, statistical significance of coefficients, and model fitting, the MIMIC model in this paper consists of only 3 exogenous socioeconomic variables (age, literacy and income) to assess the latent variable (women empowerment) and only main 5 indicators of total 10 indicators according to the frequency and percent of inadequate respondents in each indicator. The 3 exogenous variables: age, education and monthly income of the respondents act as the determinants of empowerment farmers according to Rathnachandra SD, Malkanthi SH, 2021. They revealed that these factors enhance the active participation in the household decision making process which are significant requirements to empower rural women and alleviate their poverty.

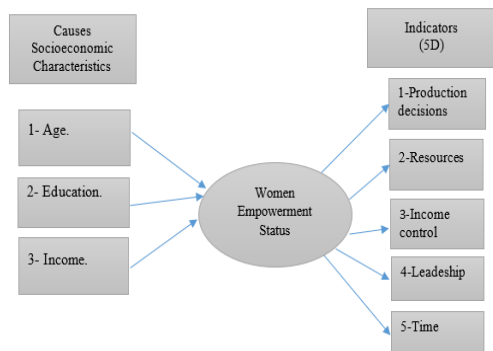


Figure (1) Path diagram of MIMIC model explains the impact of socioeconomic characteristics of women on five dimensions (SDE) and its indicators through the latent variable (women empowerment status).

### Sample

This paper uses primary data extracted from two funded international development projects in Egypt: (1) Matrouh Rural Sustainable Development project (MARSADEV) implemented by the Mediterranean Agronomic Institute of Bari, Italy (CIHEAM/Bari) and Desert Research Center (DRC), (2) Women Economic Empowerment project (WEE) implemented by (CIHEAM/Bari) and Executive Agency of Comprehensive Development Projects (EACDP) belongs the Ministry of Agriculture and Land Reclamation (MALR), Egypt. Three different samples are formed from three governorates below two regions in Egypt. The first sample is in Almathany community, Alnegaila district, Matrouh governorate which presents *North Coast region*<sup>1</sup>. The second sample is in Shandaweel Island village, Almaragha district, sohad governorate and the third sample is in Alkobania village, Aswan district, Aswan governorate, both 2<sup>nd</sup> and 3<sup>rd</sup> samples represent *South of Upper Egypt region*. The paper applies a simple random sampling approach by the formula of Yamane, 1967 in the three regions. In Mathany community, 124 individual (62 men and 62 women) is selected randomly from the total of 180 individual present 30 beneficiary households. In Shandaweel village, 96 individual (48 men and 48 women) is selected randomly from the total of 125 person present 25 beneficiary households. In Kobania village, 114 individual (57 men and 57 women) is selected randomly from the total of 160 person present 40 beneficiary households.

<sup>1</sup> According to the General Organization of the Physical Planning (<https://Gopp.gov.eg>), Egypt consists of 7 regions ; *Alexandria and North Coast region* which includes Beheira, Alexandria, and Matrouh governorates; *Delta region* which includes Menoufia, Gharbiya, Kafr Al-Shaikh, Dakahliaa and Damietta; *Greater Cairo region* which includes Giza, Al-Qalubeiah, and Cairo, *Sues Canal region* which includes Al-Sharkia, Port- Said, North Sinai,

The sampling equation is:  $n = \frac{N}{1+N(e^2)}$ , (n) is the sample size, N is population size, and (e) is the level of precision at 95% confidence interval

## RESULTS AND DISCUSSION

Although WEAI index and its sub-indices: 5DE, and GPI consider women and men achievements in the entirely computation, this paper shows only the results of women scores due to insignificant inadequacy scores of men, i.e. the disempowerment index (M<sub>0</sub>) is less than 20% in the five dimensions empowerment (5DE) or in other words, their empowerment scores is more than 80% of the five dimensions empowerment (5DE). This section demonstrates first the descriptive statistics of the sample which is classified into adequate and inadequate respondents and second, the results of WEAI index and its development between 2017 and 2022.

### First: The descriptive statistics of the samples

The distribution of respondents 'women on socio-economic characteristics by their adequacy status in Mathany community in 2017 shows that for age structure: 64.5% of Bedouin women who have inadequate scores in (5DE) are young adults (18-28 years), 19.4% are middle aged adults (29-39), and only 16.1% of women who have adequate scores in (5DE) are old aged women (> 40 years). For education level, 77.4% of women who have inadequate scores in (5DE) are illiterate (1<6 years), i.e. they cannot read and write because they even ever enroll into formal education or don't complete primary school, 6.5% have intermediate level of education (6- 12 years), i.e. they complete the primary and preparatory schools, while only 16.1% of women who have adequate scores in (5DE) are considered highly educated (> 13 years). For household income level, 64.5% of women who have inadequate scores in (5DE) are from low income families (< L.E.20000/ year), and 19.4% from middle income families (L.E.20000- 40000 / year), while only 12.9% of women who have adequate scores in (5DE) are from middle income families while only 3.2% from high income families (>L.E. 40000 / year). In 2022, presentation of women who have adequate scores is increased in old aged women category (35.5%) as a result of the age structure development. A better situation in their presentation in high education (33.5%), middle income (16.1%), and high income (19.4%). (Table 1).

The distribution of respondents 'women on the 10 empowerment indicators (5DE) by their adequacy status in Mathany community in 2017 shows that for production domain, 83.9% of Bedouin women are inadequate in the indicator of decisions related to the agricultural activities except livestock raising activity although only 32.3% of them are inadequate in the relative autonomy indicator (RAI). For Resource domain, 83.9% of women are inadequate in the indicator of assets 'ownership as they don't possess any major asset but they only possess the poultry, some sheep and goats and cell phone as a minor asset( in this paper, cell phone is considered a minor asset due to its dispersion and availability for every person and household). 40.3% of women are inadequate in the indicator of decisions related to purchase, sale, transfer assets because they

South Sinai, Ismailia, and Suez governorates; *North Upper Egypt region* which includes Fayoum, Bani Suef and Minya governorates ; *Assuit region* which includes Assuit and New Valley governorates; and *South Upper Egypt region* which includes Sohag, Qena, Luxor, Aswan, and Red Sea governorates.

have all rights to dispose livestock assets. Only 32.3% of Bedouin women are inadequate in indicator of access to credit, as they provide money (if they need) through rotating saving with relatives and neighbors. For income domain, 80.6% of women are inadequate in control over the use of income. For Leadership domain, 64.5% of women are inadequate in group membership indicator, but only 40.3% are inadequate in speaking in public indicator as old women have ability to reconcile between disputed neighbors and relatives. For time domain, 64.5% of Bedouin women are inadequate in workload indicator as most of them work more than 10.5 hour/day during harvest season in their own families 'farms or in the rented fig orchids with their families in addition to daily chores and fetching potable water but only 40.3% of them are inadequate in satisfaction of their leisure, this may be because their simple Bedouin daily routine and electricity is not available all time to entertainment and watching TV. In 2022, all inadequacy (and of course adequacy) frequencies improved. Mainly the inadequate women in the indicators of production decisions, the ownership assets, income, membership, and workload decreased to 61.3%, 64.5%, 64.5%, 56.5%, and 51.6% respectively (Table 1)

The distribution of respondents 'women on socio-economic characteristics by their adequacy status in Shandaweel village sample in 2017 shows that for age structure: 66.7% of rural women who have inadequate scores in (5DE) are young adults, 6.2% are middle aged adults, and only 27.1% of women who are adequate are old aged women. For education level, 52.1% of women who have inadequate scores in (5DE) are illiterate, 20.8% have intermediate level of education, while only 27.1% of women who have adequate scores in (5DE) are considered highly educated. For household income level, 41.7% of women who have inadequate scores in (5DE) are from low income households, and 31.2% are from middle income households, while only 27.1% of women who have adequate scores in (5DE) are from high income households. In 2022, presentation of women who have inadequate score is decreased in young adult category (41.7%), while presentation of women who have adequate score is increased but distributed between middle and old aged categories (41.7%, 14.5% respectively). The same notice is observed for education, presentation of women who have adequate score is increased but distributed between intermediate and high education categories (31.25%, 25% respectively). For income level, women who belong low income households and have inadequate score in 2017 are still in their place in 2022 (41.7%). Additionally, presentation of women who have adequate score of empowerment is increased but distributed between middle income (20.8%), and high income (35.4%). (Table 2)

The distribution of respondents 'women on the 10 empowerment indicators (5DE) by their adequacy status in Shandaweel Island village in 2017 shows that for production domain, 60.4% of rural women are inadequate in the indicator of decisions related to the agricultural activities except livestock raising and marketing activities, while only 14.6% of them are inadequate in the relative autonomy indicator (RAI). For Resource domain, 72.9% of women are inadequate in the indicator of assets 'ownership. At most, 14.6% of women are inadequate in the indicator of decisions related to purchase, sale, and transfer assets. 18.7% of rural women are inadequate in indicator of access to credit. For income domain, 72.9% of women are inadequate in control over the use of income. For Leadership domain, 56.2% of women are inadequate in group

membership. Just 18.7% are inadequate in speaking in public indicator, 72.9% of rural women are inadequate in workload indicator. Only 14.6% of them are inadequate in satisfaction of their leisure. In 2022, most inadequacy frequencies improved. The inadequate women in the indicators of production decisions, the ownership assets indicator, income indicator, membership indicator, and workload indicator decreased to 41.7%, 43.8%, 41.7%, 37.5%, and 37.5% respectively. (Table 2)

The socioeconomic characteristics of Kobania sample in 2017 displays that 77.2% of women who have inadequate scores in (5DE) are young adults, 12.3% are middle aged adults, and just 10.5% of adequate women are old aged. Moreover, 54.4% of inadequate women are illiterate, 35.1% have intermediate education, while only 10.5% of women are highly educated. Furthermore, 45.6% of inadequate women belong low income households, and 43.9% belong middle income households, but just 10.5% of women belong high income households. In 2022 inadequate women decrease in young and middle aged adult categories (56.1% and 10.5% respectively), while adequate women increase in middle and old aged categories (15.8% and 17.6% respectively). For education, adequate women also increase in intermediate and high education categories (15.8% and 17.6% respectively). For income, inadequate women belong low income households increase, while women belong middle income decrease (54.4% and 12.2% respectively). In addition, adequate women in middle income and high income categories increase (15.8% and 17.6%). (Table 3)

The classification of inadequate and adequate women between the 10 empowerment indicators in Kobania village in 2017 shows that for production domain, 84.2% of women are inadequate in the indicator of agricultural production decisions. Only 17.5% of them are inadequate in the relative autonomy indicator (RAI). For Resource domain, 86% of women are inadequate in the indicator of assets 'ownership. Just 17.5% of women are inadequate in both indicator of purchase, sale, and transfer assets decisions and indicator of access to credit. For income domain, 89.5% of women are inadequate in control over the use of income. For Leadership domain, 78.9% of women are inadequate in group membership. At most, 12.3% are inadequate in speaking in public indicator, 73.7% of women are inadequate in workload. Just 15.7% of them are inadequate in satisfaction of their leisure. In 2022, the inadequate women in the indicators of production decisions, the ownership assets indicator, income indicator, membership indicator, and workload indicator decreased to 56.1%, 64.9%, 66.7%, 52.6%, and 52.6% respectively. (Table 3)

### **Second: Women Empowerment in Agriculture Index (WEAI)**

Table (4) shows the results of Women Empowerment in Agriculture Index (WEAI) in the 3 regions comparing 2017 to 2022. For Mathany Community sample in Matrouh governorate (the 1<sup>st</sup> region) in 2017, the (WEAI) score is only 0.266 which reflects a minor accomplishment in its two components. The 1<sup>st</sup> component, the empowerment index in the five domains (5DE), has a very low success, as its score is 0.27, while the disempowered index ( $M_0$ ) is seriously high, as its score is 0.73. The 2<sup>nd</sup> component, the gender parity index (GPI), is also incredibly slight, as its score is 0.24. Considering the two sub-indices of (5DE): the disempowerment headcount ratio index ( $H_p$ ) displays that 84% of Bedouin women are disempowered, and the intensity of disempowerment index ( $A_p$ ) shows that they have inadequacy score in 87% of the five domains. Additionally,

the two sub-indices of (GPI) show that proportion of households which have gender disparity ( $H_{GPI}$ ) is 91%, and the intensity or the average empowerment gap ( $I_{GPI}$ ) is 84%. In 2022, the (WEAI) score improves to 0.430. Fortunately, its components; (SDE) score also enhances to 0.44, i.e., disempowered index ( $M_0$ ) declines to 0.56 and (GPI) score also improves to 0.30.

For the sample of Shandaweel Island village, Sohag governorate (the 2<sup>nd</sup> region) in 2017, the (WEAI) score is 0.512. The (SDE) score is 0.51, i.e., the ( $M_0$ ) score is 0.49. The (GPI) score is 0.53, ( $H_P$ ) demonstrates that 73 % of women are disempowered, and ( $A_P$ ) demonstrates that they have inadequacy score in 67% of the five domains. Furthermore, (GPI) shows that proportion of households which have gender disparity ( $H_{GPI}$ ) is 79%, and the intensity or the average empowerment gap ( $I_{GPI}$ ) is 59 % (all these revealed scores are better off comparing with the 1<sup>st</sup> sample). In 2022, the (WEAI) score increases to 0.712. Moreover; (SDE) score also improves to 0.71, i.e., disempowered index ( $M_0$ ) declines to 0.29 and (GPI) score also improves to 0.73 (these scores proves the development of women empowerment between 2017 and 2022).

For the sample of Alkobania village, Aswan governorate (the 3<sup>rd</sup> region) in 2017, the (WEAI) score is 0.655. The (SDE) score is 0.64, i.e., the ( $M_0$ ) score is 0.36. The (GPI) score is 0.79, ( $H_P$ ) demonstrates that 89 % of women are disempowered, and ( $A_P$ ) demonstrates that they have inadequacy score in 40% of the five domains. Furthermore, (GPI) shows that proportion of households which have gender disparity ( $H_{GPI}$ ) is 86%, and the intensity or the average empowerment gap ( $I_{GPI}$ ) is 25 % (all these scores are better off comparing with the 1<sup>st</sup> and 2<sup>nd</sup> samples). In 2022, the (WEAI) score increases to 0.74. Moreover; (SDE) score also improves to 0.73, i.e., disempowered index ( $M_0$ ) declines to 0.27 and (GPI) score also improves to 0.86.

**Third: Multiple Indicators Multiple Causes**

Tables (6 to 8) display the results of MIMIC model in 2022 by JASP software in the three samples; Mathany community, Shandaweel Island village, and Kobania village. In each sample, the mimic model results are categorized into two models: the structural model which explain the association between the observable exogenous explanatory continuous variables; age, education, and income and the underlying latent variable (Women Empowerment status), and the measurement model which explain the association between the manifested endogenous continuous indicators and the latent variables. Goodness of fit criteria are given by  $X^2$ , the Comparative Fit Index (CFI), Tucker- Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Squared Residuals (SRMR) at the end of each table. To avoid collinearity between explanatory variables, the results of Variance Inflation Factor (VIF) for each sample is provided in table (5).

Table (5) shows that VIF for woman ‘age, education, and income variables are 4.63, 8.027, and 10.021 respectively, which indicate to acceptable moderate collinearity between age and other two variables, but for education and income variables, their VIFs refer to unacceptable serious collinearity. Table (6) shows that woman ‘age is the only exogenous variable which is statistically significant (at 1% level) affecting the women’s empowerment. The other two observable variables are not significant. The sign of age parameter implies that the higher the woman age, the better the empowerment situation (or the higher the empowerment score). The estimated standardized coefficient of age variable explains the marginal analysis which reveal that

as the woman ‘age variable shifts by one standard division (SD), women empowerment status will shift by 0.968 SD, ceteris paribus. The measurement model displays also the relationships between the women’s empowerment status and its five abbreviated components indicators. All the five endogenous indicators are statistically significant (at 1% level), confirming that the latent variable, women’s empowerment status, is present. The magnitude of coefficients demonstrate that as the women empowerment status changes by one SD, the indicators of inputs in productive decisions, resources’ ownership, income control, associations’ memberships and workload will change by 0.947, 0.979, 0.903, 0.902 and -0.980 respectively. The signs also match the normal logic as all signs reveal positive relationships with women’s empowerment status except workload indicator which reveals a negative relationship with women’s empowerment status as expected. The  $X^2$ , CFI, TLI, SRMR criteria verify the MIMIC model’s goodness of fit in Mathany sample.

Table (5) shows that VIF for woman ‘age, education, and income variables are 3.37, 1.965, and 2.657 respectively, which indicate to acceptable moderate collinearity for all three variables. Table (7) demonstrates that age and income variables are statistically significant at 1% level but education variable is statistically significant at 5% level. The signs of these parameters suggest that the higher woman’s age, education and income parameters, the better the empowerment and as these variable shift by one standard division (SD), women empowerment status will shift by 0.527SD, 0.142SD, 0.364SD respectively. The measurement model displays that all five endogenous indicators are statistically significant (at 1% level). The coefficients demonstrate that as the women empowerment status alter by one SD, the indicators of inputs in productive decisions, resources’ ownership, income control, associations’ memberships and workload will change by 0.966, 0.980, 0.964, 0.901 and -0.972 respectively. The signs also match the normal logic. The  $X^2$ , CFI, and SRMR criteria verify the MIMIC model’s goodness of fit in Shandaweel Island sample.

Table (5) illustrates that VIF for woman ‘age, education, and income variables are 1.937, 1.842, and 1.824 respectively, which refers to acceptable moderate collinearity for all three variables. Table (8) reveals that education and income variables are statistically significant at 1% level but age variable is statistically significant at 5% level. These parameters suggest that the higher woman’s age, education and income parameters by one standard division, empowerment shifts by 0.163 SD, 0.478 SD, and 0.391 SD respectively. The measurement model shows that all five indicators are statistically significant (at 1% level). The coefficients reveal that as the women empowerment status varies by one SD, the indicators of inputs in productive decisions, resources’ ownership, income control, associations’ memberships and workload will vary by 0.939, 0.090, 0.928, 0.888 and -0.981 respectively. Similarly, these signs are logic. The values of  $X^2$ , CFI, TLI and SRMR criteria confirm the MIMIC model’s goodness of fit in Kobania sample.

**CONCLUSION**

This paper aims to analyze the economic aspect of Women Empowerment in Agriculture Index (WEAI) which is developed by Alkire, et.al. 2013 for 3 different simple random samples of beneficiaries’ households who utilize from specified international agricultural development projects which are assigned entirely or partially for women empowerment. The first sample are from beneficiaries’ households of Matrouh Rural

Sustainable Development “MARSDEV” project to represent North coast Region and the second and the third samples are from beneficiaries’ households of Women Economic Empowerment “WEE” project in Sohag and Aswan governorates respectively. The sub-objectives are: (1) calculating (WEAI) for the 3 samples, monitoring its development between 2017 (the terminal of each project) and 2022 (the current situation), and highlighting the main differences of the 10 indicators which are constituting (WEAI) between regions, (2) econometric estimating of the impact of some socioeconomic characteristics on the women empowerment status in 2022. In 2017. The socioeconomic characteristics of the three samples show that the majority of women who have inadequate scores in (5DE) are young adults, illiterate, and belong low income households. In 2022, inadequate women percentage decreases in favor of an increase in adequate women in middle and old aged categories (except for North Coast of Egypt, increase happens only in old aged women category). Furthermore, in 2022, adequate women also increase in high and intermediate education categories, and middle and high income categories. From the 10 indicators of the 5DE, the majority of women in 2017 have inadequate scores in the main 5 indicators: decisions related to the agricultural activities, assets’ ownership, control over the use of income, group membership, and workload in all the 3 samples. The inadequacy of these indicators may interpreted by many reasons; the first is most rural women have limited allowance decisions except for that related to livestock raising activity. The second is most of them don’t possess any major asset but only poultry, some sheep and goats and cell phone as a minor assets. Specific exception of assets’ ownership in Sohag governorate, upper Egypt as few women in the sample possess large livestock, high-tech sewing machines, and some of them managing micro enterprises of handicrafts by manual looms for manufacturing shawls, bed sheets and coverlets by a kind of Egyptian cultural heritage called Tally. The third that although women share men in agricultural activities as for example fig, olive and mint harvesting, and grazing sheep in Matrouh governorate, North Coast of Egypt. Most women in the three samples have intrinsic value to give up their roles in decisions and expenditure for their spouses, but also there is some exception in Sohag governorate that women have power to control the income use and other decisions as purchase resources and assets in case of the spouse’ absence to work abroad. The fourth, geographical isolation and illiteracy specifically in Matrouh governorate, North Coast of Egypt cause high inadequacy of group membership except few women in Sohag governorate, upper Egypt who are members in local community development associations, and few number constitute their own business groups, while the majority don’t have membership in any association or group. The fifth is that in addition to that most women work more than 10.5 hour/day in daily chores and farm activities in the two samples of south of Upper Egypt, Bedouin women in North Coast of Egypt spend extra time day by day for fetching potable water. Another distinctive result also is that the inadequacy scores of these indicators reduced 2022 due to improvement of the beneficiaries’ characteristics as age structure, education, and income through time and may pointed to project activities of MARSDEV which provides classes to eradicate illiteracy, training for income generations as pigeon towers, and wells to reduce time efforts, and fatigue for fetching water in North Coast of Egypt. WEE project also in South of Upper Egypt provides capacity building training to enhance the handicrafts products, business and entrepreneurship courses.

The result of Women Empowerment in Agriculture Index (WEAI) in the first sample in North Coast of Egypt sample in 2017 indicate that there is only 26.6% accomplishments in the weighted 5DE and GPI which reveal that women are empowered in only 27 % of the five dimensions of empowerment (5DE), and only 24% of them enjoy gender parity. In 2022, the (WEAI) score, (5DE), and (GPI) improve to %43, 44% and 30% respectively. The WEAI results in the second sample in Sohag governorate, South of Upper Egypt in 2017 indicate there is 51.2% accomplishments in the weighted 5DE and GPI which reveal that women are empowered in 51% of (5DE) and 53% of them enjoy gender parity. In 2022, the (WEAI) score, (5DE) score, and (GPI) increases to 71.2%, 71%, and 73% respectively. The WEAI results in the third sample in Aswan governorate, South of Upper Egypt in 2017 indicate there is 65.5% accomplishments in the weighted 5DE and GPI which reveal that women are empowered in 64% of (5DE) and 79% of them enjoy gender parity. In 2022, the (WEAI) score, (5DE) score, and (GPI) increases to 74%, 73%, and 86% respectively. These results indicate to two important issues: the first is the poorest situation of women empowerment in agriculture and gender parity is in the North Coast of Egypt. The better situation of empowerment and gender parity is in Sohag governorate followed in sequence by Aswan governorate, South of Upper Egypt. The second remark is that with time, the women empowerment in agriculture and gender parity indices improve which may interpreted by agricultural developments projects.

Finally, Multiple Indicators and Multiple Causes (MIMIC) model is applied for the econometric estimation of the impact of some socioeconomic on the women empowerment status in 2022. The mimic model results are categorized into two models: the structural model which explains the association between the observable exogenous explanatory continuous variables; age, education, and income and the underlying latent variable (Women Empowerment status), and the measurement model which explains the association between the main 5 manifested endogenous continuous indicators and the latent variables. The results explain that woman ‘age is the only exogenous variable which is affecting the women’s empowerment in North coast of Egypt because old age is the only source of power in the extended Bedouin families. Moreover, for other two samples of Sohag and Aswan governorate, the three observable variables women ‘age, education, and income affect the women’s empowerment significantly, it could be noticed that there is acceptable moderate collinearity between these variables to reveal and confirm that as woman’s age advances, her formal and informal education accessibility improves, her money’s earning increases, and consequently, her empowerment increases.

In the measurement model: the statistical significance of the five endogenous indicators confirms the existence of the latent variable, women’s empowerment status. It also displays that as the women empowerment status changes by one Standard Deviation, direct changes are occurred in the indicators’ magnitudes of “inputs in productive decisions”, “resources’ ownership”, “income control”, “and associations’ memberships”, and inverse change is occurred in the indicator’s magnitude “workload”. It could be recommended that: (1) there is a priority to intensify development projects assigned for women empowerment in North Coast of Egypt region followed by South of Upper Egypt; (2) the dire need to formulate programs and policies related to women empowerment in agriculture. The first mechanism to activate these policies is implementing a national observatory for

the ministry of agriculture and land reclamation that provide annually up-to – date data about the women empowerment dimensions and gender parity.

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**APPENDIX**

**Table 1. Distribution of respondents ‘women according to adequacy, socio-economic causes and indicators in Mathany community (2017-2022)**

| Factor                    | Category   | 2017(n=62)       |      |                 |      | 2022 (n=62)      |      |                 |      |
|---------------------------|--|------------------|------|-----------------|------|------------------|------|-----------------|------|
|                           |  | Inadequate(n=52) |      | Adequate (n=10) |      | Inadequate(n=40) |      | Adequate (n=22) |      |
|                           |  | Frequency        | %    | Frequency       | %    | Frequency        | %    | Frequency       | %    |
| Explanatory (causes)      | Category   |                  |      |                 |      |                  |      |                 |      |
| 1-Age(Years)              | Young adults (18- 28)                            | 40               | 64.5 | 0               | 0    | 30               | 48.4 | 0               | 0    |
|                           | Middle-aged adults (29- 39)                      | 12               | 19.4 | 0               | 0    | 10               | 16.1 | 0               | 0    |
|                           | Old-aged adults (40>)                            | 0                | 0    | 10              | 16.1 | 0                | 0    | 22              | 35.5 |
| 2-Education level (Years) | Illiterate(1<6)                                  | 48               | 77.4 | 0               | 0    | 33               | 53.2 | 0               | 0    |
|                           | Intermediate (6-12)                              | 4                | 6.5  | 0               | 0    | 7                | 11.3 | 0               | 0    |
|                           | High(13>)  | 0                | 0    | 10              | 16.1 | 0                | 0    | 22              | 35.5 |
| 3-Income (L.E./year)      | Low (<20000/year)                                | 40               | 64.5 | 0               | 0    | 30               | 48.4 | 0               | 0    |
|                           | Middle (20000–40000/year)                        | 12               | 19.4 | 8               | 12.9 | 10               | 16.1 | 10              | 16.1 |
|                           | High (>40000/year)                               | 0                | 0    | 2               | 3.2  | 0                | 0    | 12              | 19.4 |
| Empowerment Dimensions    | Indicators                                       |                  |      |                 |      |                  |      |                 |      |
| Production                | 1-Production decision-making                     | 52               | 83.9 | 10              | 16.1 | 38               | 61.3 | 24              | 38.7 |
|                           | 2-RAI  | 20               | 32.3 | 42              | 67.7 | 8                | 12.9 | 54              | 87.1 |
|                           | 3-Ownership of land and assets                   | 52               | 83.9 | 10              | 16.1 | 40               | 64.5 | 22              | 35.5 |
| Resources                 | 4-Decisions of purchase, sale or transfer asset. | 25               | 40.3 | 37              | 59.7 | 10               | 16.1 | 52              | 83.9 |
|                           | 5-Access to credit                               | 20               | 32.3 | 42              | 67.7 | 10               | 16.1 | 52              | 83.9 |
| Income                    | 6-Control over use of income                     | 50               | 80.6 | 12              | 19.4 | 40               | 64.5 | 22              | 35.5 |
| Leadership                | 7-Group membership                               | 40               | 64.5 | 22              | 35.5 | 35               | 56.5 | 27              | 43.5 |
|                           | 8-Speaking in public                             | 25               | 40.3 | 37              | 59.7 | 10               | 16.1 | 52              | 83.9 |
| Time                      | 9-Workload                                       | 40               | 64.5 | 22              | 35.5 | 32               | 51.6 | 30              | 48.4 |
|                           | 10-Leisure                                       | 25               | 40.3 | 37              | 59.7 | 10               | 16.1 | 52              | 83.9 |

Source: calculated by the author from in-depth interview sample



**Table 2. Distribution of respondents ‘women according to adequacy, socio-economic causes and indicators in Shandaweel Island village (2017-2022)**

| Factor                    | Category   | 2017(n=48)       |      |                 |      | 2022 (n=48)      |       |                 |       |
|---------------------------|--|------------------|------|-----------------|------|------------------|-------|-----------------|-------|
|                           |  | Inadequate(n=35) |      | Adequate (n=13) |      | Inadequate(n=21) |       | Adequate (n=27) |       |
|                           |  | Frequency        | %    | Frequency       | %    | Frequency        | %     | Frequency       | %     |
| Explanatory (causes)      | Young adults (18- 28)                            | 32               | 66.7 | 0               | 0    | 20               | 41.7  | 0               | 0     |
| 1-Age(Years)              | Middle-aged adults (29- 39)                      | 3                | 6.2  | 0               | 0    | 1                | 2.1   | 20              | 41.7  |
|                           | Old-aged adults (40>)                            | 0                | 0    | 13              | 27.1 | 0                | 0     | 7               | 14.5  |
| 2-Education level (Years) | Illiterate(1<6)                                  | 25               | 52.1 | 0               | 0    | 15               | 31.25 | 0               | 0     |
|                           | Intermediate (6-12)                              | 10               | 20.8 | 0               | 0    | 6                | 12.5  | 15              | 31.25 |
|                           | High(13>)  | 0                | 0    | 13              | 27.1 | 0                | 0     | 12              | 25    |
| 3-Income (L.E./year)      | Low (<20000/year)                                | 20               | 41.7 | 0               | 0    | 20               | 41.7  | 0               | 0     |
|                           | Middle (20000-40000/year)                        | 15               | 31.2 | 0               | 0    | 1                | 2.1   | 10              | 20.8  |
|                           | High (>40000/year)                               | 0                | 0    | 13              | 27.1 | 0                | 0     | 17              | 35.4  |
| Empowerment Dimensions    | Indicators                                       |                  |      |                 |      |                  |       |                 |       |
| Production                | 1-Production decision-making                     | 29               | 60.4 | 19              | 39.6 | 20               | 41.7  | 28              | 58.3  |
|                           | 2-RAI  | 7                | 14.6 | 41              | 85.4 | 7                | 14.6  | 41              | 85.4  |
|                           | 3-Ownership of land and assets                   | 35               | 72.9 | 13              | 27.1 | 21               | 43.8  | 27              | 56.2  |
| Resources                 | 4-Decisions of purchase, sale or transfer asset. | 7                | 14.6 | 41              | 85.4 | 7                | 14.6  | 41              | 85.4  |
|                           | 5-Access to credit                               | 9                | 18.7 | 39              | 81.3 | 7                | 14.6  | 41              | 85.4  |
| Income                    | 6-Control over use of income                     | 35               | 72.9 | 13              | 27.1 | 20               | 41.7  | 28              | 58.3  |
| Leadership                | 7-Group membership                               | 27               | 56.2 | 21              | 43.8 | 18               | 37.5  | 30              | 62.5  |
|                           | 8-Speaking in public                             | 9                | 18.7 | 39              | 81.3 | 7                | 14.6  | 41              | 85.4  |
| Time                      | 9-Workload                                       | 35               | 72.9 | 13              | 27.1 | 18               | 37.5  | 30              | 62.5  |
|                           | 10-Leisure                                       | 7                | 14.6 | 41              | 85.4 | 9                | 18.7  | 39              | 81.3  |

Source: calculated by the author from in-depth interview sample.

**Table 3. Distribution of respondents ‘women according to adequacy, socio-economic causes and indicators in Kobania Village (2017-2022)**

| Factor                    | Category   | 2017(n=57)       |      |                |      | 2022 (n=57)      |      |                 |      |
|---------------------------|--|------------------|------|----------------|------|------------------|------|-----------------|------|
|                           |  | Inadequate(n=51) |      | Adequate (n=6) |      | Inadequate(n=38) |      | Adequate (n=19) |      |
|                           |  | Frequency        | %    | Frequency      | %    | Frequency        | %    | Frequency       | %    |
| Explanatory (causes)      | Young adults (18- 28)                            | 44               | 77.2 | 0              | 0    | 32               | 56.1 | 0               | 0    |
| 1-Age(Years)              | Middle-aged adults (29- 39)                      | 7                | 12.3 | 0              | 0    | 6                | 10.5 | 9               | 15.8 |
|                           | Old-aged adults (40>)                            | 0                | 0    | 6              | 10.5 | 0                | 0    | 10              | 17.6 |
| 2-Education level (Years) | Illiterate(1<6)                                  | 31               | 54.4 | 0              | 0    | 30               | 52.6 | 0               | 0    |
|                           | Intermediate (6-12)                              | 20               | 35.1 | 0              | 0    | 8                | 14   | 9               | 15.8 |
|                           | High(13>)  | 0                | 0    | 6              | 10.5 | 0                | 0    | 10              | 17.6 |
| 3-Income (L.E./year)      | Low (<20000/year)                                | 26               | 45.6 | 0              | 0    | 31               | 54.4 | 0               | 0    |
|                           | Middle (20000-40000/year)                        | 25               | 43.9 | 0              | 0    | 7                | 12.2 | 9               | 15.8 |
|                           | High (>40000/year)                               | 0                | 0    | 6              | 10.5 | 0                | 0    | 10              | 17.6 |
| Empowerment Dimensions    | Indicators                                       |                  |      |                |      |                  |      |                 |      |
| Production                | 1-Production decision-making                     | 48               | 84.2 | 9              | 15.8 | 32               | 56.1 | 25              | 43.9 |
|                           | 2-RAI  | 10               | 17.5 | 47             | 82.5 | 5                | 8.8  | 52              | 91.2 |
|                           | 3-Ownership of land and assets                   | 49               | 86   | 8              | 14   | 37               | 64.9 | 20              | 35.1 |
| Resources                 | 4-Decisions of purchase, sale or transfer asset. | 10               | 17.5 | 47             | 82.5 | 5                | 8.8  | 52              | 91.2 |
|                           | 5-Access to credit                               | 10               | 17.5 | 47             | 82.5 | 5                | 8.8  | 52              | 91.2 |
| Income                    | 6-Control over use of income                     | 51               | 89.5 | 6              | 10.5 | 38               | 66.7 | 19              | 33.3 |
| Leadership                | 7-Group membership                               | 45               | 78.9 | 12             | 21.1 | 30               | 52.6 | 27              | 47.4 |
|                           | 8-Speaking in public                             | 7                | 12.3 | 50             | 87.7 | 6                | 10.5 | 51              | 89.5 |
| Time                      | 9-Workload                                       | 42               | 73.7 | 15             | 26.3 | 30               | 52.6 | 27              | 47.4 |
|                           | 10-Leisure                                       | 9                | 15.7 | 48             | 84.2 | 5                | 8.8  | 52              | 91.2 |

Source: calculated by the author from in-depth interview sample.

**Table 4. Results of Women Empowerment in Agriculture Index (WEAI) in 2017 and 2022**

| Item   | Mathany community               |                      | Shandaweel Island              |                      | Kobania Village                 |                     |
|--|---------------------------------|----------------------|--------------------------------|----------------------|---------------------------------|---------------------|
|  | 2017                            | 2022                 | 2017                           | 2022                 | 2017                            | 2022                |
| Total dual adult-households sample (m)   | 24 households                   |                      | 19households                   |                      | 28 households                   |                     |
| Total number of individuals (n)  | 124 observations, 62 F and 62 M |                      | 96 observations, 48 F and 48 M |                      | 114 observations, 57 F and 57 M |                     |
| Disempowered individuals(q)  | 52                              | 40                   | 35                             | 21                   | 51                              | 38                  |
| Disempowerment Headcount Ratio(Hp)   | 0.84                            | 0.65                 | 0.73                           | 0.44                 | 0.89                            | 0.67                |
| Intensity of disempowerment(average of inadequacy score ) (AP)                                       | 0.87                            | 0.87                 | 0.67                           | 0.67                 | 0.4                             | 0.4                 |
| Disempowerment index (M0)=(Hp)X(AP)  | 0.73                            | 0.56                 | 0.49                           | 0.29                 | 0.36                            | 0.27                |
| Empowerment index (SDE)=1-(M0)   | 0.27                            | 0.44                 | 0.51                           | 0.71                 | 0.64                            | 0.73                |
| Households suffering gender disparity (r)  | 22                              | 20                   | 15                             | 9                    | 24                              | 16                  |
| % of households have gender disparity (HGPI)= (r) suffering households/ (m) total households sample) | 0.91                            | 0.83                 | 0.79                           | 0.47                 | 0.86                            | 0.75                |
| Intensity or average empowerment gap(I GPI)  | 0.84                            | 0.84                 | 0.59                           | 0.57                 | 0.25                            | 0.25                |
| Gender Parity Index (GPI)=1- (HGPI X IGPI)   | 0.24(=1-0.91 X 0.84)            | 0.30(=1-0.83 X 0.84) | 0.53(=1-0.79 X 0.59)           | 0.73(=1-0.47 X 0.57) | 0.79(1-0.86 X 0.25)             | 0.86(1-0.57 X 0.25) |
| WEAI = 0.9(SDE) + 0.1(GPI)   | 0.266                           | 0.430                | 0.512                          | 0.712                | 0.655                           | 0.74                |

Source: calculated by the author

**Table 5. Collinearity diagnosis for exogenous variables by Variance Inflation Factor (VIF)**

| Model           | Age (X1) | Education (X2) | Income(X3) |
|-----------------|----------|----------------|------------|
| Mathany,2022    | 4.630**  | 8.027***       | 10.021***  |
| Shandaweel,2022 | 3.370**  | 1.965**        | 2.657**    |
| Kobania,2022    | 1.937**  | 1.842**        | 1.824**    |

The rule of thumb :( \*) VIF=1, Not Collinearity; (\*\*) VIF>1 to 5, Moderate Collinearity; (\*\*\*) VIF> 5, Serious Collinearity.

Source: calculated by the author by JASP software.

**Table 6. Results of MIMIC Model of Women's Empowerment in Mathany community**

| Model                          | Coefficient | S.E   | Standard Coefficient | R <sup>2</sup> |
|--------------------------------|-------------|-------|----------------------|----------------|
| Structural Model               |             |       |                      |                |
| Age(                           | 5.281***    | 0.789 | 0.968                |                |
| Education                      | -0.563      | 0.520 | -0.093               |                |
| Income(X3)                     | 0.573       | 0.546 | 0.102                |                |
| Measurement Model              |             |       |                      |                |
| Inputs in productive decisions | 0.159***    | 0.023 | 0.947                | 0.897          |
| Resources' ownership           | 0.035***    | 0.005 | 0.979                | 0.958          |
| Income control                 | 0.253***    | 0.038 | 0.903                | 0.815          |
| Associations' Memberships      | 0.019***    | 0.003 | 0.902                | 0.814          |
| Workload                       | -0.022***   | 0.003 | -0.980               | 0.961          |
| R <sup>2</sup> (Total)         |             |       |                      | 0.960          |

Model Fitting: Baseline Model X<sup>2</sup>, DF.25 = 716.398\*\*\* &

Factor Model X<sup>2</sup>, DF.17 = 48.508\*\*\*.

CFI=(0.954); TLI=(0.933); RMSEA=(0.173); SARMR=(0.022)<sup>†</sup>

The rule of thumb: the model has appropriate fit if (f) Comparative Fit Index (CFI)>0.9; (h) Tucker-Lewis Index (TLI)>0.9; (hh) Root Mean Square Error of Approximation (RMSEA) < 0.05; (hhh) Standardized Root Mean Square Residuals (SRMR) < 0.08; (c) Significant; and (-) Insignificant.\*\* and \*\*\* denote the statistical significance at 5% and 1% respectively.

Source: calculated by the author by JASP software.

**Table 7. Results of MIMIC Model of Women's Empowerment in Shandaweel Island village**

| Model                          | Coefficient | S.E   | Standard Coefficient | R <sup>2</sup> |
|--------------------------------|-------------|-------|----------------------|----------------|
| Structural Model               |             |       |                      |                |
| Age                            | 1.860***    | 0.385 | 0.527                | -              |
| Education                      | 0.650**     | 0.331 | 0.142                | -              |
| Income                         | 1.346***    | 0.336 | 0.364                | -              |
| Measurement Model              |             |       |                      |                |
| Inputs in productive decisions | 0.252***    | 0.032 | 0.966                | 0.933          |
| Resources' ownership           | 0.051***    | 0.006 | 0.980                | 0.960          |
| Income control                 | 0.489***    | 0.061 | 0.964                | 0.929          |
| Associations' Memberships      | 0.038***    | 0.005 | 0.901                | 0.812          |
| Workload                       | -0.035***   | 0.004 | -0.972               | 0.945          |
| R <sup>2</sup> (Total)         |             |       |                      | 0.90           |

Model Fitting: Baseline Model X<sup>2</sup>, DF.25 = 595.87\*\*\* &

Factor Model X<sup>2</sup>, DF.17 = 66.428\*\*\*.

CFI=(0.913); TLI=(0.873); RMSEA=(0.246); SARMR=(0.026)<sup>†</sup>

The rule of thumb: the model has appropriate fit if (f) Comparative Fit Index (CFI)>0.9; (h) Tucker-Lewis Index (TLI)>0.9; (hh) Root Mean Square Error of Approximation (RMSEA) < 0.05; (hhh) Standardized Root Mean Square Residuals (SRMR) < 0.08; (c) Significant; and (-) Insignificant.\*\* and \*\*\* denote the statistical significance at 5% and 1% respectively.

Source: calculated by the author by JASP software.

**Table 8. Results of MIMIC Model of Women's Empowerment in Kobania village**

| Model                          | Coefficient | S.E   | Standard Coefficient | R <sup>2</sup> |
|--------------------------------|-------------|-------|----------------------|----------------|
| Structural Model               |             |       |                      |                |
| Age                            | 0.537**     | 0.284 | 0.163                | -              |
| Education                      | 1.492***    | 0.298 | 0.478                | -              |
| Income                         | 1.135***    | 0.265 | 0.391                | -              |
| Measurement Model              |             |       |                      |                |
| Inputs in productive decisions | 0.336***    | 0.037 | 0.939                | 0.883          |
| Resources' ownership           | 0.075***    | 0.008 | 0.090                | 0.964          |
| Income control                 | 0.595***    | 0.068 | 0.928                | 0.860          |
| Associations' Memberships      | 0.041***    | 0.005 | 0.888                | 0.789          |
| Workload                       | -0.048***   | 0.005 | -0.981               | 0.963          |
| R <sup>2</sup> (Total)         |             |       |                      | 0.805          |

Model Fitting: Baseline Model X<sup>2</sup>, DF.25 = 594.8\*\*\* &

Factor Model X<sup>2</sup>, DF.17 = 48.258\*\*\*.

CFI=(0.945); TLI=(0.919); RMSEA=(0.180); SARMR=(0.027)<sup>†</sup>

The rule of thumb: the model has appropriate fit if (f) Comparative Fit Index (CFI)>0.9; (h) Tucker-Lewis Index (TLI)>0.9; (hh) Root Mean Square Error of Approximation (RMSEA) < 0.05; (hhh) Standardized Root Mean Square Residuals (SRMR) < 0.08; (c) Significant; and (-) Insignificant.\*\* and \*\*\* denote the statistical significance at 5% and 1% respectively.

Source: calculated by the author by JASP software.

## التحليل الإقتصادي لمؤشر تمكين المرأة في الزراعة ، دراسة مقارنة بين بعض أقاليم جمهورية مصر العربية

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قسم الدراسات الإقتصادية ، شعبة الدراسات الإقتصادية والإجتماعية ، مركز بحوث الصحراء ، ش متحف المطرية ، ص.ب. 11714 ، القاهرة ، ج.م.ع.

يستهدف البحث التحليل الإقتصادي لمؤشر تمكين المرأة في الزراعة WEAI لثلاث عينات عشوائية بسيطة للمنتفعين من بعض مشروعات التنمية الزراعية كمشروع MARSDEV بمطروح ، إقليم الساحل الشمالي ، ومشروع WEE بسوهاج وأسوان ، إقليم جنوب الصعيد ج.م.ع. من خلال (1) حساب مؤشر WEAI بمكونيه: أبعاد التمكين الخمسة -SDE ( الإنتاج، الموارد، الدخل، القيادة ، أعباء العمل والفراغ) ، و المساواة بين الجنسين GPI ، ورصد تغييرات المؤشر بين عامي 2017 ( إنتهاء المشروع ) و 2022 ( الوضع الراهن) ، وإلقاء الضوء على إختلافات المؤشر بإقليمي الدراسة (2) التقدير القياسي لأثر بعض الخصائص الإقتصادية الإجتماعية على المتغير الكامن (تمكين المرأة) عام 2022 من خلال النموذج البنائي القياسي متعدد المؤشرات - متعدد الأسباب MIMIC . أوضحت النتائج أن أغلب النساء اللاتي توصفن بعدم التمكين من الفئات العمرية صغيرة السن ، ومستوى تعليمي منخفض ومستوى دخل منخفض. ويعتبر إقليم الساحل الشمالي هو الأسوأ من حيث مؤشر التمكين والذي بلغ 26.6% عام 2017 مشيراً إلى إحرار إنجازات ضعيفة في أبعاد التمكين الخمسة والمساواة بين الجنسين. وفي عام 2022 تحسنت قيمة المؤشر للعينات الثلاث نتيجة لجهود التنمية الزراعية . أوضحت نتائج نموذج MIMIC أن عمر المبحوثة هو المصدر الوحيد للتمكين بالأسر البدوية الممتدة بإقليم الساحل الشمالي ، في حين تؤثر متغيرات العمر والتعليم والدخل معا على تمكين المرأة بإقليم جنوب الصعيد. وتبين أيضاً أن تغيراً قدره وحدة معيارية لمتغير التمكين يسبب تغييراً طردياً في مؤشرات التمكين عدا مؤشر أعباء العمل ، الذي يتناسب عكسياً مع متغير التمكين. يوصى بإعادة توجيه أولويات التنمية إلى إقليم الساحل الشمالي ، وإعداد مرصد قومي لرصد تحديات مؤشر تمكين المرأة في الزراعة.