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An Economic Study of The Wadi Rehabilitation Impact on The Society's Welfare in Matrouh Governorate (Case Study- Kharouba Wadi)

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ABSTRACT

This paper aims to analyze the impact of Wadi Kharouba rehabilitation on the society's welfare through: (1) econometric estimation of the impact of the Wadi' add-value and households 'demographic variables on per capita expenditure per month as a proxy variable of beneficiaries 'welfare; and (2) identifying the preference between individual welfare indicators and collective welfare indicators from farmers and society' points of views. A census of the Agarma tribe households benefited from Wadi rehabilitation is surveyed by in-depth interview questionnaire in July, 2022. Two-Stages Least Square-Instrumental Variable (2SLS-IV) technique is applied to overcome the endogeneity problem. The empirical results show that as the Wadi add -value increases by 1%, the per capita expenditure increase by 37.225%. Furthermore, demographic characteristics such as household head' age, household size, education, and dependency ratio significantly influence the add value and then per capita expenditure variables. Another purposive sample of experts is surveyed to identify the preference between individual and collective welfare criteria and indicators of Wadi Kharouba. Analytic Hierarchy Process (AHP) show that the highest preference is assigned to individual welfare criterion (53%) which indicates the priority of Bedouin's economic outcomes in trade off collective welfare criterion of society and environment (47%).High priorities are given to three indicators: "farm income to total income" (32.1%), "add food and fodder production" (26.8%) and "abating of land common conflicts" (17.8%). The findings suggest that scaling up the rehabilitation activities, specifically irrigation facilities will enhance per capita expenditure, livelihood and household welfare in the marginalized Bedouin communities.

Keywords: Add- Value; Welfare; AHP; Wadi Rehabilitation.

INTRODUCTION

Arid and semi-arid lands 'rehabilitation becomes one of the global suggested procedures to revive local economies, enhance livelihood, and achieve welfare in coastal regions. The UN Decade on Ecosystem Restoration (2021-2030) recommend to mainstream rehabilitation approaches which include suitable land and water management (SLWM) practices for about 3.5 million km^2 of irrigated, rained and rangeland agro- ecosystems in the Middle East and North Africa (MENA) region (FAO,2022). Also, Egypt is one of the concerned countries which responds to the Land Degradation Neutrality Target Setting Program (LDN TSP) through rehabilitate and increase productivity of 8000 km^2 of rangeland and rainfed areas by 2030 using SLWM practices in north coastal areas (Desert Research Center,2018). Nasr (1999) defined the rehabilitation procedures in: dams to conserve water and soil, micro-catchment to collect water, cisterns to store harvested water and earth dykes (spate irrigation and small head pumps) to divert water for irrigation.

In the North Western Coastal Zone of Egypt, long drought periods, unsustainable exploitation practices including firewood gathering, over-grazing of rangelands, traditional tillage and degradation of vegetation cover forced the local community to rehabilitate Wadies which are accounted 218 Wadies running from south to north [i](El-Sadek and Mohamed, 2017). The Egyptian agricultural development strategy moves towards rehabilitating the abandoned arid and semi-arid cultivated lands to improve rural communities' livelihood and welfare in desert marginalized communities which suffer from water irrigation scarcity, where rainfall in Matrouh governorate is about 140 mm, which is considered one of the poorest areas in water resources which negatively affecting agricultural activities, pasture status, and consequently, the livelihood of the local Bedouin communities. (AOAD, 2020; Aboul - Naga et.al. 2022).

Agarma sub-basin (about 6 Km^2) of the Wadi Kharouba, located west of Marsa Matrouh district at the north western coastal region of Egypt. It is one of rehabilitated Wadies where 13.5 Hectare (ha) was abandoned, severely degraded landscape, and bared soil are reclaimed and cultivated by Matrouh Rural Sustainable Development (MARSADEV) Project, funded by CIHEAM/Bari and implemented by Desert Research Center, 2014 - 2017 (Zdruli, Zucca, 2018).Wadi Kharouba is a typical arid Mediterranean climate which is described by long hot dry summer and short cool rainy winter. Its topography consists of bottom flat area and slops which are considered as watersheds provide irrigation for cultivating crops and trees. The project implemented reclamation works (levelling and soil movements), constructions of dykes, reservoir and semicircle terraces, plantation of figs and

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olives trees in addition to good agricultural practices(GAPs) (MARSDEV, 2016).

Considering the social welfare in Wadi Kharouba, this paper adopted the classical utilitarian welfare function, introduced by Bentham (1789) and developed by economists such as Mill (1861), Marshall (1890) and Pigou (1920) which are considered the official theory of traditional welfare economics (Sen, 2000; Scarborough, Bannett, 2009; Pollak, 1979; Varian, 2010). Randall (1987) described the social welfare function (SWF) mathematically by the distributed societal preferences among the individual members of the society. Hence, the SWF, is a function of utilityU_i, for individuals, $i = I \dots \dots n$ in society, $SWF = w(U_1, U_2, \dots . U_n)$. Myles (1995) aggregated the individual utilities of individuals $i = I \dots \dots n$ to maximize the society' utilities, that is:$SWF\ (U_1 \dots . U_n) = \sum_{i=1}^{n} U_i$.The classical utilitarian SWF assumes a linear relationship where the utility of each individual or group of individuals is treated equally when aggregating social welfare. SWF also reflects the willingness to trade off the utility or wellbeing of one individual for another (Pearce 2006; Scarborough, et.al. 2009). In this paper, SWF displays the trade- off between suggested welfare alternatives: individual welfare indicators (which consider the economic returns of farmers); and collective welfare indicators (which consider the society) among all involved stakeholders in Wadi Kharouba: the Bedouins in one side; and the authority and ecologists in the other side in a hierarchical process.

Problem Statement

The research problem is that although Wadi Kharouba have been rehabilitated during 2014-2017, and although the conducted technical studies have documented the role of Wadi Kharouba in fig and olive production, the impact of rehabilitation on householders' welfare is still ignored. Also, the comparison between the individual welfare indicators of farmers and the collective welfare indicators of the overall society may have been disregarded. Moreover, the first paper question is "if the householders achieve add-value from Wadi Kharouba rehabilitation, what are the impact of these add- values on welfare?, and the second question is "Are individual welfare indicators more prioritized than collective welfare indicators from farmers' point of views?. This papers imposed two hypotheses: the first is that the rehabilitation procedures including cistern establishments and good agricultural practices are improving the add-value of crops and livestock which enhancing householders' welfare since 2017 till now; and the second hypothesis is that the individual welfare indicators have the same weight of collective welfare indicators from farmers' point of views and the society point of views.

Research objectives

Based on the mentioned problem, this research paper aims to: analyze the impact of Wadi Kharouba rehabilitation on the society's welfare through:

1- Econometric estimation of the impact of the add-value of farm activities and demographic variables of householders on the per capita expenditure per month as a proxy variable of beneficiaries 'welfare.
2- Identifying the preference between individual welfare indicators and collective welfare indicators from farmers' point of views and society point of views.

Literature Review:

This part shows the main activities of rehabilitation and policy actions that the government adopted to improve livelihood and welfare of Bedouin communities in west northern coast of Egypt. The rehabilitation activities include: (1) water facilities construction such as cistern, reservoirs, pivot irrigation systems, cement dykes and semi-circles; (2) good agricultural practices of fig, olive and barley; and (3) livestock raising and graze management to enhance household welfare.

Few national studies documented the impact of rehabilitation interventions in north western coast of Egypt on household well-being. Hoffet, et.al.(2012) showed that conducting cisterns and reservoirs techniques in north western coast of Egypt have the potential for improvement in land rehabilitation, vegetative cover and aquifers. It also has socioeconomic potential for stabilization and enhancement of living standards. However, these techniques require an integrated watershed management to take into account ecological, socioeconomic and political concerns in order to achieve sustainable land and water management. Lasseur, et.al (2013) draw attention to that Wadi rehabilitation in coastal zones of western desert of Egypt extremely increased private land possession, enhanced farm diversity income, altered the traditional pastoral system based on mobility to a settled agro – pastoral system, and reduced the role of tribal power in face of drought hazards. Alary *et al.* (2016) proved the connection between changes of Bedouins' lifestyle and land reclamation projects accompanied by reservoirs and dikes 'constructions as well as the extension of irrigation canals in the coastal zone of western desert, Egypt. They showed a clear relationship between intensity of social networks within the traditional society, the level of education and the assets of land and livestock as a result of rehabilitation projects.

Daoud *et al.* (2016) introduced the Wadi rehabilitation as the only alternative for small breeders in North Western Coastal Zones (NWCZ) of Egypt. Due to drought conditions, large areas of rangeland around the villages are no longer available neither in winter nor in spring. However, the most breeders decided to invest their labor in Wadi agriculture, planting fig and olive trees, barley, and vegetables. Since 1993 Matrouh Resources Management Project (MRMP) invested in water harvesting; infrastructure; and supply of potable and irrigation water to satisfy Bedouins' demand of Wadies. The main two actions adopted by MRMP were: (1) building cisterns in the villages; and (2) construction of dykes and dams in the beds of the Wadies. Abdalla. et.al. (2018) studied the water availability of Wadi Kharouba. The study area located along the Wadi channel bed that was reclaimed into terraces, to be cultivated. Thy proved that these terraces may store up to 50,000 m^3 of water and this water might be used by the crops for whole spring-summer periods. Aboul-Naga, et.al.(2022) assessed the main householders' perceived developmental needs of local Bedouin communities in the rural hot dry costal zones of western desert in order to improve the development and policy actions. Hierarchical clustering analysis (HCA) is applied for weighting the householders' development needs. Fieldwork was carried out in 2018 to score the priority of the following proposed development

activities :cistern for domestic use, cistern for supplement irrigation, good agricultural practices for barley, goat improvement, goat raising, rural poultry, dairy processing, fruit and vegetable processing, home gardens, range shrubs and veterinary services. Results showed that: (1) cistern, as rainfall catchments are the major water source, 77% of them for domestic use, 10% for supplement irrigation, and the rest (13%) are used for both; (2)the majority of families (92.7%) suffer from inadequacy of water for domestic use. They purchased water (300 m3/year) by 22L.E. /m^3 depending on the source, distance, and season; and (3) the majority of householders (95%) ranked their highest necessity for water cisterns followed by water reservoirs (78.6%), whereas pasture development got the lowest priority.

Internationally, many empirical studies illustrated the role of irrigation interventions in arid lands in reducing poverty and household well-being. Bwisa (2015) assessed the impacts of water harvesting projects in Kenya on householders' well-being. Results showed that water projects interventions promote economic growth and help alleviate poverty, save time in collecting water, and improve crop yields and livestock yields.

Ibrahim (2017) explained that after rehabilitation of Tulus irrigation project in Sudan, about 80% of the community has sufficient income to meet family needs while before the project only 31% were generating sufficient income. After the project improvement, community shifted from poor and traditional agricultural systems depending on rainfall and few crops to higher productivity crops in a wider agricultural area. Improvement of Wadi regulates the water supply and makes it more usable than before and water supply is becoming sufficient as confirmed by 96% of the respondents. Christian et. al. (2019) have reported that participation in irrigation farming in South Africa could serve as a way to create new job opportunities, both on and off the farm, boost rural incomes, improve livelihood, improve food security and alleviate poverty through improvement in farm productivity.

Manda, *et.al.* (2021) evaluated the impacts of adoption soil and water conservation technologies on householders' welfare in Tanzania. The results showed that the adoption increased household income by an average of 49%. Moreover, it had a significant positive impact on food security and micronutrient consumption indicators: household dietary diversity (HDD), household food insecurity access scale (HFIAS) and consumption of iron and vitamin-rich foods. Adetoro, *et.al.* (2022) examined the role of socioeconomic factors that influence farmers' participation in irrigation practices, in addition to the impact of this participation on farmers' food consumption expenditure per capita (proxy for welfare) in South Africa. Results showed that gender, household size, educational attainment and crop diversification were the main factors that influenced farmers 'decision to participate in irrigation practices, as well as participation in irrigating practices improved their food consumption per capita by 44%.

Data and Methodology

Two types of surveys are conducted to achieve the research objectives. First; a census of the all Agarma tribe (28 households) benefited from Wadi Kharouba rehabilitation is surveyed by in-depth interview questionnaire in July, 2022. The questionnaire provides primary data about: (1) demographic and socioeconomic characteristics of beneficiaries (household head age; household size; dependency ratio; and household head education) (2) farm activities; (3) cost – return and add-values of crops and livestock; (4) acquired good agricultural practices training. Second; a purposive sample of experts in ecology, horticulture, pest management, soil, water, and economy fields have enough information of the ecological and economic features of Wadi Kharouba is surveyed by e-mail. The survey is designed and implemented through following phases: the first stage aims to re-formulate and review the suggested welfare indicators by 6 experts and the second stage aims to pair-wise compare and weight these indicators by another 6 experts.

To investigate the impact of Wadi Kharouba rehabilitation on welfare, 2SLS technique is applied to model the relationship between welfare status which is proxided by per capita expenditure per month variable and the other explanatory variables as follow:

$$\boldsymbol{Log\ Exp.} = \boldsymbol{b_0 + b_1 Log\ HHAge + b_2 Log\ HSize + b_3 Log\ Dep. + b_4 Log\ HHEdu. + b_5 Log\ AddV. + u} \quad (1)$$

Where $\boldsymbol{Exp.}$ **= per capita expenditure (L.E.);** $\boldsymbol{HHAge}$ **= household head age. ;** $\boldsymbol{HSize}$**= household size;** $\boldsymbol{Dep.}$**= dependency ratio;** $\boldsymbol{HHEdu.}$ **= household head education;** $\boldsymbol{AddV}$ **= add- value of crops and livestock (L.E) = (total outputs values – total inputs value).**

The impact of explanatory variable $AddV.$ on $Exp.$ can't be predicted directly since add-value of crops and livestock also affected by beneficiaries' socioeconomic characteristics, i.e. $AddV.$ could be an endogenous variable. Two-Stage Least Square –Instrumental Variable (2SLS-IV) is one of the appropriate approaches to deal with the endogeneity problem (Maddala, 1992). Three instrumental variables (*Meet, Dist.,* and *Train*) are imposed as follow:

$$\boldsymbol{Log\ AddV.} = \boldsymbol{\gamma_0 + \gamma_1 Log\ HHAge + \gamma_2 Log\ HSize + \gamma_3 Log\ Dep. + \gamma_4 Log\ HHEdu. + \gamma_5 Log\ Meet + \gamma_6 Log\ Dist. + \gamma_7 Log\ Train. + + \omega} \quad (2)$$

Where: $\boldsymbol{Meet}$ **= meetings attendance times with board of MARSDEV project;** $\boldsymbol{Dist.}$ **= the geographical distance variable expressed by km, which measure the distance between Wadi and household residency out Wadi Kharouba to reflect the household head challenges and difficulties to manage and cultivate the Wadi,** $\boldsymbol{and\ Train.}$ **= the training accessibility variable or beneficiaries attendance times of practical training of MARSDEV project. Parameters,** $\boldsymbol{u}$ **and** $\boldsymbol{\omega}$ **are stochastic terms of the first and second equations respectively;** $\boldsymbol{b_0}$ **and** $\boldsymbol{\gamma_0}$ **are intercepts;** $\boldsymbol{b_1}$ **to** $\boldsymbol{b_5}$ **and** $\boldsymbol{\gamma_1}$ **to**$\boldsymbol{\gamma_7}$ **are elasticity or slope coefficients of corresponding variables.**

Firstly, OLS method is applied and checked for Multi-collinearity[ii]. Secondly, 2SLS is applied to overcome collinearity problem of OLS. The endogeneity problem causes standard errors coefficients biasness, hypotheses tests invalidity and violates the OLS assumptions of BLUE. This paper applies Endogeneity test and Weak Instruments (WI) test via Stata14.2 software following (Kennedy, 2008) and (Stock and Yogo, 2005) to check whether the nominated instrumental variables (*Meet, Dist.,* and *Train.*) associate strongly with the supposed endogenous variable (AddV).

To identify the preference between individual welfare indicators and collective welfare indicators of Wadi Kharouba rehabilitation, this paper applies the Analytic Hierarchy Process (AHP), developed by (Saaty, 1980)

assisted by SpiceLogic Hierarchy Process Software. The first step of AHP is portraying the diagram which is consisting of three levels: level (1) is formalizing the general objective of the analysis: optimum society's welfare indicators of Wadi Kharouba rehabilitation, level (2) is defining the main criteria of comparisons: collective benefits and individual benefits, and level (3) is consisting of 12 alternatives of indicators which are compared between them (Saaty, 1990).

The second step is weighting the indicators through constructing the judgment matrices of pair-wise comparisons, the process in which the relative importance between each two proposed indicators in relation to another indicators is scored (Table 1). The surveyed judgments are scaled between 1 to 9 as follow:

Table 1. Pairwise comparison scales

Scale	**1**	**3**	**5**	**7**	**9**	**2,4,6,8**
Preference	Equal	Moderate	Strong	Very strong	Extreme	Intermediate

Source: Sajadian, *et al*, 2017.

The collective benefits criteria include:

1) Landscape appearance and restore (Pearson *et. al*., 1999; Hoffet, et.al., 2012; Aboul-Naga, *et.al*.2022).
2) Integrated pest management (Edwards, 1989; Daoud *et al*., 2016).
3) Chemical, biological and integrated nutrient management of soil (Saltiel, 1994).
4) Availability arable lands for food & fodder production (ha) (Tatlidil, *et al*, 2009; El-Sadek and Mohamed, 2017; Aboul-Naga, *et.al*. 2022).
5) Availability of Irrigation source and conservation of water equipment, reservoir and cement dikes (Kirchmann, 2000; Abdalla. *et.al*. 2018; Aboul-Naga, *et.al*. 2022; El-Sadek and Mohamed, 2017).
6) Abating conflicts of common land ownership (Van Cauwenbergh, *et al*, 2007; Alary *et al*. ,2016)
7) Employment and contribution of women to agricultural activities(Hoffet, et.al.,2012; Aboul-Naga, et.al., 2022)

The Individual benefits criteria include:

1) Share of agricultural income in total income (Comer, *et al*, 1999; Daoud *et al*., 2016).
2) Self-employment source (Daoud *et al*., 2016).
3) Yields & Good Agricultural practices (GAPs) (Manda, et.al. 2021).
4) Fodder substitute source (Daoud *et al*., 2016; El-Sadek and Mohamed, 2017).
5) Add Value of crops' processing (Christian *et. al*., 2019).

Two main characteristics are assigned for pairwise comparisons: the priority of each indicator to itself equal (1), if the priority of indicator (X) to indicator (Y) is (φ), then the priority of indicator (Y) to indicator (X) is (1/φ).

The third step is computing the relative weight of each indicator. SpiceLogic Analytic Hierarchy Process Software is applied to calculate this relative weight through geometric mean as follow:

$$gm_x = \sqrt[n]{P_{xx} + P_{xy} + \cdots + P_{xn}} = \sqrt[n]{1 + P_{xy} + \cdots + P_{xn}}$$

$$\vdots$$

$$gm_n = \sqrt[n]{P_{nx} + P_{ny} + \cdots + P_{nn}} = \sqrt[n]{P_{nx} + P_{ny} + \cdots + 1}$$

Where gm_x is geometric mean of indicator x, and P_{nx} is the priority of indicator n in relation to indicator x. Then to get the relative weight RW_x, the weight of factor x is normalized as follow:

$$Relative\ Weight = Rw_X = \frac{gm_X}{\sum_{X=1}^{n} gm_n}$$

***Rw_X* refers to normalization process of weights for geometric mean *gm* of indicator *x to n*.**

The fourth step is calculating the final weight $\overline{W_i}$ of each indicator i among all criteria Cj and sub- criteria SCi as follow:

$$\overline{W_i} = RW_{Cj} * RW_{SCi}$$

Finally, the Consistency Ratio (CR) [iii]is computed to check the judgment validity. The consistency hypothesis is accepted if CR value ≤ 0.1(Sajadian, *et al*, 2017).

RESULTS AND DISCUSSIONS

1. Econometric Estimation of the Wadi Kharouba rehabilitation impact on beneficiaries' welfare

Descriptive statistics

Table (2) illustrates the descriptive statistics of the beneficiaries' socio-economic characteristics. The average of per capita expenditure per month is L.E. 913.8, ranges between L.E 700 to 1097. Additionally, this average is higher than the Egyptian average per capita poverty line which is estimated at L.E.857, year 2021.

Table 2. Descriptive statistics of the Wadi Kharouba beneficiaries, 2022

variable	**Mean**	**Min.**	**Max.**
Per capita expenditure per month(L.E.)	913.8	700	1097
Household Head Age (year)	40	32	56
Household size	6	4	8
Household Dependency Ratio	0.903	0.67	1.8
Household Head Education(year)	3	0	18
Wadi Add-Value (Thousand L.E.)per season	11.6	7	16
Meetings attendance times	7	0	15
Geographical distance (Km)	6.7	3	11
Training accessibility	4	1	6

Source: Author's calculation of Wadi survey, 2022

The household head age average is 40 years, ranges between 32 to 56 years, the household size average is 6 members, ranges between 4 to 8 members but dependency ratio average is 0.903 ranges between 0.67 (sufficient members in workforce) to 1.8 (few members in workforce). Moreover, the household head education average is only 3 years ranges between (0) year for illiterate beneficiaries (the majority) and 18 years of highly-educated (a unique case). The add-value of cultivating figs and olives and grazing sheep in Wadi Kharouba is thousand L.E.11.6, ranges between thousand L.E. 7 to 16. Furthermore, the average meeting attendance with MARSDEV board is 7 time ranges between 0 to 15 to reflect careless to effective participations in discussions and decisions. The geographical distance

average is 6.7 km ranges between 3 km to 11 km, i.e. all beneficiaries reside in Marsa Matrouh district. Lastly, the average times of training accessibility to GAPs is 4 times ranges between 1 to 6 training courses.

OLS and 2SLS results

Table (3) represents the results of OLS and 2SLS of the impact of Wadi Kharouba rehabilitation on per capita expenditure per month (L.E.). The OLS results indicate that only household head age ($Log\ HHAge$) variable and add-value ($Log\ AddV.$) variable make significant contribution to percentage changes in household welfare($Log\ Exp.$) . The diagnostic check of the model indicates that adjusted R^2 equal 0.89 and variance inflation factor (VIF) equal 9.09, i.e. the model suffers from serious multicollinearity problem. Conversely, the 2SLS results indicate that values of adjusted R^2 in the first and second stages are reasonable, equal 0.78 and 0. 71 respectively, and the values of (VIF) are proper, equal 4.54, and 3.45 respectively. In first stage model, coefficients of instrumental (IV) variables($Log\ Meet$; $Log\ Dist.$and $Log\ Train.$) are treated as instrumental variable for the endogenous variable ($Log\ AddV.$).Results indicate that all the three (IV) variables are statistically significant at a 1% level. Results refers that 1% increase of meetings attendance times ($Log\ Meet$) with the board of MARSDEV project contributes to an increase of Wadi add-value ($Log\ AddV.$) by about 1.2%.This result reflects beneficiaries 'levels of participation, decision making and utilization of extensional services of MARSDEV project as the initial meetings show conflicts of interest between beneficiaries and MARSDEV board related to the feasibility of Wadi Kharouba rehabilitation. On the other hand, the meetings provide social conversation between beneficiaries about the common land possession.

Table 3. Econometric Estimation of the Wadi Kharouba rehabilitation impact on beneficiaries' welfare

Dep. variable / Indep.Variables	OLS			1st stage of 2SLS			2nd Stage of 2SLS		
	$Log\ Exp.$			$Log\ AddV.$			$Log\ Exp.$		
	Coefficient	Std.Err.	t-value	Coefficient	Std.Err.	t-value	Coefficient	Std.Err.	t- value
Household Head Age ($Log\ HHAge$)	0.674	0.109	6.15***	1.993	0.475	4.36***	0.871	0.121	7.184***
Household Size($LogHSize$)	0.869	1.502	0.58	0.633	0.050	12.583***	0.108	0.028	3.91***
Household dependency Ratio ($Log\ Indep.$)	-0.036	0.117	-0.31	-5.626	2.803	-2.007**	-1.796	0.219	-8.18***
Household Head Education ($Log\ HHEdu.$)	0.869	1.502	0.580	10.303	1.694	6.08***	4.950	0.715	6.923***
Wadi Add-Value, L.E.($Log\ AddV.$)	9.582	4.541	2.11**	-	-	-	37.225	5.731	6.50***
Log Meet	-	-	-	1.189	0.390	3.047***	-	-	-
Long Dist	-	-	-	-1.454	0.416	-3.495***	-	-	-
Long Train	-	-	-	6.130	2.032	3.016***	-	-	-
Constant	-0.137	0.153	-0.900	-0.009	0.028	-0.322	-23.501	2.393	-9.82***
Reg. Statistics	Obs.=28,F(5,22)=(375.78)***, Adjusted R^2=0.89, VIF=9.090			Obs.=28,F (7,20)=(62.212)***, R^2 =0.78, VIF=4.54			Obs.=28,Wald Chi ^{2} =(572.96)***, R^2 =0.71, VIF=3.45		

****, *** represent 5%, 1% significance levels respectively.**

Source: Author's calculation of Wadi survey by Stata, 2022.

Moreover, ($Log\ Train.$)variable also refers that 1% increase of training accessibility contributes to an increase of Wadi add-value by 6.13%.The training accessibility or attendance times reflect to what extent the beneficiaries concern about and benefit from practical training and field days of Good agricultural Practices (GAPs)of fig and olive trees in other districts from MARSDEV project. Training increases the beneficiaries consent and enthusiasm to rehabilitate Wadi Kharouba, transfer their new feedbacks and improve Wadi add-value. On the contrary, Results show a negative impact of ($Log\ Dist.$)variable on Wadi add-value, as 1% increase of the geographical distance between Wadi and household residency out Wadi Kharouba decreases Wadi Add-Value by 1.454%. This result emphasizes that geographical distance of residency sets transportation difficulties and real challenges in front of the household head to manage and cultivate the Wadi.

Demographic characteristics variables: ($Log\ HHAge$) ; ($LogHSize$) and ($Log\ HHEdu.$) are statistically significant at 1% level in the first and second stage models and ($Log\ Dep.$) variable is statistically significant at 5% and 1% levels in the first stage and second stage models respectively. Results refer that 1% increase of household head age ($Log\ HHAge$) enhances the Wadi add-value directly by 1.993% but improve the per capita expenditure per month($Log\ Exp.$) by 0.871%. For household size($HSize$) , 1% increase of household size increases Wadi add-value and per capita expenditure per month by 0.633% and 0.108% respectively. On contrary; results indicate that household dependency ratio ($Log\ Indep.$) is negative, as 1% increase in household dependency ratio decreases Wadi add-value and per capita expenditure per month by 5.626% and 1.796% respectively.

The opposite signs of household size and household dependency ratio is not surprising and logically interpreted where household size growth is desirable to introduce unpaid workers in the own household farm which increases the per capita expenditure indirectly through improving the Wadi add- value. On the other hand, household dependency ratio is not desirable because it reflects the household members out labor force (under 16 and above 60), so as this ratio increases as the Wadi add-value decreases and then per capita expenditure. Furthermore, the results indicate that as the Wadi add value ($Log\ AddV.$) increases by 1%, the per capita expenditure per month and then household welfare ($Log\ Exp.$) increase by 37.225%. It is concluded from the previous results that demographic characteristics play a significant role in explaining variations in household welfare and also the importance role of Wadi rehabilitation in achieving household welfare.

Weak instrument and exogenetiey tests

Post-estimation tests are conducted to check the reliability of 2SLS. F-ratio (minimum eigenvalue statistic)

test is conducted for testing weakness of selected instrumental variables. The null hypothesis is the instrumental variables $Log\ Meet$, $Log\ Dist$. and $Log\ Train$ are weak .[iv] Table (4) shows that F(3, 20)= 518.13 is significant at 1%. The null hypothesis is rejected, i.e. the selected instrumental variables are not weak and produce reliable coefficients and hypothesis. Durbin and Wu-Hausman tests are conducted also for testing endogeneity. The null hypothesis is Wadi Add-Value ($Log\ AddV$.) variable is exogenous. Table (4) shows that Durbin (score) Chi ^{2} (1) = 14,426, and Wu-Hausman F (1, 21) =22.319.The two statistics are significant at 1%, so the null hypothesis is rejected and the ($Log\ AddV$.) variable is endogenous.

Table 4. Post- Estimation Tests

Variables	Test	Hypothesis	Statistic	Decision
endogenous repressor (1) Wadi Add-Value, ($Log\ AddV$.)	Weak Instruments	H_0 : Instruments are weak	F(3, 20)= 518.13***	Reject
Excluded Instruments (3) Long meet Long Dist Long train	endogeneity	H_0: Variables are exogenous	Wu- Hausman F(1,21)=22.319*** Durbin (score) Chi2 (1)= 14.426***	Reject

Source: Author's calculation of Wadi survey by Stata, 2022.

2.The preference between individual and collective welfare indicators of Wadi Kharouba

The results of preference between welfare indicators of Wadi Kharouba rehabilitation are explained according to the two proposed criteria; collective benefits and individual benefits as the following four steps:

The diagram of the Hierarchal Analytic Process (AHP)

Figure (1) represents the diagram of the Hierarchal Analytic Process (AHP) as follow:

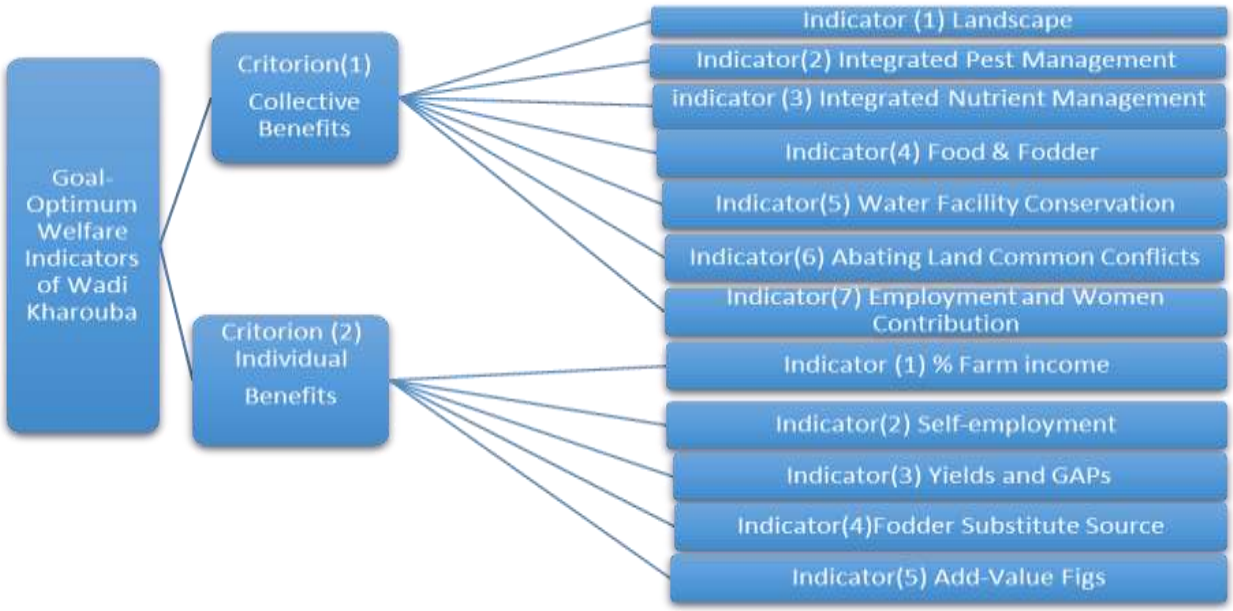

Figure 1. AHP diagram of optimum welfare indicators of Wadi Kharouba

The weight of each criterion

table (5) shows that the weights of collective and individual benefits are (0.467, 0.533) respectively, which mean that the highest benefit share is assigned to individual benefits (53%) to refer the importance of independent decisions and private outcomes of Bedouin farmers to be involved in the Wadi-Kharouba rehabilitation. In addition, the collective benefits criterion represents close importance (47%) which reflects the returns of society and environment.

Table 5. Weight of proposed welfare criterion

Criterion	Weight
Collective Benefits	0.467
Individual Benefits	0.533

Source: analyzed by the author via SpiceLogic AHP Software

The relative weights of indicators

The relative weights of collective indicators

In Tables (6), each indicator is weighted relative to other indicators in the same criterion. However, the results indicate that the highest relative weights are assigned for "add food and fodder production" and "abating of land common conflicts" indicators as their priorities represent about 35.3% and 22.3% respectively. The mentioned two results are logic, as MARSDEV project designed and implemented Wadi Kharouba rehabilitation over 13.5 ha to add additional area of food production specifically figs and olives, the most two cultivated trees in Matrouh governorate. Otherwise, some wild plant species are cropped in semicircles terraces (a technique of water harvesting) for food, *Opuntia ficus-indica* and *Medicago araborea*, *Atriplex sp.pl*. (Halimus and portulacoides) as fodder, and *Moringa oleifera* as medicinal plant. Furthermore, in the first step of the project, the rehabilitation process faces a real challenge to accomplish the rehabilitation agreement with local beneficiaries because of the common ownership of Wadi Kharouba between Agarma inheritors which causes a conflict of interest to

achieve the agreement and gain benefits from the rehabilitation.

Table 6. the relative weight of collective indicators

Indicators	Weight
Landscape appearance and restore.	0.123
Integrated Pest Management	0.025
Integrated nutrient management of soil	0.039
Add food and fodder production (ha)	0.353
Water facility conservation	0.115
Abating of common land conflicts	0.223
Employment and women contribution	0.122

Source: analyzed by the author via SpiceLogic AHP Software.

Despite the highest priorities of the two mentioned indicators, the following three indicators of "landscape appearance and restore , "employment and women contribution" and "water facility conservation" have approximate weights, as their priorities represent 12.3% , 12.2% and 11.5% respectively. This results are reasonable also because the ecological indicator of landscape enjoyment is set in a late arrangement after strategic and society indicators in the marginalized communities. Additionally, the project introduces many occasional employment in the field of construction works as leveling, building cement dykes, reservoir and semicircles and works of drip irrigation system installation. Similarly, any additional cultivated area provide extra family work, specifically women and youths, the main laborers in fig harvesting and packaging stages. In term of conserving the water facilities indicator, MARSDEV project in Wadi Kharouba establishes protection structures at the water intake area to prevent the siltation (collection of polluted particulate terrestrial, silt, clay and sold materials) of the water in the reservoirs or cisterns. Certainly, these authorized preservation procedures parallel with the maintenance of hoses and tubes insure the agricultural stability in Wadi Kharouba. Beside the minor priorities of Integrated Pest Management & Integrated nutrient management of soil indicators, MARSDEV project introduces some mechanical and biological interventions such as traps to fight the fig pests and flies, and compost applications to amend the soil fertility.

The relative weights of individual indicators

In table (7), the relative weights of individual indicators are demonstrated. The highest weights are assigned for "share of farm income to total income" and "self-employment source" as their priorities represent 49.1% and 25.7% respectively. These results indicate that from beneficiaries' points of views, the economic return represented by additional income is the main motivation of rehabilitation and its reflection on private welfare. Classifying the source of farm income into wages and self-employment, the self-employment is a considerable source of income in Wadi Kharouba which has impact on households 'welfare. The initial descriptive statistics of the survey illustrated that all beneficiaries in Wadi Kharouba are self-employed and their farm income from crops and livestock represents about 75% of total income. Furthermore, the yields and GAPs indicator's priority is 14.3%. Although this priority is slightly small, it comes in the reasonable role after income and employment as it has indirect impact on welfare. The project also introduced some training of Good Agricultural Practices as water management, fig and olive trees pruning, fig processing, IPM, and processing compost to enhance figs and olives trees. In addition, the indicators of fodder substitute source and add-value of fig processing don't have a considerable importance on Wadi Kharouba welfare as their weights are 0.080, 0.029 respectively.

Table 7. the relative weight of individual indicators

Indicator	Weight
% Farm income to total income	0.491
Self-employment source	0.257
Yields and GAPs	0.143
Fodder substitute Source	0.080
Add-value of figs	0.029

Source: analyzed by the author via SpiceLogic AHP Software.

The final weights of indicators

In table (8) final weight of each indicator is determined relative to the total set of indicators below the two criteria (collective and individual). The results indicate that the share of farm income to total income , add food and fodder production and abating common land conflicts indicators are the most important indicators as their priorities represent 32.1%, 26.8% and 17.8% respectively. The summation of the three highest indicators account 76.7% from twelve indicators. Although the other nine indicators have insignificant weights, their roles in agricultural sustainability and welfare cannot be ignored. Also, these results point to the crucial role of income generation, food availability and abating the conflicts of interest to improve the livelihood in the marginalized desert communities. The consistency ratio is 0.0973 i.e. CR less than 0.1, so the surveyed judgments are transitive and consistent.

Table 8. the final relative weight of all indicators

Indicator	Weight
Landscape appearance and restore.	0.029
Integrated Pest Management	0.009
Integrated nutrient management of soil	0.007
Add food and fodder production (ha)	0.268
Water facility conservation	0.003
Abating of common land conflicts	0.178
Employment and women contribution	0.004
% Farm income to total income	0.321
Self-employment source	0.053
Yields and GAPs	0.046
Fodder substitute Source	0.041
Add-value of fig processing	0.041

Source: analyzed by the author via SpiceLogic AHP Software.

CONCLUSION

Rehabilitating arid and semi-arid lands becomes a crucial necessity in the current drought conditions to conserve the livelihood of local Bedouin communities in north western coast of Egypt. The activities of levelling soil, constructing dykes, and reservoir and semicircle terraces in addition to providing good agricultural practices (GAPs) are implemented by Matrouh Rural Sustainable Development (MARSADEV) project to rehabilitate Wadi Kharouba (2014-2017). Two stages least square (2SLS-IV) approach is applied to empirically analyze the impact of Wadi Kharouba rehabilitation on beneficiaries' welfare status which is proxided by per capita expenditure per month variable. The demographic characteristics variables such as household head' age, household size, household head' education, and dependency ratio are some of the driving factors that significantly influenced the add value and then per capita expenditure variables. The other instrumental variables such as meeting attendance, training accessibility and geographical distance have a statistical significant impacts on add-value variable. Beneficiaries 'per capita expenditure per month are

improved as a result of add – value enhancement of raising livestock and planting figs and olives trees. Analytic Hierarchy Process (AHP) is applied to identify the preference between individual and collective welfare criteria and indicators of Wadi Kharouba. The highest preference is assigned to individual welfare criterion (53%) which indicates the priority of Bedouin's economic outcomes in trade off collective welfare criterion of society and environment (47%). Welfare indicators such as "share of income to total income" (32.1%), "add food and fodder production" (26.8%) and "abating of land common conflicts" (17.8%) have the major priorities (sum = 76.7%), these reflect the crucial role of income generation as an individual welfare and key incentive of Bedouins to be involved in Wadi rehabilitation.

Based on the significance role of Wadi rehabilitation on household and society' welfare, the following recommendations are suggested:

1) Scaling up the activities of Wadies rehabilitation such as constructing of irrigation water facilities in the marginalized Bedouin communities to enhance per capita expenditure, livelihood and household welfare.
2) Conducting the local infrastructures such as education, training, and transportation side by side with rehabilitation procedures will enhance the beneficiaries' demographic characteristics and hence add- value of cultivating crops and grazing livestock.
3) Introducing awareness campaigns to improve the Bedouins' point of views about the complementary interests between the individuals, society, and environment.
4) In the context of achieving food security, the finding of this study suggest that improving water and soil management, and GAPs could practically increase the productivity of cultivated areas.

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دراسة إقتصادية لأثر إعادة تأهيل الوديان على رفاهية المجتمع بمحافظة مطروح (دراسة حالة- وادى الخروبة)

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الملخص

يهدف البحث إلى تحليل أثر إعادة تأهيل وادى الخروبة على رفاهية المجتمع بالساحل الشمالى الغربى لمصر من خلال : (1) التقدير القياسى لتأثير متغيرالقيمة المضافة وغيره من المتغيرات الديموجرافية على متوسط الإنفاق الشهرى / الفرد ، و (2) تحديد الأفضلية بين مؤشرات الرفاهية الفردية التى تعكس مصلحة المزارع ، ومؤشرات الرفاهية الجماعية التى تعكس مصلحة المجتمع . إستخدم البحث أسلوب الحصر الشامل لجميع المنتفعين من قبيلة العجارمة، بوادى الخروبة والمستفيدين من إعادة تأهيل الوادى لتجميع إستمارات الإستبيان من خلال المقابلة الشخصية فى يوليو ، عام 2022 .إستخدم البحث طريقة 2SLS-IV للتغلب على مشكلة المتغيرات الداخلية endogeneity . وأظهرت النتائج أن زيادة 1% لمتغير القيمة المضافة يتسبب فى زيادة متوسط الإنفاق 37.225 %، و أن الخصائص الديموجرافية مثل عمر وتعليم رب الأسرة ، وحجم الأسرة ، ونسبة الإعالة تؤثر بشكل كبير على متغير متوسط الإنفاق الشهرى / فرد. وبإستخدام عينة أخرى عمدية من الخبراء تم تحديد الأفضلية بين مؤشرات الرفاهية الفردية والجماعية بوادى الخروبة. إستخدم البحث أسلوب التحليل الهرمى Analytic Hierarchy Process- AHP للمقارنات الزوجية بين معيارى المصالح الفردية والجماعية . وإتضح حصول معيار الرفاهية الفردية على أعلى تفضيل (53%) مقابل معيار الرفاهية الجماعية (47%) ، مما يشير إلى أولوية العوائد الإقتصادية عند المقايضة مع المصالح المجتمعية والبيئية. وحققت مؤشرات : "نسبة الدخل المزرعى من إجمالى الدخل 32.1% " ، و " زيادة إنتاج الغذاء والعلف 26.8%" ، و " تخفيف النزاع حول مشاع الملكية 17.8% " أعلى أفضلية. يوصى بالتوسع فى نطاق أنشطة إعادة تأهيل الوديان ، وخاصة التى تتعلق بتقنيات الرى لتعزيز سبل العيش ورفاهية المجتمعات الهامشية.

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[i] FAO (2022) defined Wadi as the bed or valley of a seasonal stream in arid or semi-arid areas that is usually dry, except for a short time after spate flow events (a few hours to a few days).

[ii] Multicollinearity is characterized by high correlation between two or more explanatory variables, i.e. they explain extensive amount of the variance of each other and (R^2) is overvalued although most parameters are statistically insignificant. Moreover; producing wrong direction (signs). Variance Inflation Factor (VIF) is applied to test multi-collinearity. (VIF) value depends on tolerance factor which is defined by the percentage of the variance in the independent variable that is not accounted for by the other independent variables. However, (VIF) is the reciprocal of tolerance factor $(1/(1-R^2))$ and refers to the degree to which the standard errors are inflated due to the level of collinearity. The rule of thumb: VIF=1 indicates no collinearity, VIF >1 to 5 indicates moderate collinearity, and VIF> 5 is serious collinearity)

[iii] Consistency ratio reflects how much the transitivity rule is violated. The rule which reflect the correct respondent's preference between X and Z indicators in case that X is preferred than Y and Y is preferred than Z. The higher the consistency ratio, the more deviation between actual preference and the transitive reflection rule.

[iv] Good instrument satisfy the condition $Cov(Z, \varepsilon) = 0$, i.e. the instrumental variable Z affects the dependent variable Y through endogenous variable X