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Extensional and Economic Requirements for Applying Contract Farming on Oilseed Sunflower Crop between Farmers of West-Minya and Surrounded Zones

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ABSTRACT

The research problem is lack of oilseed sunflower area in West Minya (WM) in the national project "Cultivation 1.5 Million Feddan", Middle Egypt (ME) and Bani Mazaar (BM). The aims are: identify extensional requirements (knowledge, attitude, practice and behavior (KAPB)) and economic requirements (technical efficiency (TE_{CRS}) and economic efficiency (CE) for applying sunflower contracting.531 farmers are selected by simple random sampling. Only 90 farmers represent 16.9% respond to sunflower contracting following Desert Research Center' demo-plots. Data are collected by personal interview during Nov. 2021 to May2022. Descriptive statistics, correlation, multiple regression, and Data Envelopment analysis (DEA) are employed to achieve these aims. Results are: the lowest (KAPB) levels are in WM (52.2%, 48%, 44.8% and 48.3%), while the highest scores are in ME (88%, 82%, 80% and 80.7%). Pearson correlation demonstrates significant positive relationships between farmers' behavior and education, income and experience, while significant negative correlations with age. (R^{2}) of multiple linear regression proves that independent variables explain (72%, 82 % and 86%) of respondents 'behavior in three zones respectively. (DEA) demonstrates that sunflower isn't produced efficiently (TE_{CRS}= 0.878 and CE=0.796) i.e. the same output can be achieved even if inputs and costs are decreased by (12.2%) and (20.4%). Additionally, WM'farmers are the least efficient than others, conversely, ME 'farmers are the highest efficient. To achieve the target output (1076.46 kg/Fadden), it is recommended to rationalize and re-allocate excessive resources. Also, Nash equilibrium (win, win) is achieved if decision maker provides flexible floor price, extensional service and recycles by- products.

***Keywords*:** Behavior; Data Envelopment; Nash Equilibrium

INTRODUCTION

In the era of epidemics and wars, most developing countries face a challenge in food availability specifically the net food imports 'countries. Egypt is one of these countries which imports the main strategic crops such as cereals and vegetable oils. Indeed, the edible vegetable oils sector in Egypt is exposed to a number of challenges represented in: (1) the small cultivated area of oil crops (soybean, sunflower, sesame and groundnuts) which ranges between 277 to 264 thousand Feddan represents 1.77 % to 1.63% of the cropped area which ranges between 15.64 to 16.21 million Feddan during 2016-2021 Agricultural Statistics (2016-2021) , (2) the low self-sufficiency rate of domestic oil production which is extracted from domestic oilseeds where it ranges between 58 to 85 thousand ton represents 3.31% to 6.68% of the domestic vegetable oil supply which ranges between 1.752 to 1.273 million tons during 2016-2021 Food Balance Statistics (2016-2021) and (3) the imports value of edible vegetable oils is L.E.19152 million which represent 8.32% of the total imports in the food balance trade which is L.E.230142 million Foreign Trade Statistics (2016-2021). Furthermore, the oilseeds sunflower crop as one of the important vegetable oil crops shows a poor position that its cultivated area is 1335.3 Feddan represents only 5.90% of the total cultivated sunflower area which is 22628.2 Feddan during 2016-2021 Agricultural Statistics (2016-2021). At the same time the imports value of sunflower oil is L.E.4333 million represents 22.6% of the imports value of edible vegetable oils which is L.E.19152 million Foreign Trade Statistics (2016-2021).

In anticipation of these challenges, the government of Egypt adopts the policy of land reclamation and horizontal expansion since the sixtieth of the last century to establish new rural communities and face the population growth and food demand. The national project "Cultivation of One and half Million Fadden" which is established in 2016 and administrated by the Egyptian Countryside Development Company **(**ECDC**)** is one of these ambitious reclamation projects. Furthermore, West Minya zone is considered one of the important zones in the project in term of its reclaimed area which is about 620000 Feddan, represents 41.33% of the project area. NWRC (2017). Also, the early graduated youths' project in Middle Egypt zone is another project which is reclaimed and established in 1986, covers 49274 Feddan and is administered by the General District of Development and Cooperative (GDDC) of El-Minya and Beni-Suef governorates GDDC (2021). It is imposed that the two mentioned projects in addition to the old valley in El Minya governorate contribute in filling the strategic crops shortage specifically the oil crops. Although oilseed sunflower is

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recommended to be cultivated in the summer crop pattern in West Minya zone under salinity of 2000 to 3000 ppm NWRC (2017), neither oil-type nor non-oil type of sunflower crop are presented in the 2021 statistics of the project. Similarly, in Middle Egypt zone neither oil-type nor non-oil type of sunflower crop are displayed in the 2021 statistics. Moreover, in the old valley of El-Minya governorate which places in the fourth rank of cultivated sunflower area. A total of 1194 Fadden of non-oil type is cultivated, represents 5.9% of the total cultivated sunflower area in Egypt which is 22628.2 Feddan during 2016-2021 Agricultural statistics (2016-2021).

To encourage small-scale farmers to contract on the oilseed sunflower in these zones, Desert Research Center (DRC) designs and funds an experimental program titled "Extensional Campaign for Improving the Economic Efficiency of Oil Crops 'Value Chains-ECIVC" in West Minya and surrounded area during Nov. 2022 to May2022. The program sets up ten demo-plots: two demo plots in West Minya zone, four demo-plots in Middle Egypt zone and four demo-plots in the old valley of El-Minya. Additionally, ECIVC team in corporation with the Contracting Farm Center (CFC) provide trainings to improve the farmers' knowledge, attitude, practices and behavior (KAPBs)towards contract farming of oilseed sunflower. On the other hand, demo-plots introduces the good agricultural practices (GAPS) which can help in dissemination of oil-type cultivation and improve their economic efficiency.

Problem statement

Based on the mentioned presentation of the current status of oil crops specifically oilseed sunflower , the main problem of this research is identified by the lack of cultivated area of oilseed sunflower whether in the newly reclaimed lands or in the old valley of El-Minya governorate which is may return to shortage of knowledge, negative attitudes and incorrect agricultural practices of farmers towards oil-type sunflower which is grown under the contract farming in addition to the inefficiency of managing the economic resources. Therefore, the paper questions are classified into extensional and economic approaches of questions. The extensional questions are: (1) what is the current levels of knowledge, attitude, practice and behavior (KAPBs) of farmers towards contract farming of oilseed sunflower in the three zones?, then, is there any difference in the levels of KAPBs between farmers from different zones?, (2) is there a correlation between farmers' behavior towards contract farming of oilseed sunflower in the three zones and their socio-demographic characteristics?, and (3)what are the impact of the respondents' socio-demographic characteristics on the farmers' behavior?. The economic questions are : (1) is the contract farming succeed to achieve the technical, allocative and economic efficiency in managing the agricultural resources to produce oilseed sunflower in the three zones?, then, is there a significant difference between the levels of efficiency criteria in the different zones?, (2) what are the efficient target mean scores of inputs and outputs on the frontier of the isoquant curve?, (3) how much the deficit (the surplus) of output/inputs between the actual and the target mean scores on the frontier of the isoquant curve?, and (4) is the contract farming of oilseed sunflower succeeded to achieve Nash Equilibrium situation?

Objectives

According to the described problem statement and research questions, the main objective of this paper is documented by identifying the most important extensional requirements for applying the contract farming on oilseed sunflower in West-Menia and surrounded zones through:

1- Identifying the socio-demographic characteristics of the respondents in the three zones and inspecting the differences between farmers from different zones,
2- Identifying the current levels of knowledge, attitude, practice and behavior (KAPBs) of farmers towards contract farming of oilseed sunflower in the three zones, in addition to inspecting the statistical significance of differences in the KAPBs levels between farmers from different zones,
3- Identifying and inspecting the correlation between farmers' behavior towards contract farming of oilseed sunflower in the three zones and their socio-demographic characteristics,
4- Econometric estimating of the impact of the farmers' socio-demographic characteristics on the farmers behavior,

In addition to identifying the most important economic requirements through:

1- Identifying the descriptive statistics of outputs and inputs quantities of oilseed sunflower crop and inspecting the differences between different zones,
2- Econometric estimating of the technical, allocative and economic efficiency scores of oilseed sunflower production under contract farming in the three zones, in addition to inspecting the statistical significance of differences in the efficiency criteria 'scores between farmers from different zones,
3- Calculating the target mean scores of inputs and outputs on the frontier of the isoquant curve.
4- Calculating the deficit (the surplus) of output/inputs between the actual and the target mean scores on the frontier of the isoquant curve.
5- Identifying the optimal contracting situation of oilseed sunflower which achieve Nash Equilibrium.

Hypotheses

In the extensional model:

1- the null hypothesis of the respondents 'characteristics - $H_{0\varphi}$: no statistical significant differences between the respondents' socio-demographic characteristics in the three zones,
2- The null hypothesis of the first objective - H_{01} no statistical significant differences in the KAPBs levels between farmers towards contract farming of oilseed sunflower in the three zones,
3- The null hypothesis of the second objective - H_{02} : no statistical significant correlation between farmers' behavior towards contract farming of oilseed sunflower in the three zones and their socio-demographic characteristics,
4- The null hypothesis of the third objective - H_{03}: no statistical significant impact of the farmers' socio-demographic characteristics on the farmers' behavior.

In the economic model:

1- The null hypothesis of output/inputs - $H_{0\varphi}{}^{\varepsilon}$: no statistical significant differences of oilseed sunflower output/inputs between the three zones,

2- The null hypothesis of the first objective-H_{01}^{ε}: no statistical significance of differences in the scores of (total technical efficiency $H_{01/1}^{\varepsilon}$, pure technical efficiency $H_{01/2}^{\varepsilon}$, scale efficiency $H_{01/3}^{\varepsilon}$, economic efficiency $H_{01/4}^{\varepsilon}$ and allocative efficiency $H_{1/5}^{\varepsilon}$) between farmers of oilseed sunflower crop from different zones.

Importance of the research

This paper introduces some actions and procedures which could be considered by the decision makers to expand the cultivation of oilseed sunflower crop under contract farming. These procedures include the extensional services and the economic environment which encourage farmers to cultivate oilseed sunflower under contract farming in the newly reclaimed lands.

Operational definition

The operational definitions of this paper consist of two approaches:

The extensional requirements which include the level of knowledge, attitude, practice and behavior (KAPBs) of farmers towards contract farming of oilseed sunflower in the three zones.

The economic requirements which include the technical, allocative and economic efficiency levels of oilseed sunflower production under contract farming in the three zones, in addition to the equilibrium contract price.

1.Literature Review

Contract farming (CF) becomes a new popular channel which links farmers with buyers in one or more agri-food business chains (processing, distribution and consumption). Will (2013) describes CF as a vertical integration relates to a merger of two or more nodes of value chain within one firm. This integration may be classified as backward integration of processors into farming or forward integration of farms into trading and or processing. Contract farming (CF) is defined as forward agreements specifying the obligations of farmers and buyers as partners in business. Legally, farming contracts involve the sellers' (farmers') commitment to supply the specified quantities, and the buyers' (processors'/ traders') duty to off-take the goods and introduces the agreed payments. Moreover, the buyers normally afford to deliver inputs (e.g. seeds, fertilizers and other production inputs); financial credit and other non-financial services (e.g. training, extension, transport and other logistic services) FAO (2012). Generally, contract farming are classified into five models: (1) informal models, (2) intermediary models, (3) multipartite models, (4) centralized models, and (5) nucleus estate models Baumann (2000); Eaton and shepherd (2001); Bijman 2008).In *informal CF model*: small firms accomplish simple, informal seasonal production contracts with smallholders, while in *intermediary CF model*: the intermediary provides embedded services and facilities in charge and purchase the crop. Instead, in *multipartite CF model*: the farm – firm arrangement accompanied by agreements with 3rd party service providers (such as companies, financial institutions and cooperatives), while in *centralized CF model*: the buyers 'involvement may vary from specifying seed varieties to control the whole production and harvesting processes. Lastly, *nucleus estate CF model*: the buyer invests in her/his own lands, machines of processing to construct nucleus estate, in which farmers are linked to provide their obligations. There is no scheme for the design and operation of successful contract farming arrangements. Rather every scheme depends on market opportunities, product features and national and international conditions FAO (2012).

Certainly, CF has many advantages for farmers and whole parties in the agri-food business. CF can help increase agricultural productivity, improve the livelihood of poor farmers; and play an important role in preventing rural exodus Sita, *et al.* (2018). Also, contract farming can improve the integration between farmers and inputs 'suppliers, enhance value chains, and reduce overhead costs Baumann (2000); Saes (2005). Nationally, some researchers pointed to the advantages of CF for farmers, contract parties (mediators, processors, companies) and the macroeconomic structure. For farmers, CF can help assure the marketing of the crops in terms of a stationary farm gate price and net return, reduce the impacts of agricultural risk and uncertainty, provide some inputs, awareness and extensional services relating to new technology, reduce marketing waste and improve production and marketing efficiency. For contract party, CF can help sustain the product supply and assure the information consistency. For macroeconomic structure, contract farming can help avoid the negative impacts of small scale farms, increase national add-value, agricultural income and food safety Elnefili and Hussein (2018).

On the other hands, another national researches survey the most important constraints of CF from farmers' points of views and suggested solutions. Undoubtedly, the majority of farmers complain against the buyers' violation of receipt and payment dates which put farmers in a risk. Farmers suggest to intervene the cooperatives and or the extensional agency Shalaby (2013). Additionally, dispersion of small scale farms, poor facilities of agricultural marketing, risk averse attitudes of farmers, inconsistent information of quantity, quality and prices and slow litigation procedures are additional constraints of CF Elnefili and Hussein (2018). Mohamed and Ghaly (2021) point to that the absent role of authority in contract procedures gives the buyers a manipulation power to reduce the quality gradation in order to reduce deal' prices. Kassem (2020) suggests a strategy to develop the contract farming through improving the supply chains of crops and final products, increasing the investments and capacity of processing plants to increase the contract farms. Also, Zahran *et al.* (2012) suggest that the preferred contract farming model is contracting directly between agribusiness firms and farmers to provide annually renewable documented contract; production inputs; extensional services and fixed price. They suggested also to constitute a dispute resolution committee to judge between the farmers and the companies.

Generally, the main challenges face the oil crops in Egypt are: the diminishing of cultivated area and production of oil crops which threaten the domestic supply and consumption of vegetable oils, increasing the food gap of oil crops and diminishing of the self- sufficiency from 95% in sixtieth to 60% in seventieth to 30% in eightieth, to10 % in ninetieth and less than 10% during 2000-2010 which causing high value of imports and deficits in trade and payments balances Nassar, (2015). The domestic production of vegetable oils only covers the domestic consumption till 52.58 day/year during (1995-2011) Sayed (2013). Also, productivity of Sunflower in main producing governorates is diminishing specifically in EL-Minya governorate, which is 1.05 ton/Feddan, places in the 5th order which is a back rank comparing to the other governorates

Hussein et.al.(2019). Moreover, Farmers give up to cultivate vegetable oil crops during 2000-2015 due to the agricultural policy which are adopted by the government to increase the cultivated cereals area which negatively affects the oil crops area Aly (2019).

Specifically, the most important constraints of the expansion of cultivating sunflower oil species are: low price of contracts, high cost of production inputs specifically chemical fertilizers , poor agricultural practices, low productivity per Feddan , lack of extensional brochures and absence role of the governmental contracting procedures El-Tantawy et.al.(2016) .On the other hand, the most important independent variables affecting the current cultivated area of sunflower crop are: one-year lagged gate price and cultivated area Sharabi (2014). Regarding to the main agricultural inputs of sunflower crop, researches point to the chemical nutrients, the manual labor, and the machinery which should be blended and employed efficiently to minimize their cost and maximize production Nassar (2015). In another research, manual labor and machinery labor represent 100% of sunflower production cost Mohamed and Ghali (2014). However, in another research, wages is considered a main constraint of cost production because sunflower crop is a labor intensive crop Aly (2019). Additionally, some recommendations are proposed: setting a guarantee price covers the production cost and equals to the world price, also establishing suitable storage system provided by aeration cooling and moisture controlling to prevent seeds mold and quality damage Nassar (2015), organizing farmers in groups to benefit from the economies of scales and extensional services in addition to improve the contracts commitments for all parties Mohamed and Ghali (2014), and creating new investment opportunities in the industrial zones and removing all threatens and weakness of its development Mohamed (2019).In the future, it is possible to improve the self-sufficiency rates of oil crops and alleviate its gap by employing the available scarce resource efficiently, high productive species, and adopting motivating policies to stimulate farmers to cultivate oil crops. Extensional means, agents, and communication also play an important role for disseminating the new productive species, rationalizing consumption and reduce waste Saber, *et al.* (2015)

Methodology

Geographical scope

This research is conducted in three separated but adjacent zones in El-Minya governorate, namely; West Minya zone, Middle Egypt zone and Bani Mazaar district[i]. Mainly, the research is conducted in West Minya zone due to it being the largest reclaimed area of the national project "Cultivation of One and half Million Fadden". On the other hand, it is located in the geographical frontier of El-Minya governorate which places in the fourth rank of cultivated sunflower area. Its area is 1194 Fadden represents 5.3% of the total cultivated sunflower area in Egypt which is 22628.2 Fadden in (2016-2021) Agricultural statistics (2016-2021). The study focuses on the project's land that are distributed to investors in the fourth phase which are 24232 Feddan divided into 104 counties. The area of each county is 233 Feddan and each county includes 10-23 farmers ECDC (2021). The proposed summer field crops pattern in that area consists of sorghum, groundnuts and sunflower and irrigated by ground water (2000-3000pmm) NWRC (2017). Remarkably, the actual total field crops area includes only 520 Fadden of groundnuts and sorghum. Five counties are the largest in terms of area which is 120 Fadden representing 23% of the total summer field crops area and managed by 100 farmers Table 1.

The second zone is Middle Egypt zone, the total summer field crops (sorghum, groundnuts, sesame and maize) area is 19829 Fadden GDDC (2021). Two cooperative associations are considered the largest in terms of summer field crops area, namely; El-Thoaar and El-Wafaa which cover 4961 Feddan represent 25.02 % of the total summer field crops and managed by 496 farmers Table 1. While the third zone is the old valley of El- Minya which covers 400000 Fadden and administrated by Agricultural Directorate of El Minya governorate. Bani Mazaar district is considered the largest in terms of sunflower crop (only food use species for snacks) which covers 1244 Fadden represents 74% of sunflower area in El-Minya governorate which is 1686 Fadden Agricultural statistics (2016-2021). Similarly, two villages are considered the largest in terms of sunflower crop area, namely; Ashrouba village and Shelkam village which cover 420 Feddan of meal sunflower represents 33.8% of sunflower crop in Bani Mazaar district and managed by 610 farmers Table 1.

Table 1. Distribution of population, samples, demo-plots.

Administrative Zone /district	Sub-Zone	Cultivated area (Fadden)	Population (farmer)	Sample size (farmer)	Demo-plots	Respondents (Farmer)
West Minya	The 4th phase ECDC lands	120 sorghum- groundnuts	100	80 (80%)	2	15 (18.75%)
Middle Egypt	El-Thoaar & El-Wafaa cooperatives	4961 sorghum- groundnuts-sesame-maize	496	217 (43.75%)	4	30 (13.82%)
Bani Mazaar	Ashrouba & Shelkam villages	420 snack food sunflower	610	234 (38%)	4	45 (19.2%)

Source: ECDC (2021); IDSC (2021); GDDC (2021); Agricultural Directorate of El Minya governorate, ECIVC program, DRC.

Human scope

Due to the farmers' refusal to grow oilseed sunflower, the population consists of all farmers of summer field crops in the selected farms in West Minya and Middle Egypt zones and meal sunflower farmers in Bani Mazaar. In each zone, a simple random sample is specified by the equation of Krejcie& Morgan (1970). The sample size of West Minya is 80 farmers represent 76.9% of the population Furthermore, the sample size of Middle Egypt is 217 farmers represent 43.75% of the population similarly, the sample size of Bani Mazaar district is 234 farmers represent 38% of the population Table 1.The respondents' farmers who accept the contract farming of oilseed sunflower crop are distributed as follow: 15 farmers represent 18.75% of the sample size in West Minya, 30 farmers represent 13.82% of the sample size in Middle Egypt Zone and 45 farmers represent 19.2% of the sample size in Bani Mazaar district Table 1.

Time scope

The pre-tests, symposiums, demo-plots and data collection process started from November 2021 till May 2022 in the three mentioned zones.

Data collection instrument

A questionnaire is designed to provide the data from the three samples by personal in-depth interview. The questionnaire consists of seven sections, namely; (1) socio-demographic characteristics of the respondents, (2) a total of 10 questions regarding the respondents' knowledge level of contract farming and oilseed sunflower, (3) a total of 10 questions relating to the respondents Attitude level of contract farming and oilseed sunflower, (4) a total of 10 questions regarding to the respondents 'performance level of GAPs under contract farming of oilseed sunflower crop, (5) physical quantities of productive inputs and outputs of oilseed sunflower crop, (6) production costs distributed among farm practices and production inputs, (7) Revenue and profit.

Variables

In this section the variables is classified into two classes, namely; the extensional requirements model and the economic requirements model. In the extensional requirements model, the explanatory variables consist of four variables related to the socio-demographic characteristics of the respondents , namely; (1) age (year), (2) education level (year), (3) household farm income (L.E./year) and (4) Experience of contract farming (years). Additionally, the dependent variables also consist of four variables, namely; (1) respondents' knowledge level, (2) respondents' attitudes level, (3) respondents' practice level and (4) respondents' behavior level. Each variable is constituted by respondents' answers of the ten questions. In the knowledge and attitude variables, the respondents are given an option of five likert scale which ranges from 1 represent strongly disagree, 2 represents disagree, 3 represents moderately agree, 4 represents agree and 5 represents strongly agree, while in the practice variable, the third variable, the respondents are given an option of five likert scale which ranges from 1 represent never, 2 represents seldom, 3 represents sometimes, 4 represents usually and 5 represents always. The theoretical range of the three variables extents between 10 to 50 degrees, while the practical range extents between 18 to 50 degrees. The category length is given simply by the formula: $\frac{50-18}{3} \approx 10$ .The categories of knowledge, attitude and practice are: low (18-28), moderate (29-39) and high (40-50). Furthermore, the behavior level variable is simply considered a horizontal aggregation of the three mentioned variables. The theoretical range of the behavior variable extents between 30 to 150 degrees, while the practical range extents between 54 to150 degrees. The category length is given simply by the formula: $\frac{150-54}{3} = 32$ .The categories of behavior levels are: low (54-85), moderate (86-117) and high (118-150).

On the other hand, ***the economic requirements model*** consists of five explanatory variables: (1) fertilizers (effective units/ Fadden), (2) human labor (hour/ Fadden), (3) machinery labor (hour/Fadden), (4) seeds (kg/ Fadden) and (5) cultivated area of oilseed sunflower (Fadden). The dependent variable is the yield of oilseed sunflower per Fadden.

Quantitative approach

In the extensional requirements model, SPSS is employed to analyze the descriptive statistics such as frequency, percentage, mean, and standard deviation to achieve the objectives of identifying the respondents KAPBs levels. Furthermore, ANOVA and the Pearson correlation is applied to identify the relationship between the respondents' socio-demographic characteristics and their behavior toward the contract farming of oilseed sunflower. In addition, multiple linear regression is employed to identify the impact of the respondents' socio-demographic characteristics on their behavior toward the contract farming of oilseed sunflower.

On the other hand, in the economic requirements model**,** Data Envelope Analysis (DEA) approach is applied to evaluate the technical and economic efficiency of the oilseed sunflower farms. Farrel (1957) introduced two approaches to measure efficiency: the first is Input -Oriented approach which addresses the question: By how much can input quantities be proportionally reduced without changing the output quantities produced?" The alternative one is Output- Oriented approach which asks the question "By how much can output quantities be proportionally expanded without altering the input quantities used?" Coelli (1996), Günden, *et al*. (2006).

DEA is a non-parametric mathematical programming model which is commonly used to evaluate the efficiency of Decision Making Units (DMUs) depends on the Farrel (1957) approaches of efficiency measurements. The first DEA model was introduced by Charnes, Cooper and Rhodes (1978) which had an input-orientation and assumed a constant return to scale Günden (2006). The model employs the linear programming to construct a piece-wise efficiency frontier. The inefficient DMUs are compared with the efficient units on this frontier. Input- Oriented -CCR model is depicted as follow:

$$\textbf{Maximize}: \mathbf{E_m} = \frac{\sum_{j=1}^{J} \mathbf{U_{jm} Y_{jm}}}{\sum_{i=1}^{I} \mathbf{V_{im} X_{im}}} \dots\dots\dots\dots\dots\dots (1)$$

$$\textbf{subject to}: \frac{\sum_{j=1}^{J} \mathbf{U_{jm} Y_{jn}}}{\sum_{i=1}^{I} \mathbf{V_{im} X_{in}}} \leq \mathbf{1}, \mathbf{n} = \mathbf{1}, \dots \mathbf{N} \dots\dots\dots (2)$$

Where:

E_m = The efficiency of the mth DMU,
Y_{jm} = The jth output of the mth DMU,
X_{im} = The ith input of the mth DMU,
U_{jm} and V_{im} = The output and input weights respectively,
U_{jm} , $V_{im} \geq 0$, i=1, 2,……I, and j=1,2,……J,
Y_{jn} and X_{in} are the jth output and ith input respectively of the nth DMU, n=1,2,…N.

The problem is finding the optimal values of the unknown weightsU_{jm} and V_{im} to maximize the efficiency of mth DMU.This non – parametric mathematical linear problem is solved by Data Envelopment Analysis Program ***(***DEAP***)*** software introduced by Coelli(1996). Also, this study employs the variable return to scale (VAR) approach of the DEA model Which is introduced by Banker, Charnes and Cooper (1984) to classify the source of total technical efficiency of constant return to scale (TTE $_{CRS}$) to pure technical efficiency of variance return to scale (TE $_{VRS}$) and scale efficiency (SE). If for any DMU, (TTE $_{CRS}$) score is different from (TE $_{VRS}$), then this indicates that the firm has scale inefficiency, and that the scale inefficiency can be calculated by the following formula:

$$\mathbf{TTE_{CRS} = TE_{VRS} * SE} \dots\dots\dots\dots (3)$$

Moreover, when input prices are involved, is defined DMUs are assumed to allocate resources efficiently under variable return to scale (allocative efficiency, AE $_{VRS}$) by using the combination of inputs that minimizes the cost of producing a level of output Sivarajah (2017).Also, the economic efficiency (EE$_{VRS}$) is defined by the ability for any DMU to achieve the technical efficiency under variable return

to scale (TE_{VRS}) and allocative efficiency under variable return to scale(AE_{VRS}) according to the following formula:

$$EE_{VRS} = TE_{VRS} * AE_{VRS} \dots \dots \dots \dots (4)$$

The data used in this study are based on the primary data collected from the nineteen farms.

Regarding to the successfulness of the contract farming of oilseed sunflower to achieve Nash Equilibrium situation, this research applies the game theory approach which is developed by von Neumann and Morgenstern. According to Harsanyi, 1963, Nash Solution (Nash, 1953) is an axiomatic unique solution in a bargaining game between two players to determine the exact position of the agreement in which neither party's position can be improved without at the same time worsening the position of the other party (Pareto optimality) and also no player has an incentive to change his strategies. In this research, the game is dominated by the decision maker (player ①) and the farmers of oilseed sunflower (player ②). The decision maker has three alternative actions: 1) to provide only floor price of oilseed sunflower; 2) to provide floor price and extensional services and (3) provide floor price, extensional services and recycle residues of the oilseed sunflower crop. On the other hand, the farmers have two alternative reactions: response or nonresponse to the decision maker 'actions.

RESULTS AND DISCUSSIONS

First: Extensional requirements of contract farming

Identifying the socio-demographic characteristics of the respondents & inspecting the differences between farmers from different zones.

Table 2 shows the most important variables of the respondents' background (age, education, income and experience). In terms of age variable, the majority of the respondents in West Mina zone (73.3%) are in the 1st age category (30<45 years), while the majority of the respondents in Middle Egypt zone (83.3%) are in the 2nd age category (45<60 years) but the majority of respondents in Bani Mazaar district (80%) are in the 3rd age category (60> years). The mean scores of the respondents' ages are: 35, 50.9, 60.3 years in the three mentioned zones respectively. ANOVA result shows that $F_{.Calculated}$ is statistically significant at 1 %,($F_{.Calculated}$ = 133.3 >$F_{Critic.\ 87,\ 2}$=3.101).On the other hand, in terms of education variable, in West Mina zone, almost a half of respondents (53.3%) has a middle level of education (6 <12 years) and (46.7%) of them have a high level of education (12> years). While in Middle Egypt zone, the majority of the respondents (73.3%) has a high level of education (12> years) but around the quarter of respondents (26.7%) has a middle level of education (6<12 years). Conversely, in Bani Mazaar district the majority of the respondents (71.2%) has a low level of education (0 < 6), around the quarter of them (24.4%) has a middle level of education (6<12 years) and the minority (4.4%) has a high level of education (12> years).The mean scores of the respondents' education are: 10.4, 13.2, 5.1 years in the three mentioned zones respectively. ANOVA result shows that $F_{.Calculated}$ is statistically significant at 1%, ($F_{.Calculated}$ = 206.6 >$F_{Critic.\ 87,\ 2}$=3.101).

Regarding the household farm income of the respondents, in West Mina zone, the majority of the respondents (73.3%) earns low farm income (L.E20 <35 thousand/ year) and (20%) of them earn moderate farm income (L.E35 <50 thousand/year) and only (6.7%) of them earn high farm income (L.E 50 >thousand/year). Conversely, in Middle Egypt zone, more than a half of the respondents (63.3%) earns high farm income (L.E 50 > thousand/ year) and around the quarter of respondents (26.7%) earns moderate farm income (L.E35 <50 thousand/year) and the minority (10%) of them earns low farm income (L.E 20 <35 thousand/year). While in Bani Mazaar district, more than a half of the respondents (66.7%) earns moderate farm income (L.E35 <50 thousand/year) and (17.7%) of them earn high farm income (L.E 50 > thousand/ year) and (15.6%) of them earn low farm income (L.E 20 <35 thousand/year). The mean scores of the respondents' annual farm **income** are: L.E.33.8, 54.5 and 46.8 thousand/ year in the three mentioned zones respectively. ANOVA result demonstrates that $F_{.Calculated}$ is statistically significant at 1%, ($F_{.Calculated}$ = 49.6 >$F_{Critic.\ 87,\ 2}$=3.101).

Table 2. Socio-demographic characteristics of the respondents

Variable	West Minya (N=15)			Middle Egypt (N=30)			Bani Mazaar (N=45)			F-Cal.*	Prob.
	F.	%	Mean	F.	%	Mean	F.	%	Mean		
Age(Year)											
(30 < 45)	11	73.3		3	10		3	6.7			
(45<60)	3	20.0	35	25	83.3	50.9	6	13.3	60.3	133.3	0.001
(60 >)	1	6.7		2	6.7		36	80			
Education(Year)											
0< 6	0	0		0	0		32	71.2			
6-12	8	53.3	10.4	8	26.7	13.2	11	24.4	5.1	206.6	0.001
>12	7	46.7		22	73.3		2	4.4			
Farm income (Thousand L.E./Year)											
20<35	11	73.3		3	10		7	15.6			
35<50	3	20	33.8	8	26.7	54.5	30	66.7	46.8	49.6	0.005
50>	1	6.7		19	63.3		8	17.7			
Experience(Year)											
0< 5	13	86.6		5	16.7		5	11.1			
5<10	1	6.7	4.1	21	70	8.1	13	28.9	11.2	32.2	0.006
10>	1	6.7		10	13.3		27	60			

(*) F.Crit (87, 2) =3.101. Source: Findings of the research

Concerning the respondents' experience of contract farming, in West Mina zone, the majority of the respondents (86.6%) has low experience (0 <5 years) and (6.7%) of them have middle experience (5< 10 years) and also (6.7%) of them have high experience (10 >years). While in Middle Egypt zone, the majority of the respondents (70%) has middle experience (5 <10 years), (16.7%) has low experience (0 <5 years) and (13.3%) has high experience (10 >years). Conversely, in Bani Mazaar district, more than a half of the respondents (60%) has high experience (10 >years), (28.9%)

of them have middle experience (5 <10 years) and (11.1%) of them have low experience (0 <5 years). The mean scores of the respondents' experience are: 4.1, 8.1 and 11.2 years in the three mentioned zones respectively. ANOVA result shows that $F_{.Calculated}$ is statistically significant at 1%, ($F_{.Calculated}$ = 32.2 >$F_{Critic.\ 87,\ 2}$=3.101). Based on the ANOVA results, the null hypothesis "$H_{0\varphi}$" which states that "there is no statistical significant differences between the respondents' socio-demographic characteristics (age, education, farm income and experience) in the three zones" is rejected, therefore it is concluded that there are statistical significant differences between farmers in the mentioned variables in the three zones. about a quarter of the respondents (26.7%) is on a moderate knowledge level and only (20%) of the respondents are on a high knowledge level of contract farming. The mean score of knowledge is (26.1 represents 52.2%) which refers to that the respondents of West Minya zone are still on a low knowledge level about contract farming of oilseed sunflower crop. On the other hand, in Middle Egypt zone, the results reveal that only (3.3%) of the respondents are on a low knowledge level of contract farming and (20%) of them are on a moderate knowledge while the majority (76.7%) is on a high knowledge level of

Identifying the current level of knowledge, attitude, practice and behavior (KAPBs) of farmers towards contract farming of oilseed sunflower & the statistical differences between farmers from different zones.

Levels of respondents 'knowledge about contract farming of oilseed sunflower crop.

The knowledge, attitudes, practices and behavior levels of the sunflower 'farmers towards contract farming in the three mentioned zones are demonstrated in Table 3. In terms of knowledge levels in West Minya, (53.3%) of the respondents are on a low knowledge level of contract farming,

Table 3. Distribution of respondents' knowledge, attitude, practice and behavior toward contract farming of oilseed sunflower crop.

variable	West Minya(n=15)		Middle Egypt(n=30)		Bani Mazaar(n=45)		FCalculated	Prob.
	F.	%	F.	%	F.	%		
Knowledge								
Low (18-28)	8	53.3	1	3.3	2	4.4		
Moderate (29-39)	4	26.7	6	20	35	77.8	7.44	0.001
High (40-50)	3	20	23	76.7	8	17.8		
Mean, (%)	26.1(52.2%)		44(88%)		34.9(69.8%)			
Attitude								
Low (18-28)	10	66.7	4	13.3	5	11.1		
Moderate (29-39)	3	20	5	16.7	34	75.6	8.96	0.003
High (40-50)	2	13.3	21	70	6	13.3		
Mean	24(48%)		41(82%)		33.8(67.6%)			
			Practices					
Low (18-28)	12	80	7	23.4	8	17.8		
Moderate (29-39)	2	13.3	4	13.3	32	71.1	18.58	0.0001
High (40-50)	1	6.7	19	63.3	5	11.1		
Mean	22.4(44.8%)		40(80%)		30.8(61.6%)			
Behavior								
Low (54-85)	12	80	7	23.3	11	24.4		
Moderate (86-117)	2	13.3	5	16.7	30	66.7	13.02	0.0001
High (118-150)	1	6.7	18	60	4	8.9		
Mean	72.5(48.3%)		121(80.7%)		103.6(69.1%)			

(*) F.Crit (87, 2) =3.101. Source: Findings of the research.

contract farming. The mean score of knowledge is (44 represents 88%**)** which refers to that the respondents of Middle Egypt zone are on a high knowledge level about contract farming of oilseed sunflower crop. As to the knowledge levels in Bani Mazaar zone, the results reveal that only (4.4%) of the respondents are on a low knowledge level of contract farming while the majority of them (77.8%) is on a moderate knowledge level and (17.8%) of the respondents are on a high knowledge level of contract farming. The mean score of knowledge is (34.9 represents 69.8%) which refers to that the respondents are on a moderate level of knowledge. Additionally, ANOVA is employed to inspect whether there is a difference in respondents 'knowledge about contract farming between the three mentioned zones. The results reveal that $F_{.Calculated}$ = 7.44 >$F_{Critic.\ 87,\ 2}$=3.101 and P-value is less than 0.01, thus it is concluded that there is a statistical significant difference in respondents' knowledge about contract farming between the three zones.

According to the mean score of respondents' answers for the10 knowledge questions, Table 4 explains that the two statements "CF improves farm income" and "CF has a guaranteed market for the crop" are recorded in the 1st rank (M= 4.9 in West Minya, M=5 in Middle Egypt, M= 5 in Bani Mazaar). The three statements "CF supports farmers to access to production inputs, credit and extensional services", "CF supports technology transfer" and "CF improves farm management" are recorded in the 2nd rank (M= 2.4 in West Minya, M=3.5 in Middle Egypt, M= 3.4 in Bani Mazaar). The statement "CF protects farms from price and other production risks" is recorded in the 3rd rank (M= 2.1 in West Minya, M=3.3 in Middle Egypt, M= 3.2 in Bani Mazaar). The two statements "CF is an agreement between farmers and contractors" and "CF is a written or verbal, formal or informal agreement" are recorded in the 4th rank (M= 2.0 in West Minya, M=3.4 in Middle Egypt, M= 3.1 in Bani Mazaar). Finally, the two statements "CF is important for oil sunflower species." and "CF is important to combat climate changes" are recorded in the 5th rank (M= 1.5 in West Minya, M=2.7 in Middle Egypt, M= 2.9 in Bani Mazaar).

Table 4.Mean scores of respondents' knowledge about contract farming of oilseed sunflower crop

Statement/score percentage	West Minya (n=15)		Middle Egypt (n=30)		Bani Mazaar (n=45)		Rank
	Mean	SD	Mean	SD	Mean	SD	
1.CF is an agreement between farmers and contractors	2	1.4	3.4	1.1	3.1	1.1	4
2.CF is a written or verbal , formal or informal agreement	2	1.4	3.4	1.1	3.1	1.1	4
3.CF improves farm income.	4.9	0.3	5	0.0	5	0.0	1
4. Has a guaranteed market for the product.	4.9	0.3	5	0.0	5	0.0	1
5.CF. supports farmers to access to production inputs, credit and extensional services.	2.4	1.2	3.5	0.9	3.4	1.7	2
6.CF. supports technology transfer.	2.4	1.2	3.5	0.9	3.4	1.7	2
7.CF improves farm management.	2.4	1.2	3.5	0.9	3.4	1.7	2
8. CF. protects farmers from price risk and other production risks.	2.1	1.3	3.3	0.8	3.2	1.0	3
9. CF is important for oil species of sunflower.	1.5	1.2	2.7	1.6	2.9	1.7	5
10. CF is important to combat climate changes.	1.5	1.2	2.7	1.6	2.9	1.7	5

Source: Findings of the research.

Levels of the respondents' attitudes towards the contract farming of oilseed sunflower crop.

In terms of the respondents 'attitude towards the contract farming of oilseed sunflower in West Minya zone, Table 3 reveals that more than a half of the respondents (66.7%) is on a low attitude level towards contract farming, (20%) of them are on a moderate level and only (13.3%) of the respondents are on a high attitude level. The mean score of the attitude 'levels is (24 represents 48%) which refers to that the respondents in West Minya zone are on a low attitude level towards the contract farming of oilseed sunflower crop. Furthermore, the results in Middle Egypt zone reveal that (13.3%) of the respondents are on a low attitude level towards contract farming and (16.7%)of them are on a moderate level while the majority of them(70%) is on a high attitude level towards contract farming. The mean score of attitude 'levels is (41 represents 82%) which refers to that the respondents in Middle Egypt zone are on a high attitude level towards contract farming of oilseed sunflower crop. On the contrary, the results in Bani Mazaar zone reveal that (11.1%) of them are on a low attitude level towards contract farming while the majority of the respondents (75.6%) is on a moderate attitude level towards contract farming and (13.3%) of them are on a high attitude level towards contract farming. The mean score of attitude is (33.8 represents67.6%) which refers to that the respondents in Bani Mazaar zone are on a moderate attitude level towards the contract farming of oilseed sunflower crop. Depending on ANOVA, the results demonstrate that $F_{.Calculated} = 8.96 > F_{Critic.\ 87,2} = 3.101$ and P-value is less than 0.01, therefore there is a statistical significant difference in respondents' attitudes towards contract farming between the three zones.

Regarding the mean score of respondents' reply for the10 attitude statements, Table 5 depicts that the arrangements of the respondents' answers are different in the three zones. First, the highest two statements "Willing to improve farm income through CF" and "Willing to improve standard of living through CF " are recorded in the 1st rank in the three zones(M= 5). Three statements are arranged in the 2nd rank, namely; "Willing to acquire entrepreneurship positions regarding CF", "Willing to acquire information by training of CF" and "Willing to gain skills by training of GAP" in West Minya zone (M=2.07) and Middle Egypt zone (M=3.4) but the statement "Accept to try the oil species only under extensional supervision" has the 2nd priority in Bani Mazaar (M=3.4). The 3rd rank is recorded for the statement" Feeling regret if I missed any research call" in West Minya zone (M=1.9), the statement "Accept to try the oil species only under extensional supervision" in Middle Egypt zone (M=2.5) and "Willing to acquire entrepreneurship positions regarding CF" in Bani Mazaar zone (M=3.3).

Table 5. Mean scores of respondents' attitude towards contract farming of oilseed sunflower crop

Statement/ score percentage	West Minya (n=15)		Middle Egypt (n=30)		Bani Mazaar (n=45)	
	Mean(SD)	Rank	Mean(SD)	Rank	Mean(SD)	Rank
1.Feeling more productive to be involved in CF	1.6(1.2)	4	3.2(1.2)	4	2.8(1.2)	5
2.Feeling more motivated to be involved in CF	1.6(1.2)	4	3.2(1.2)	4	2.8(1.2)	5
3.Willing to improve farm income through CF.	5.0(0.0)	1	5.0(0.0)	1	5.0(0.0)	1
4. Willing to improve standard of living through CF.	5.0(0.0)	1	5.0(0.0)	1	5.0(0.0)	1
5.Willing to acquire entrepreneurship positions regarding CF	2.07(1.2)	2	3.4(0.88)	2	3.3(1.1)	3
6.Willing to acquire information by training of CF	2.07(1.2)	2	3.4(0.88)	2	3.02(1.03)	4
7.Willing to gain skills by training of GAP	2.07(1.2)	2	3.4(0.88)	2	3.02(1.03)	4
8. Accept to try the oil species only under extensional supervision.	1.3(1.03)	5	2.5(1.7)	3	3.4(1.7)	2
9. Accept to try CF to avoid risks of spot marketing.	1.3(1.03)	5	1.7(0.78)	6	2.8(1.6)	5
10.Feeling regret if I missed any research calls	1.9(1.2)	3	3.1(0.94)	5	2.5(1.07)	6

Source: Findings of the research.

The 4th rank is given for the statements "Feeling more productive to be involved in CF" and "Feeling more motivated to be involved in CF" in West Minya (M=1.6) and Middle Egypt (M=3.2) but the statements "Willing to acquire information by training of CF" and "Willing to gain skills by training of GAP" " have the 4th priority in Bani Mazaar zone (M=3.02). The 5th rank are given to the statements "Accept to try the oil species only under extensional supervision" and "Accept to try CF to avoid risks of spot marketing" in West Minya (M=1.3), the statement" Feeling regret if I missed any research call" in Middle Egypt zone (M= 3.1) and the statements "Feeling more productive to be involved in CF" and "Feeling more motivated to be involved in CF" in Bani Mazaar zone (M= 2.8). Finally, the 6th rank are given for the statement "Accept to try CF to avoid risks of spot marketing" in Middle Egypt zone (M= 1.7) and the statement "Feeling regret if I missed any research call in Bani Mazaar zone (M= 2.5).

C. Levels of the respondents' GAPs of oilseed sunflower crop under the contract farming.

Concerning the respondents' performance levels of oilseed sunflower' GAPs under the contract farming, Table 3

demonstrates that in West Minya, the majority (80%) of the respondents is on a low performance level while (13.3%) of them are on a moderate performance level and only (6.7%) of them are on a high performance level. The mean score of the performance level is (22.4 represents 44.8%) which denotes to that the respondents of West Minya zone are on a low performance level of oilseed sunflower' GAPs under the contract farming. Moreover, the results in Middle Egypt reveal that around a quarter (23.4%) of the respondents is on a low performance level and (13.3%) of them are on a moderate level while more than a half of the respondents (63.3%) is on a high performance level. The mean score of the performance level is (40 represents 80%) which denotes to that the respondents of Middle Egypt zone are on a high performance level of oilseed sunflower' GAPs under the contract farming. Furthermore, the results in Bani Mazaar zone reveal that (17.8%) of the respondents is on a low performance level while the majority (71.1%) of them is on a moderate level and only (11.1%) of them are on a high performance level of GAPs under the contract farming. The mean score of the performance level of GAPs under contract farming in Bani Mazaar is moderate (30.8 represents 61.6%). Results of ANOVA demonstrate that $F_{.Calculated} = 18.85 > F_{Critic.\ 87,\ 2} = 3.101$ and P-value is less than 0.01, therefore there is a statistical significant difference in performance level of oilseed sunflower GAPs under the contract farming between the three zones.

Concerning the mean score of the actual performance of the respondents. The facilitators and agronomic expert record the reply for the 10 practices statements as shown in Table 6. The highest score of the two practices "Till soil and add phosphate fertilizer" and "Lining soil into 12 line/2 casaba " are recorded in the 1st rank in the three zones (M= 5). Three practices are arranged in the 2nd rank, namely; "Reducing plant density to enhance plant growth", "Fertilizers 'application[ii]" and "Hoeing soil to combat weed and insects" in West Minya zone (M=1.8) and Middle Egypt zone (M=3.8) but the practice of "Harvesting[iii]" has the 2nd priority in Bani Mazaar (M=3.44). The 3rd rank is recorded for the practice "Recycling the residues to produce compost[iv]" in West Minya zone (M=1.7), the practices "Cultivation in earlier time to combat climate change" and "Adding organic manure before plantation" in Middle Egypt zone (M=3.7) and "Reducing plant density to enhance plant growth" in Bani Mazaar zone (M=3.42). The 4th rank is given for the practices "Cultivation in earlier time to combat climate change" and "Adding organic manure before plantation" in West Minya zone (M=1.4), the practice "Recycling the residues to produce compost" in Middle Egypt zone (M=3.6) and the practice "Hoeing soil to combat weed and insects" in Bani Mazaar zone (M=3. 2).The 5th rank is given to the practices "Harvesting" and "Installing a beehive on the field" in West Minya (M=1.3), Practice "Harvesting" in Middle Egypt zone (M= 3.3) and the practices" Cultivation in earlier time to combat climate change" and Adding organic manure before plantation" in Bani Mazaar zone (M=3.06).Finally, the 6th rank is given for the practice "Installing a beehive on the field" in Middle Egypt zone (M= 2.5) and the practice "Installing a beehive on the field" and "Recycling the residues to produce compost" in Bani Mazaar zone (M=2.6).

Table 6. Mean scores of respondents 'GAPs performance in producing oilseed sunflower crop

Statement/ score percentage	West Minya (n=15)		Middle Egypt (n=30)		Bani Mazaar (n=45)	
	Mean(SD)	Rank	Mean(SD)	Rank	Mean(SD)	Rank
1. Cultivating in earlier time to combat drought and dry weather.	1.4(1.08)	4	3.7(1.2)	3	3.06(1.11)	5
2. Adding organic manure before plantation (15-20 m3/Fadden).	1.4(1.08)	4	3.7(1.2)	3	3.06(1.11)	5
3.Tillaging soil and add phosphate fertilizer (100 kg/Fadden)	5(0)	1	4.9(0.37)	1	5(0)	1
4.Lining soil into 12 lines/ 2 casaba(3.08 m)	5(0)	1	4.9(0.37)	1	5(0)	1
5. Reducing plant density to enhance plant growth.	1.8(1.11)	2	3.8(1.03)	2	3.42(1.03)	3
6.Firtilizers application:	1.8(1.11)	2	3.8(1.03)	2	3.2(0.97)	4
7. Hoeing soil to combat weeds and insects.	1.8(1.11)	2	3.8(1.03)	2	3.2(0.97)	4
8.Harvesting	1.3(0.99)	5	3.3(1.6)	5	3.44(1.7)	2
9. Installing a beehive on the field	1.3(0.99)	5	2.5(1.4)	6	2.91(1.68)	6
10. Recycling the residues	1.7(1.07)	3	3.6(0.99)	4	2.6(1.003)	7

Source: Findings of the research.

Levels of respondents' behavior towards the contract farming of oilseed sunflower crop.

In this study, it is imposed that the knowledge, attitude and practice are the main factors that drive the farmers' behaviors towards the oil-type sunflower rather than non-oil type and other summer competitive crops under contract farming. With reference to the behavior levels in West Minya, Table 3 demonstrates that the majority of the respondents (80%) is on a low behavior level towards contract farming while (13.3%) of them are on a moderate

behavior level and only (6.7%) of them are on a high level of behavior towards contract farming. The mean score of behavior is (72.5 represents 48.3%) which refers to that the respondents of West Minya zone are on a low level of behavior towards contract farming of oilseed sunflower crop. Moreover, the behavior levels in Middle Egypt

demonstrate that around a quarter of the respondents(23.3%) is on a low behavior level towards contract farming, (16.7%) of them are on a moderate level of behavior towards contract farming and around a half of the respondents(60%) is on a high level of behavior towards contract farming. The mean score of behavior is (121 represents 80.7%) which refers to that the respondents of Middle Egypt zone are on a high level of behavior towards contract farming of oilseed sunflower crop. Similarly, behavior levels in Bani Mazaar zone reveal that about a quarter of the respondents (24.4%) is on a low level of behavior towards contract farming while around a half of them (66.7%) is on a moderate level of behavior towards contract farming and only (8.9%) of them are on a high level of behavior towards contract farming. The mean scores of behavior towards contract farming in Bani Mazaar zone is moderate (103.6 represents 69.1%). The results of ANOVA show that $F_{.Calculated} = 13.02 > F_{Critic.\ 87,\ 2} = 3.101$ and P-value is less than 0.01, therefore there is a statistical significant difference on behavior towards contract farming of oilseed sunflower crop between the three zones.

It is concluded from the ANOVA results of KAPBs that the null hypothesis (H_{01}) which declares that "there are no

statistical significant differences in the KAPBs levels between farmers towards contract farming of oilseed sunflower in the three zones" is rejected while there are statistical significant differences of KAPBs towards contract farming of oilseed sunflower crop between the three zones.

Identifying and inspecting the correlation between farmers' behavior towards contract farming of oilseed sunflower in the three zones and their socio-demographic characteristics

Referring to Table 7, the results show that the three socio-demographic characteristics (education, income and experience) have significant and positive relationship with the respondents' behavior towards the contract farming of oilseed sunflower while the respondents 'age variable has a significant and negative relationship with the respondents' behavior. Also, results shows that there are high relationship between each of the age, education, income and experience variables and the respondents' behavior in Middle Egypt zone (r= -0.78, 0.87, 0.85 and .81 respectively). On the other hand, there are moderate relationship between each of the age, education, income and experience variables and the respondents' behavior in Bani Mazaar zone (r= -0.60, 0.69, 0.58 and 0.49 respectively).Conversely, there are low relationship between each of the age, education, income and experience variables and the respondents' behavior in west Minya zone (r= -0.39, 0.37, 0.39 and 0.27 respectively). Moreover, the P-value of all correlation coefficients are less than 0.05 in West Minya Model, while the correlation coefficients in Middle Egypt and Bani Mazaar Model are less than 0.01. Accordingly, the null hypothesis (H_{02}) which states that "there is no statistical significant correlation between farmers' behavior towards contract farming of oilseed sunflower and their socio-demographic characteristics " is rejected while there are statistical significant correlations between farmers' behavior towards contract farming of oilseed sunflower and their socio-demographic characteristics.

Table 7. Correlation between the socio-demographic characteristics and respondents' behavior towards contract farming of oilseed sunflower crop

variable	West Minya		Middle Egypt		Bani Mazaar	
	r	Prob.	r	Prob.	r	Prob.
Age	-0.39	0.046	-0.78	0.007	-0.60	0.000
Education	0.37	0.014	0.87	0.000	0.69	0.007
Income	0.39	0.032	0.85	0.000	0.58	0.000
Experience	0.27	0.011	0.81	0.000	0.49	0.000

Source: Findings of the research.

Econometric estimating of the impact of the farmers' socio-demographic characteristics on the farmers' behavior.

In this part, the multiple linear regression is employed to investigate the impact of the independent variables (age, education, income and experience) on the respondents 'behavior towards the contract farming of oilseed sunflower. Primarily, regression models are detected and confirmed to the absence of multicollinearity[v]. Based on the adjusted determination coefficients ($R^{2\backslash}$) , Table 8 illustrates that the independent variables (age, education, income and experience) provide the best prediction for respondents 'behavior and explain about 72%, 82 % and 86% of the variation in respondents 'behavior towards contract farming of oilseed sunflower in West Minya zone, Middle Egypt zone and Bani Mazaar zone respectively. Accordingly, in West Minya zone, the results show a statistically significant negative impact of respondents 'age on their behavior at 1% and a statistically significant positive impact of respondents 'education and income on their behavior at 5% while there is no statistically significant impact of respondents 'experience on their behavior towards contract farming. Moreover, Table 8 explains that if the variables of age, education and income increase by 1%, the respondents' 'behavior change by (-1.5%), (2.9%) and (0.38%) respectively.

Table 8. Multiple linear regression of the impact of the respondents' socio-demographic characteristics on their behavior towards contract farming of oilseed sunflower crop

	b	SE	t-stat.	p-value	Mean	%
West Minya						
Age	-0.53	0.152	-3.49	0.006	35	-1.5
Education	0.302	0.131	2.31	0.043	10.4	2.9
Income	0.131	0.057	2.30	0.044	33.8	0.38
Experience	0.139	0.109	1.28	0.234	4.1	-
$R^{2\backslash}$ =0.72						
Middle Egypt						
Age	-0.516	0.238	-2.17	0.039	50.9	-1.01
Education	3.806	0.552	6.89	0.0003	13.2	28.8
Income	0.568	0.169	3.36	0.002	54.5	1.04
Experience	1.921	0.738	2.60	0.005	8.1	23.6
$R^{2\backslash}$ =0.82						
Bani Mazaar						
Age	-0.831	0.063	-13.19	0.00001	60.3	-1.38
Education	0.267	0.054	4.94	0.0002	5.1	5.24
Income	0.869	0.297	2.93	0.006	46.8	1.86
Experience	0.297	0.156	1.90	0.010	11.2	2.65
$R^{2\backslash}$ =0.86						

Source: Findings of the research

Furthermore, in Middle Egypt zone, the results show a statistically significant negative impact of respondents 'age on their behavior at 5% and a statistically significant positive impact of respondents 'education, income and experience on their behavior at 1%. Additionally, any change of age, education, income and experience by 1%, the respondents 'behavior change by (-1.01%), (28.8%), (1.04 %) and (23.6) respectively. Likewise, in Bani Mazaar zone, the results show

a statistically significant negative impact of respondents 'age on their behavior at 1% and a statistically significant positive impact of respondents 'education, income and experience on their behavior at 1%. As well, any change of age, education, income and experience by 1%, the respondents 'behavior changes by (-1.38%), (5.24%), (1.86 %) and (2.65) respectively. The null hypothesis (H_{03}) which states that "there is no statistical significant impact of the farmers' socio-demographic characteristics on the farmers' behavior" is rejected while there is a statistical significant impact of the farmers' socio-demographic characteristics on the farmers' behavior towards contract farming of oilseed sunflower.

Second: Economic requirements of oilseed sunflower crop under contract farming

This section demonstrates the results of Data Envelopment Analysis (DEA) considering input oriented method. Generally, the model asks the question "how much production inputs per Feddan of an inefficient farms can be decreased in reference to the efficient farms which lies on the frontier curve provided that the output level of the inefficient farm is kept constant. The inputs includes the effective units of fertilizers and nutrients (EU/Feddan); human labor hours (H/Feddan); machinery hours(H/Feddan); seeds (Kg/Feddan) and cultivated land area of sunflower crop (Feddan).

Identifying the descriptive statistics of outputs and inputs quantities of oilseed sunflower crop & inspecting the differences between different zones.

Table 9 demonstrates the descriptive statistics of the outputs/inputs quantities of oilseed sunflower crop. On average, the productivity of oilseed sunflower crop is (965.5 kg/Feddan) ranges between the lowest productivity in West Minya zone (598.6 kg/Feddan) and the highest productivity in Middle Egypt zone (1171.77 kg/Feddan), while the productivity of oilseed sunflower crop in Bani Mazaar zone is close to that of Middle Egypt zone (950.35 Kg/Feddan). On the other hand, the average quantity of fertilizers is (86.69 EU/Feddan) ranges between the lowest amount in middle Egypt zone (79.12 EU/Feddan) and the highest amount in West Minya zone (103.2 EU/ Feddan), while the average amount of human labor is (17.27H/Feddan) ranges between (15.89H/Feddan) in Bani Mazaar zone and (20.14 H/Feddan) in West Minya zone. Similarly, the average amount of machinery labor is (10.28H/Feddan) ranges between (9.33H/Feddan) in Bani Mazaar zone and (12.49H/Feddan) in West Minya zone. Also, the average amount of seeds is (5.7 kg /Feddan) ranges between (5.04 kg /Feddan) in West Minya zone and (6.58 kg /Feddan) in Middle Egypt zone, while the average cultivated area of sunflower is (0.932 Feddan) ranges between (0.688 Feddan) in Bani Mazaar zone and (1.25 Feddan) in Middle Egypt zone. The results of ANOVA explain that ($F_{.Calculated} > F_{Critic.\ 87,\ 2}$=3.101) and P-value is less than 0.01, therefore there is a statistical significant difference of oilseed sunflower output (productivity) and employed inputs of production between the three zones. Accordingly, The null hypothesis ($H_{0\varphi}{}^{\varepsilon}$) which states that "there are no statistical significant differences of oilseed sunflower output/inputs between the three zones "is rejected. Instead, there are statistical significant differences of oilseed sunflower output/inputs between the three zones.

Table 9. Descriptive statistics of the outputs and inputs quantities of oilseed sunflower crop

variable	WestMinya(n=15)		MiddleEgypt(n=30)		Bani Mazaar(n=45)		All zones(n=90)		*FCalculated	Prob.
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Yield(Kg/Feddan)	598.6	0.894	1171.77	0.24	950.35	0.16	965.5	1.9	790.512	0.0003
Fertilizers(EU/Feddan)	103.2	2.8	79.12	1.12	86.25	0.42	86.69	1.17	47.857	0.007
Labor (H/Feddan)	20.14	0.089	17.91	0.402	15.89	0.187	17.27	1.59	151.6	0.0008
Machinery(H/Feddan)	12.49	0.313	10.58	0.156	9.33	0.466	10.28	1.19	433.79	0.0005
Seeds(Kg/Feddan)	5.040	0.027	6.58	0.21	5.37	0.17	5.7	0.647	588.45	0.0001
Land(Feddan)	1.020	0.289	1.25	0.034	0.688	0.147	0.932	0.301	118.89	0.004

* **($F_{critic.}$ 87, 2 =3.101). Source: Findings of the research.**

Econometric estimating of the technical, allocative and economic efficiency scores of oilseed sunflower production under contract farming in the statistical differences in the efficiency criteria 'scores between farmers from different zones.

A. The results of the technical and the scale efficiencies

The total technical efficiency (TE_{CRS}) of sunflower' farmers is explained in Table 10. Again, (TE_{CRS}) is classified into two components: pure technical efficiency (TE_{VRS}) and scale efficiency (SE). In terms of TE_{CRS}, the mean score which covers all zones is (0.878). This score indicates to that the same output level of oilseed sunflower crop can be achieved even if the employed inputs are decreased by (12.2%). Notably, this inefficient score of total technical efficiency is caused by non-achieving the minimum production inputs (pure technical efficiency, TE_{VRS} = 0.892) and non-optimality scale of production (scale efficiency, SE= 0.985). Additionally,

Table 10. The coefficients of efficiency in producing oilseed sunflower.

Zone		Total Efficiency Score TE_{CRS}	Technical Efficiency Score TE_{VRS}	Scale Efficiency Score SE	Allocative Efficiency score AE	Economic Efficiency score CE
West Minya (n=15)	Min.	0.587	0.589	0.607	0.625	0.374
	Max.	0.607	1.000	1.000	0.782	0.468
	Mean	0.594	0.621	0.972	0.679	0.403
Middle Egypt (n=30)	Min.	0.968	0.994	0.974	0.859	0.836
	Max.	1.000	1.000	1.000	1.000	1.000
	Mean	0.985	0.997	0.988	0.866	0.853
Bani Mazaar (n=45)	Min.	0.833	0.838	0.913	0.804	0.668
	Max.	1.000	1.000	1.000	1.000	1.000
	Mean	0.889	0.867	0.987	0.907	0.797
Mean of all units(n=90)		0.878	0.892	0.985	0.907	0.796
*F Calculated		291.58	156.177	0.812	84.05	762.9
Prob.		0.00008	0.0001	0.447	0.0001	0.00001

* **($F_{critic.\ 87,\ 2}$ =3.101).Source: Findings of the DEA.**

Table 11 displays that between 90 farms, there are (24) farms represent (26.7%) achieve total technical efficiency, (34) farms represent (37.8%) achieve pure technical efficiency and (25) farms represent (27.7%) achieve the scale efficiency.

Table 11. The count and percentage of the efficient farms in producing oilseed sunflower crop

Efficiency	West Minya (n=15)		Middle Egypt(n=30)		Bani Mazaar (n=45)		All zones (n=90)	
	count	%	count	%	count	%	count	%
Total Efficiency Score TE_{CRS}	0	0	21	70	3	6.7	24	26.7
Technical Efficiency Score TE_{VRS}	1	6.7	21	70	12	26.6	34	37.8
Scale Efficiency Score SE	1	6.7	21	70	3	6.7	25	27.7
Allocative Efficiency score AE	0	0	10	33.3	11	24.4	21	23.3
Economic Efficiency score CE	0	0	7	23.3	2	4.4	9	10

Source: Findings of the DEA.

Concerning the total technical efficiency (TE_{CRS}) scores by zones; Table 10 explains that the mean score in West Minya zone is (0.594) ranges between (0.587) and (0.607), while in Middle Egypt zone (TE_{CRS}) score is (0.985) ranges between (0.968) and (1.0) and in Bani Mazaar zone (TE_{CRS}) score is (0.889) ranges between (0.833) and (1.0).The highest (TE_{CRS}) score is of Middle Egypt zone and the lowest is of West Minya zone. ANOVA result proves that there is a statistically significant difference in the total technical efficiency (TE_{CRS}) between the three mentioned zones ($F_{.Calculated}$ = 291.58 >$F_{Critic.}$ 87, 2=3.101 and p-value is less 0.01). Accordingly, the null hypothesis ($H_{01/1}^{e}$) which states that "there is no statistical significance of difference in the total technical efficiency score between farmers of oilseed sunflower crop from different zone" is rejected while there is a statistical significant difference in the total technical efficiency scores between farmers of oilseed sunflower crop from different zones. In addition, Table 11 explains that there are (21) farms represent (70 %)of Middle Egypt zone achieve the total technical efficiency while(3)farms represent (6.7%) of Bani Mazaar zone and none farm of West Minya zone achieve the total technical efficiency.

Similarly, Table 10 demonstrates that the mean score of pure technical efficiency (TE_{VRS}) in West Minya zone is (0.621) ranges between (0.589) and (1.0) , while in Middle Egypt zone, (TE_{VRS}) score is (0.997) ranges between (0.994) and (1.0) and in Bani Mazaar zone, (TE_{VRS}) score is (0.867) ranges between (0.833) and (1.0) . ANOVA result proves that there is a statistically significant difference in the pure technical efficiency (TE_{VRS}) between the three zones ($F_{.Calculated}$ = 156.177 >$F_{Critic.}$ 87, 2=3.101 and p-value is less than 0.01). Accordingly, the null hypothesis ($H_{01/2}^{e}$) which states that "there is no statistical significance of difference in the pure technical efficiency score between farmers of oilseed sunflower crop from different zone" is rejected while there is a statistical significant difference in the pure technical efficiency score between farmers of oilseed sunflower crop from different zone". The highest pure technical efficiency (TE_{VRS}) score is of Middle Egypt zone and the lowest is of West Minya zone. In addition, Table 11 displays that there are (21) farms represent (70 %) of Middle Egypt zone achieve the pure technical efficiency while (12) farms represent (26.6%) of Bani Mazaar zone and only one farm of West Minya zone achieve the pure technical efficiency.

Additionally, Table 10 shows that the mean score of scale efficiency (SE)in West Minya zone is (0.972) ranges between (0.607) and (1.0) , while in Middle Egypt zone, (SE) score is (0.988) ranges between (0.974) and (1.0) and in Bani Mazaar zone, (SE) score is (0.987) ranges between (0.913) and (1.0) . ANOVA result proves that there is a statistically insignificant difference between zones ($F_{.Calculated}$ = 0.812 < $F_{Critic.\ 87,\ 2}$=3.101, p-value=0.447). Hence, the null hypothesis ($H_{01/3}^{e}$) which states that "there is no statistical significance of difference in the scale efficiency score between farmers of oilseed sunflower crop from different zone" is accepted, which may be interpreted by the close scale efficiency (SE) scores among the three zones. Moreover, Table 11 shows that there are (21) farms represent (70 %) of Middle Egypt zone achieve the scale efficiency while (3) farms represent (6.7%) of Bani Mazaar zone and only one farm of West Minya zone which represents (6.7%), achieves the total technical efficiency.

The results of the allocative and the economic efficiencies

In terms of the economic (cost) efficiency (CE), Table 10 explains that the mean score of economic efficiency (CE) which covers all zones is (0.796). This score indicates to that the same output level of sunflower crop can be realized even if the inputs costs are decreased by (20.4%). Commonly, this inefficient score of economic efficiency is discriminated into two sources: non-achieving the minimum production inputs (total technical efficiency TE_{CRS} = 0.878, which is discussed above) and non-optimality level of production cost, i.e. the production cost is higher than the minimum production cost (allocative efficiency AE= 0.907). Moreover, Table 11 explains that between 90 farms, only (9) farms represent (10%) achieve the economic efficiency, while (21) farms represent (23.3%) achieve the allocative efficiency.

Viewing the economic efficiency (CE) by zones, Table 10 clarifies that (CE) in West Minya zone is (0.403) ranges between (0.374) and (0.468). While in Middle Egypt zone, (CE) is (0.853) ranges between (0.836) and (1.0) and in Bani Mazaar zone, (CE) score is (0.797) ranges between (0.668) and (1.0). ANOVA result proves that there is a statistically significant difference in the economic efficiency between the three mentioned zones ($F_{.Calculated}$ = 762.9 >$F_{Critic.}$ 87, 2=3.101, P-value is less 0.01). Therefore, the null hypothesis ($H_{01/4}^{e}$) which states that "there is no statistical significance of difference in the economic efficiency score between farmers of oilseed sunflower crop from different zone" is rejected, while there is a statistical significance of difference in the economic efficiency score between farmers of oilseed sunflower crop from different zone. Additionally, the highest (CE) score is of Middle Egypt zone and the lowest is of West Minya zone. In addition, Table 11 displays that there are (7) farms represent (23.3 %) of Middle Egypt zone achieve the economic efficiency while only (2) farms represent (4.4%) of Bani Mazaar zone and none farm of West Minya zone achieve the economic efficiency.

Also, Table 10 reveals that the allocative efficiency (AE) in West Minya zone is (0.679) ranges between (0.625) and (0.782) While in Middle Egypt zone, (AE) score is (0.866) ranges between (0.859) and (1.0), while in Bani Mazaar zone, (AE) score is (0.907) ranges between (0.804) and (1.0). ANOVA result proves that there is a statistically significant difference between zones ($F_{.Calculated}$ = 84.05 >$F_{Critic.}$ 87, 2=3.101, P- value is less than 0.01). Hence, the null hypothesis ($H_{01/5}^{e}$) which states that "there is no statistical significance of

difference in the allocative efficiency score between farmers from different zone" is rejected, however there is a statistical significance of difference in the allocative efficiency score between farmers of oilseed sunflower crop from different zone. The highest (AC) score is of Bani Mazaar zone and the lowest is of West Minya zone. In addition, Table 11 shows there are (11) farms represent (24.4%) of Bani Mazaar zone achieve the allocative efficiency, while in Middle Egypt zone there are (10) farm represent (33.3%) achieve the allocative efficiency and none farm of West Minya zone achieve the allocative efficiency.

Calculating the efficient target mean scores on the frontier of the isoquant curve.

Table 12 demonstrates the efficient target mean scores of output and inputs on the frontier. The mean target of output is 1076.46 Kg/Feddan ranges between 980.3 kg/Fadden in West Minya zone to 1175.1 kg/Feddan in Middle Egypt zone. Concerning the target mean scores of inputs on the efficient frontier, the fertilizers application mean is 75.46 ranges between 73.17 EU/Feddan in West Minya zone and 77.9 EU/Feddan in Middle Egypt. In terms of human labor, the target mean score is 16.4 H/Feddan ranges between 15.6 H/Feddan in West Minya zone and 17.5 H/Feddan in Middle Egypt. Additionally, the target mean score of machine labor is 9.35 H/Feddan ranges between 8.5 H/Feddan in West Minya zone to 10.4 H/Feddan in Middle Egypt zone. On the other hand, the target mean score of seed is 5.7 Kg/Feddan ranges between 5.04 Kg/Fadden in West Minya zone and 6.5 Kg/Fadden in Middle Egypt zone, while the mean target score of sunflower cultivated land area is 0.84 Feddan ranges between 0.5 Feddan to 1.2 Feddan.

Table 12. The target means of output/inputs on the frontier.

variable	WestMinya(n=15)	Middle Egypt (n=30)	Bani Mazaar (n=45)	All zones(n=90)
Yield(Kg/Feddan)	980.3	1175.1	1042.7	1076.46
Fertilizers(EU/Feddan)	73.17	77.9	74.5	75.46
Labor (H/Feddan)	15.6	17.5	15.8	16.4
Machinery(H/Feddan)	8.5	10.4	8.9	9.35
Seeds(Kg/Feddan)	5.04	6.5	5.3	5.7
Land(Feddan)	0.5	1.2	0.68	0.84

Source: Findings of the DEA.

Calculating the deficit (surplus) of output/inputs between the actual and the target mean scores on the frontier of the isoquant curve.

Table 13 also summarizes the quantities and percentage of frontiers inputs and output. In terms of oilseed sunflower productivity, the deficit mean of all zones is (110.96) kg/Feddan represents (11.49%) of the actual output. This deficit mean ranges between (3.33) Kg/Feddan represents (0.28%) in Middle Egypt zone and (381.7) kg/Feddan represents (63.8%) in West Minya zone. Moreover, the irrational surplus mean of fertilizers is (11.23) EU/Feddan represents (12.95%) of the actual input. This surplus of fertilizers ranges between 1.22 EU/Feddan represents (1.54%) in Middle Egypt zone and (30.03) EU/Feddan represents (29.1%) in West Minya zone. Additionally, the surplus mean of human labor is only (0.87) H/Feddan represents (5.04%) of the actual input. This surplus of human labor ranges between (0.09) H/Feddan represents (0.57%) in Middle Egypt zone and (4.54) H/Feddan represents (22.5%) in West Minya zone, while surplus mean of machinery labor is (0.93) H/Feddan represents (9.05%) of the actual input. This surplus of machinery labor ranges between (0.18) H/Feddan represents (1.7%) in Middle Egypt zone and (3.99) H/Feddan represents (31.9%) in West Minya zone. Otherwise, the employed quantities of seeds are rational as an average of all zones except for a slight surplus in Middle Egypt zone (1.22%) and Bani Mazaar zone (1.3%). Similarly, the surplus mean of cultivated area of oilseed sunflower is only (0.092) Feddan represents (9.87%) of the actual cultivated land. This surplus ranges between (0.008) Feddan represents (1.16%) in Bani Mazaar zone and (0.52) /Feddan represents (51%) in West Minya zone.

Table 13. The deficit and surplus quantities between the actual and the efficient target means of output/inputs

Variables	West Minya(n=15)		Middle Egypt(n=30)		Bani Mazaar(n=45)		All zones(n=90)	
	quantity	%	quantity	%	quantity	%	quantity	%
yield(Kg/Feddan)	-381.7	-63.8	-3.33	-0.28	-92.35	-9.72	-110.96	-11.49
Fertilizers(EU/Feddan)	30.03	29.1	1.22	1.54	11.75	13.62	11.23	12.95
Labor (H/Feddan)	4.54	22.5	0.41	2.29	0.09	0.57	0.87	5.04
Machinery (H/Feddan)	3.99	31.9	0.18	1.70	0.43	4.61	0.93	9.05
Seeds (Kg/Feddan)	0	0.0	0.08	1.22	0.07	1.30	0	0.00
Land (Feddan)	0.52	51.0	0.05	4.00	0.008	1.16	0.092	9.87

Source: Findings of the DEA.

Identifying the optimal contracting situation of oilseed sunflower which achieve Nash Equilibrium .

This section summarizes the actions and reactions of the contract bargaining game. Table 14 demonstrates the payoff matrix of the Nash Equilibrium. First of all, the game consists of two players: player ①, is the decision maker and player ② is the farmers of oilseed sunflower. The decision maker sets up three actions while the farmers have 2choices for each action: response or nonresponse. Action (1) is providing flexible floor price of oilseed crop, in which CFC determines the minimum contract price of oilseed sunflower (L.E.8500 per ton). This price can be increased if the global / domestic marketing price of oilseed sunflower rises but if the global / domestic marketing price falls, farmers receive the contract price which is L.E.8500 per ton. The cost of this action is (0), the profit of receiving the crop (+1), the total payoff of the decision maker is [+1+ 0 = +1] but if the decision maker doesn't receive the oilseed crop, s/he gains (0) profit and his payoff becomes [0+ 0 = 0]. If the farmers response to action (1), they gain (+1) profit of oilseed sunflower crop but they deprive from the higher profit of other summer crops (-1), i.e. the total payoff of farmers is [+1+ (-1) = 0]. Conversely, if the farmers nonresponse to action (1), they gain (0) profit of oilseed sunflower crop but they gain (+1) profit from the other summer crops, i.e. the total payoff of farmers is [0+ 1 = 1]. Regarding to Action (2), the decision maker is providing flexible floor price of oilseed crop in addition to the extensional services. The cost of this action which represents the

extensional services (-1), the profit of receiving the crop (+1), the total payoff of the decision maker is [+ 1 + (-1) = 0]. But if the decision maker doesn't receive the oilseed crop, s/he gains (0) profit and his payoff becomes [0+ (-1) = -1]. In terms of farmers' reactions; if the farmers response to action (2), they gain (+1) profit of oilseed sunflower crop but they still deprive from the higher profit of other summer crops (-1), i.e. the total payoff of farmers is [+1+ (-1) = 0]. On the contrary, if the farmers nonresponse to action (2), they gain (0) profit of oilseed sunflower crop but they gain (+1) profit from the other summer crops (+1), i.e. the total payoff of farmers is [0+ 1 = 1]. Furthermore, Action (3): the decision maker is providing flexible floor price of oilseed crop, recycling the residues and providing the extensional services. The cost of this action which represents the extensional services (-1), the profit of receiving the crop (+1), and receiving compost and fodders (+1), thus the total payoff of the decision maker is [+ 1 +1 + (-1) = +1]. In relation to farmers' reactions; if the farmers response to action (3), they gain (+1) profit of oilseed, and (+ 1) profit of compost and fodder but they still deprive from the higher profit of other summer crops (-1), therefore the total payoff of farmers is [+1+ 1 + (-1) = +1]. On the contrary, if the farmers nonresponse to action (3), they deprive themselves from two fold contract deal (oilseed and by-products), therefore their lost opportunity is (-2) profit but they gain (+1) profit from the other summer crops, i.e. the total payoff of farmers is [(-2) + 1 = -1].

The previous discussion reveal that the point (Action (3), Response) or (1, 1) or (win, win) strategy is the best equilibrium point, in which the decision maker payoff is (1) and also the farmers payoff is (1). This point verifies the Nash[vi] equilibrium in which no player has an incentive to change his strategies. If the decision maker provides only the flexible floor price of oilseed, the farmers may prefer other summer crops because they have inconsistent information and negative attitude towards the oilseed crop and/or the contract farming. If the decision maker provides the flexible floor price in addition to the extensional services, the spot market of other summer crops may still more profitable. But if the decision maker provides the floor price of oilseed, the extensional service and the recycling by- products, the opportunity cost and gains of this action increase, therefore the farmers cannot loss this action.

Table 14. Payoff matrix of Nah Equilibrium

		Player (2) Farmers	
		Response	Nonresponse
Playe1①Dicesion Maker	Action (1) : Floor price of oilseed crop	(1,0)	(0,1)
	Action (2): Floor price of oilseed crop extensional services	(0,0)	(-1,1)
	Action (3) : Floor price of oilseed crop recycling residues extensional services	(1,1)	(-1, -1)

Source: Findings of the research.

CONCLUSION AND RECOMMENDATIONS

Based on the results gained, it is concluded that socio-demographic characteristics of the farmers such as age, education, farm income and experience of contract farming are varied between different zones. Consequently, these variations of socio-demographic characteristics affect farmers' knowledge, attitude, practices and behavior (KAPBs) towards contract farming of oilseed sunflower crop. In other words, if farmers have sufficient and consistent information about contract farming of oilseed sunflower crop, therefore, they build positive attitudes, apply good agricultural practices and improve their behavior towards contract farmers. The low achievements of (KAPB) in West Minya zone is interpreted by the personal socio-demographic of the respondents which represented by low level of experience whereas this zone is newly reclaimed, the farm scale is higher than the economic scale in addition to that most operators are investors who possess these lands for speculation. Conversely, the high achievements of (KAPB) in Middle Egypt zone is interpreted by the high level of education and moderate experience. Otherwise, farmers of Bani Mazaar zone have low level of education, they are on a moderate levels of (KAPBs) because they have high experience of traditional styles of agricultural which is inherited from their families.

On the other hands, Data Envelopment Analysis (DEA) considering input oriented method is applied to know how much production inputs per Feddan of an inefficient farms can be decreased in reference to the efficient farms which lies on the frontier curve provided that the output level of the inefficient farm is kept constant. The mean score of the total technical efficiency with respect to constant return to scale (TE_{CRS}) and economic (cost) efficiency (CE) of farmers of West Minya zone are the lowest than others, conversely, mean scores of Middle Egypt zone are the highest than others. These discrepancies of efficiency scores between zones are interpreted by: (1) the differences of output/input in each farm, (2) the differences between farmers' socio-demographic characteristics and (3) the differences between levels of farmers' KAPB. Furthermore, the target output on the frontier of the isoquant could be achieved by reallocating resources in a rational and economic use. On the other hands, the best (Nash) equilibrium strategy of contracting (win, win) is verified when the decision maker sets a flexible floor price of oilseed, provides extensional service and recycles the by-products of the crop. At this point, farmers response immediately without any incentive to change their strategy even if the spot market of other summer crops are more profitable because they benefit twice from contract of oilseed sunflower crop. In conclusion, farmers should have positive KABP to apply contract farming of oilseed crop in addition to manage production inputs efficiently at a minimum amount and cost on the frontier of isoquant curve.

Thus the recommendation of the extensional requirement model are as following:

1- Not all farmers are exposed to the concept of contract farming specifically in the newly reclaimed lands; thus, adequate discussions, symposiums, transmissions of extensional programs through campaigns, demo-plots, social media, TV and radio are recommended.
2- Also, extension agents play vital roles in terms of disseminating information.
3- The socio-demographic characteristics of farmers should be considered in improving the levels of their KAPB towards contract farming of oilseed sunflower.

The recommendations of the economic requirement model are as following:

1- Rationalizing and re-allocating the excessively used resources to alternative crop, specifically, the efficient target of oilseed sunflower output requires to rationalize inputs of fertilizers by 12.95%, human labor by 5.04%,

machinery labor by 9.05% and cultivated area by 9.87% as an average of all zones.

2- It is possible to design a contract scheme in which farmers with different cost structures can join together. This design contribute in: (a) ensuring the extensional services coverage; (b) reducing the marginal cost of extensional services and agronomic follow-up ;(c) setting a monopolistic bargaining power which could be managed by the cooperatives to gain monopoly profit for its members
3- Also, this contract scheme should link between the national chains of oilseed sunflower crop, sunflower oil and cake meal of sunflower. This scheme provides flexible floor price of oilseed and extensional service in addition to recycling the by- products of the crop into silage and compost to contribute in : (a) solving the oilseed sunflower gap; (b) solving the livestock feeds gap ; (c) achieving extra farm profits from the add value of silage and compost.
4- Mainstreaming the national companies of refining and processing vegetable oils in the contract scheme to bear the cost of extensional services and recycling the residues.
5- Further researches which consider reallocating the summer crop pattern and oilseed sunflower crop should be conducted under the circumstances of water salinity, climate change and irrigation shortage.

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المتطلبات الإرشادية والإقتصادية لتطبيق الزراعة التعاقدية على محصول عباد الشمس الزيتى بين المزارعين بمنطقة غرب المنيا والمناطق المحيطة

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الملخص

تتمثل مشكلة الدراسة فى نقص مساحات محصول عباد الشمس الزيتى بمنطقةغرب المنيا (مشروع إستصلاح 1.5 مليون فدان) ، ومنطقتى مصر الوسطى وبنى مزار . إستهدف البحث: (1)تحديد المتطلبات الإرشادرية : المعارف ، والإتجاهات ،والممارسات، وسلوك المزارعين نحو التعاقد على المحصول . (2)المتطلبات الإقتصادية : الكفاءة الفنية والإقتصادية . إعتمد البحث على عينة عشوائية بسيطة (90) مزارع المستفيدين من الحقول الإرشادية للمحصول لمركز بحوث الصحراء.وتم تجميع بيانات الاستبيان بالمقابلة الشخصية خلال (نوفمبر 2021 - مايو 2022) . أستخدمت مؤشرات الإحصاء الوصفى وتحليل الإرتباط والإنحدار المتعدد ونموذج تحليل مغلف البيانات لتحقيق أهداف البحث. وأوضحت النتائج ما يلى : تعتبر أدنى متوسطات المعارف والاتجاهات والممارسات والسلوك بمنطقة غرب المنيا (52.2%، 48%، 44.8%، 48.3% على الترتيب) بينما تعتبر أعلاها بمنطقة مصر الوسطى (88%، 82%، 80%، 80.7% على الترتيب). وأوضحت نتائج معامل الإرتباط لبيرسون وجود علاقة طردية معنوية بين خصائص المزارعين (التعليم ،والدخل المزرعى، و سنوات الخبرة)وسلوكهم نحو الزراعة التعاقدية . وتوضح نتائج تحليل مغلف البيانات على مستوى العينة أن محصول عباد الشمس لا يتم إنتاجه بكفاءة تامة ، حيث بلغت الكفاءة الفنية والإقتصادية للعينة (0.878) ،(0.796) على الترتيب ، أى أنه يمكن تحقيق نفس مستوى الإنتاج بإستخدام قدر أقل من المدخلات(12.2%)، و التكاليف (20.4%) . و تبين أن مزارعى غرب المنيا الأقل كفاءة ،بينما يعتبر مزارعى مصر الوسطى الأكثر كفاءة. للوصول للمستوى المستهدف للإنتاجية (1076.46 كجم / فدان)، يوصى بترشيد مدخلات الانتاج ،وتبنى إستراتيجية للتعاقد لتقديم سعر ضمان مرن ، وخدمات إرشادية، وتدوير المنتجات الثانوية لتحقيق توازن ناش (الفوز للمزارع وجهة التعاقد).

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[i] The cultivated area of old valley of EL-Minya governorate which covers 79% of the governorate area consists of nine districts: EL-Edwa, Maghagha, Bani-Mazaar, Maattai, Sammaloot, Abou Korkaas, Mallawi and Dair –Mouass) IDSC (2021).

[ii] Fertilizers' application :nitrogen (250 kg ammonium sulfate+ 150 kg ammonium nitrate) is classified into two doses, in the 2nd dose: 50 kg potassium is added and micro nutrients are sprayed twice: 1st after 30days and 2nd after 15 days of the 1st .

[iii] Harvesting includes: starting after the heads 'color changes to yellow, aerating the heads in open air for one week, storing the kernels in dry place and ensuring that the moisture doesn't increase 9-10%.

[iv] Recycling includes: stalks, leaves and empty heads to produce compost.

[v] Multicollinearity is detected by Variance Inflation Factors (VIF) which is commonly applied to measure how much the variance of the estimated coefficients are increased over the case of no correlation among the independent variables. If VIF coefficient for one of the variables is around or greater than (5), there is a collinearity problem associated with that variable Maddala (2001); Justine (2012).

[vi] John F.Nash, an American mathematician ,won the 1994 Noble Prize in economics with others for their work in game theory