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EUROPEAN UNION – JOINT RURAL DEVELOPMENT PROGRAMME (EU-JRDP)

Capitalisation 4: Best Water Harvesting Practices in the Drylands of North West Coastal Zone of Egypt

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The opinions expressed in this document represent the authors' points of view which are not necessarily shared by the European Commission or by the authorities of the concerned countries.

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Acronyms and Abbreviations

ACF	Action Contre la Faim
ACSAD	Arab Center for the Studies of Arid zones and Drylands
AICS	Italian Agency for Development Cooperation
ARC	Agricultural research Centre
CCICREES	Climate Change Information Center & Renewable Energy & Expert Systems
CEDARE	Centre for Environment and Development for the Arab Region and Europe
CfP	Call for Proposal
CfW	Cash for Work
DRC	Desert Research Centre
EAFRD	European Agricultural Fund for Rural Development
EGP	Egyptian Pound
EIAS	Environmental Impact Assessment Study
ENPARD	European Neighbourhood Programme for Agriculture & Rural Development
ENPI	European Neighbourhood and Partnership Instrument
EU	European Union
EUD	European Union Delegation, Egypt
FAO	Food and Agriculture Organisation
FiYIR	Fifth Year Implementation Report of EU-JRDP
GAP	Good Agricultural Practices
GIs	Geographical Indications
GIS	Geographic Information System
GPS	Geographic Positioning System
IGA	Income Generating Activities
IPP	Integrated Production and Protection practices
EU-JRDP	EU-Joint Rural Development Programme
FiYIR,	Fifth Year Implementation Report (EU-JRDP)
LAG	Local Action Group
M	Million
M&E	Monitoring and Evaluation
MALR	Ministry of Agriculture and Land Reclamation
MFAIC	Italian Ministry of Foreign Affairs and International Cooperation
MoIC	Ministry of International Cooperation
MoLD	Ministry of Local Development
MWRI	Ministry of Water Resources and Irrigation

NGO	Non-Government Organisation
NRM	Natural Resource Management
NWCZ	North West Coastal Zone
OFs	Organic Fertilisers
PMU	Programme Management Unit
PRA	Participatory Rural Appraisal
SAMSIMIFA	Sustainable Agricultural Mechanization System Improvement in Minya and Fayoum
SDCMR	Sustainable Development Centre for Matrouh Recourses
SEDNWCE	Social Economic Development of North West Coast of Egypt
SFA	Small Farmers' Association
SFOs	Small Farmer Organizations
sPMU	Sub Programme Management Unit of EU-JRDP
TSS	Total Soluble Solids

Feddan	*0.42 Ha*
Wadi	*Hydrographic basin formed by the seasonal rainwater floods*
Tonnes	*Metric tons*
t	*Tonnes*
Fed	*Feddan*
Sadda	*Period of interruption of irrigation water in the canals*

Executive summary

The European Union – Joint Rural Development Programme (EU-JRDP) is an "area-based" initiative taking place in three governorates, namely Matrouh, Minya and Fayoum and implemented by the Italian Ministry of Foreign Affairs and Cooperation and Development, through the Italian Embassy in Egypt with the technical assistance of the Italian Agency for Cooperation (AICS). The said action is funded by the European Union (€ 21.9 M) and co-funded in parallel by the AICS (€ 11.0 M).

In Matrouh Governorate, EU-JRDP, during the period 2016-2020, funded three actions (total EU contribution € 3.5 M) in connection with FAO, DRC and ACF/ACSAD for i) promoting water harvesting practices in the *wadis* and constructing/rehabilitating water harvesting facilities (e.g. cisterns and roman wells) for agricultural use (DRC), ii) constructing/rehabilitating water harvesting facilities for human and animal use (DRC and FAO and ACF/ACSAD) and iii) providing agricultural services to farmers (DRC and FAO). The aim is to increase water harvesting capacity and bring into production additional lands inside the wadi and make water available for animal and human consumption and agricultural use.

In total, EU-JRDP succeeded to establish and rehabilitate 1,355 cisterns and Roman wells with total storage capacity of about 208,000 m^3 and contributed to reduce the water gap for human and animal consumption by 72%. EU-JRDP succeeded to reduce drinking water costs by 87% per household and reduce time to collect and access water from 2.14 hours to 28 minutes. The 55 km of *wadis* constructed/rehabilitated by DRC are contributing to reduce erosion and converted the surface of lands to agricultural production (about 750 feddan). The decrease of soil erosion is reducing land losses in the surface layers of soils and, consequently, lands have better productivity. Land degradation, from 50% (before rehabilitation) is reduced to 25% (after rehabilitation). Both DRC and FAO provided services to farmers aimed to increase the efficiency of farming, to increase production and productivity of the main crops grown inside the *wadis*. DRC worked in all 49 *wadis* rehabilitated while the FAO in 33 *wadis* out of the 49.

To capitalise the "Best water harvesting practices in the drylands of North West Coastal Zone of Egypt", the following three axes of interventions were identified from all concerned actions financed by EU-JRDP and implemented by DRC, ACF/ACSAD and FAO:

- ✓ Axis 1: development of new wadis and the rehabilitation of existing wadis.
- ✓ Axis 2: construction or rehabilitation of cisterns, Roman wells, and reservoirs.
- ✓ Axis 3: provision of agricultural services to farmers and takes into consideration the social aspects.

The results of the study/conclusions are listed here below:

First axis: development of new wadis and the rehabilitation of existing wadis.

- ✓ The decrease of soil erosion is reducing land losses in the surface layers of soils and, consequently, lands have better productivity. Land degradation, from 50% (before rehabilitation) is reduced to 25% (after rehabilitation)1.
- ✓ Preserving the rainwater and preventing torrential flows that are causing damages, had a positive impact on the environmental ecosystem in the wadis and surrounding areas.

[1] Source: EIAS study. DRC, 2017

- ✓ The increase in the number of concrete dykes inside the wadis, was reflected positively on the increase in the area suitability for agricultural use (+91%) and plant productivity increased (+22%) and, consequently, on the income.
- ✓ The rehabilitation or the construction of wadis can be considered a best practice of sustainable management of natural resources.
- ✓ The increase in the number of new cisterns inside the wadis, was reflected positively on the increase in the area for agricultural use and, consequently, on the income of the beneficiaries.
- ✓ The livestock production is not directly affected by the development of *wadis*.

Second axis: construction or rehabilitation of cisterns, Roman wells, and reservoirs.

- ✓ The most relevant social benefit is related with the increased availability of water for home consumption.
- ✓ Drinking water costs were reduced by 87% per household and the time to collect and access water was reduced from 2.14 hours to 28 minutes.
- ✓ The intervention increased personal hygiene and reduced pollution and disease.
- ✓ The increase of water availability for home consumption are increasing incomes at family level (e.g. home gardening).

Third axis: provision of agricultural services to farmers and takes into consideration the social aspects.

- ✓ The services provided by DRC and FAO resulted in a significant increase in crop productivity of the main crops cultivated in the *wadis* (e.g. 20% and 30% productivity increase for figs and olives respectively) and related incomes.
- ✓ The distribution of olive seedlings is by far the most relevant activity.
- ✓ The intervention had a positive impact on economic aspects (e.g. crops net revenues increased because crop productivity was increased, and production costs were lower).
- ✓ The intervention had a positive impact on social aspects (e.g. participation increased and the confidence of beneficiaries toward local authorities enhanced, woman empowerment increased).

The main recommendations per each axis of intervention are listed here below:

First axis

- ✓ To prioritize *wadis* to be rehabilitated based on i) soil fertility and ii) land morphology criteria. The third criteria of choice shall be the population density.
- ✓ To construct more dykes per each Km of *wadi* (in both new and existing).
- ✓ To increase the number of cisterns and related capacity for agricultural use inside the *wadis.*
- ✓ To protect *wadis* with fences made with local available materials.
- ✓ To plant trees in the wadis of large catchment area.

Second axis

- ✓ To rehabilitate more roman wells and to construct more cisterns.
- ✓ To prepare data base on roman wells.

- ✓ To adopt preventive measures improving water quality.
- ✓ To organise awareness campaigns to spread basic water treatment measures: and other water treatment practices in case of contamination.

Third axis

- ✓ To increase the number and quality of trainings aiming at raising the degree of agricultural skills in terms of best practices for rain-fed agriculture.
- ✓ To prioritize training in agricultural best practices, controlling weeds and insects, integrated pest management, promotion of traditional GI products.
- ✓ To distribute olive seedling in September and just before the rainy season.
- ✓ To distribute seedlings and other planting materials obtained from already locally adapted species.
- ✓ To prioritize the distribution of organic fertilizers locally made.
- ✓ To purchase small tractors and small equipment to be available at local level.
- ✓ To set up a mechanism for payment of services.
- ✓ To guaranty a close follow ups of farmers especially during the planting seasons.
- ✓ To improve women empowerment through training courses on the processing of agricultural products.
- ✓ To prepare a maintenance plan for machinery and other agriculture services.
- ✓ To enhance farmers' associations to improve marketing opportunities and registration of products under GIs.

Background information

The European Union – Joint Rural Development Programme (EU-JRDP) is an "area-based" initiative taking place in three governorates, namely Matrouh, Minya and Fayoum and implemented by the Italian Ministry of Foreign Affairs and Cooperation and Development, through the Italian Embassy in Egypt with the technical assistance of the Italian Agency for Cooperation (AICS). The said action is funded by the European Union (€ 21.9 M) under the European Neighbourhood Programme for Agriculture and Rural Development (ENPARD) and co-funded in parallel by the AICS (€ 11.0 M) through: i) the "Sustainable Agricultural Mechanization System Improvement in Minya and Fayoum Governorates" (SAMSIMIFA) and ii) the "Social Economic Development of North West Coast of Egypt (SEDNWCE) in Matrouh. The main Egyptian Authorities are the MALR (Lead Ministry), the MWRI and MoLD. The Ministry of International Cooperation is the National Coordinator.

In Matrouh Governorate, EU-JRDP, during the period 2016-2020, funded three actions (total EU contribution € 3.5 M) in connection with FAO, DRC and ACF/ACSAD for i) promoting water harvesting practices in the *wadis*[2] and constructing/rehabilitating water harvesting facilities (e.g. cisterns and roman wells) for agricultural use (DRC), ii) constructing/rehabilitating water harvesting facilities for human and animal use (DRC and FAO and ACF/ACSAD) and iii) providing agricultural services to farmers (DRC and FAO).

The aim is to increase water harvesting capacity and bring into production additional lands inside the wadi and make water available for animal and human consumption and agricultural use. The final goal is to increase sustainable agricultural production in the *wadis* by managing water resources more effectively to boost the rain-fed agricultural sector of North-western Egypt. It is noteworthy that agricultural production in Matrouh is obtained mainly from *wadis*: barley (70% of the area), figs and olives (20% of the area) and other crops such as watermelon (10% of the area) are produced. All interventions were implemented in the North West Coastal Zone of Matrouh governorate in the rain-fed area from Fuka in the East to El Salloum in the West. The targeted areas are four districts, namely Ras El Hekma, Marsa Matrouh, Negila and Sidi Barrani. As per today, 100% of all works were completed.

Since all works for the rehabilitation/construction of cisterns and the rehabilitation and construction of *wadis* are carried out by local communities and are based on Cash for Work, EU-JRDP has supported the creation of a huge number of works[3]: DRC has supported the creation of 2,964 full time jobs and 1,650 short-term jobs of 3 months, while ACF/ACSAD has supported the creation of 8,100 short-term jobs of 1 month. Additional 2,620 short - term jobs were created by FAO. All the above-mentioned actions are contributing to the improvement of life quality of people living in the rural areas especially among the poorest areas of Matrouh where 9,500 extremely poor households are living.

Both DRC and FAO provided services to farmers aimed to increase the efficiency of farming, to increase production and productivity of the main crops grown inside the *wadis*. DRC worked in all 49 *wadis* rehabilitated while the FAO in 33 *wadis* out of the 49 rehabilitated by DRC.

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[2] In North-western Egypt the wadi represents the bed or valley of a stream that is usually dry except during the rainy season.

[3] Source: EU-JRDP - FiYIR, December 2019.

Scope and objectives of the study

The Operational Capitalization Study is aiming at:

- ✓ Selecting best practices that proved to improve sustainability.
- ✓ Providing solutions for implementing similar projects in the future.
- ✓ Capitalizing experiences and knowledge for implementation of similar projects in the future.
- ✓ Addressing a list of lessons learned (positive and negative).
- ✓ Recommending actions to be undertaken in the future which will serve to improve the sustainability.

This Operational Capitalisation represents therefore a formalised way to document, analyse and archive, best practices, lessons learned and recommendations and to make use of them when drafting similar projects.

The final goal of this Operational Capitalisation study is therefore to improve future project sustainability at policy, regulatory, legislative, and environmental levels.

This Operational Capitalisation study shall be provided to competent governmental entities as well as to interested development partners.

Axes of intervention

To capitalise the "Best water harvesting practices in the drylands of North West Coastal Zone of Egypt", the following three axes of interventions were identified from all concerned actions financed by EU-JRDP and implemented by DRC, ACF/ACSAD and FAO:

- ✓ Axis 1: development of new *wadis* and the rehabilitation of existing wadis.
- ✓ Axis 2: construction or rehabilitation of cisterns, Roman wells and reservoirs.
- ✓ Axis 3: provision of agricultural services to farmers - social aspects.

First axis - development of new *wadis* and rehabilitation of existing *wadis*

Definitions:

- ✓ NWCZ: North West Coastal Zone (Matrouh Governorate) is an area from Fouka in the East to El-Salloum in the West, for a depth of 40 km from the coastline.
- ✓ *Wadi*: it represents the bed or valley of a stream that is usually dry except during the rainy season.
- ✓ New *wadi* means that the targeted areas were not cultivated before the project intervention, but there was a potential to be developed and brought into production.
- ✓ Existing *wadis* are *wadis* already cultivated in the past were dykes made in the past (made mainly by sand) were damaged over the time by the rain. Agriculture production in the existing wadis were deteriorated.
- ✓ Scale out and scale up: Scale out means "scaling horizontally" the results that proved to be successful to cover wider geographical areas for greater outreach at micro-level (e.g., gradual rollout of activities in similar areas). Scale up means "scaling vertically" the successful concepts to cover broader impact through improved institutionalization, legislation, policies, development plans, improving the business environment.

Implemented works:

The works promoting better water harvesting practices in the wadis (both old and new) consist of constructing dykes (made of compact earth and stone) designed in a manner to detain and regulate flood in order to provide lands located downstream with controlled flows. An opening device is constructed through the dykes to permit downstream flow at a predetermined rate. Thus, a torrential flood that would normally last few hours is converted into a regulated flow to withstand floods so farming operations downstream can be accordingly planned. The constructed dykes are nowadays diverting intense or torrential floods from intermittent streams to adjacent lands in a regulated fashion. The water in the lands, generated from expected seasonal water flows, are controlled by the dykes that are designed to retain water and gradually release humidity in the soil for a longer period of time thus allowing cultivation of crops and trees in the land inside the *wadis*. The construction of dykes was therefore planned to reduce erosion, control flooding (that are damaging infrastructures) and retain water and humidity in the adjacent lands to practice agriculture.

In total the 55 km of *wadis* constructed/rehabilitated by DRC are contributing to reduce erosion and converted the surface of lands to agricultural production (about 750 *feddan*). In addition to the dykes. Per each Km of *wadi*, DRC has constructed 2 cisterns of 100-120 m^3 each for agricultural use".

Second axis – construction or rehabilitation of cisterns, Roman wells and reservoirs

Definitions:

- ✓ Cisterns, Roman wells and water reservoirs[4]: small and large storage basins for storing rainwater for human and animal consumption as well as agricultural use. The excavation of water cisterns in Matrouh has been traced back to the Roman period (Roman wells). Cisterns and Roman wells are commonly subterranean, rock cut, while reservoirs are constructed on the soil surfaces.
- ✓ Water cisterns: small and large storage basins for storing rainwater as main source of drinking water in the desert areas outside the cities in Matrouh governorate - so it is very important to be healthy in a large proportion - health problems may not appear because of drinking contaminated water in the short term but may appear in the long run.
- ✓ Scale out and scale up: Scale out means "scaling horizontally" the results that proved to be successful to cover wider geographical areas for greater outreach at micro-level (e.g., gradual rollout of activities in similar areas). Scale up means "scaling vertically" the successful concepts to cover broader impact through improved institutionalization, legislation, policies, development plans, improving the business environment.

Implemented works:

Cisterns, Roman wells and water reservoirs were constructed/rehabilitated to mainly store rainfall runoff water for the purpose of meeting water needs through seasonal variations. The water stored in mainly for domestic purposes. Cisterns have ranged in construction from simple to large underground structures. EU-JRDP put emphasis on the rehabilitation of Roman wells and cisterns.

[4] A cistern is a container which stores the water under the ground and is usually filled by rain water of a capacity average of 100-200 m^3; a roman well are cisterns ranging between 1,000 to 5,000 m^3; a reservoir is an artificial quadrilateral container constructed under the ground with constructed walls and roof sizing around 300-500 m^3.

In total, EU-JRDP succeeded to establish and rehabilitate 1,355 cisterns and Roman wells with total storage capacity of about 208,000 m^3 (which represent four percent of the total water storage capacity of the area[5]) and reduced the water gap for human and animal consumption by 72%[6].

Third axis – provision of agricultural services to Bedouin communities and social aspects

Definitions:

- ✓ Provision of services by DRC and FAO: advice and information provided to farmers along with the delivery of selected inputs to help them to solve their problems and improve their livelihoods.
- ✓ Water adequacy: sufficiency and suitability of water that is physically and continuously available to satisfy the water demands

Implemented works:

DRC has provided, free of charge and across all targeted wadis (49), the following services, and inputs to the benefit of farmers inside wadis: trainings, land levelling with bulldozers in rocky areas, ploughing, fruit cops planting, spraying and technical support. Representatives from local committee, stakeholders.

FAO has operated in 33 (out of the 49 *wadis* targeted) by establishing 125 demonstrations fields with modern facilities (drip irrigation system) for olive, figs and almond and providing the following services: i) theoretical and hands-on training on GAP; ii) agricultural inputs including organic fertilizers, insecticides and pruning tools.

Methodology of the study and data analyses

The Capitalisation was carried out as follows:

- ✓ Analysis of annual reports (FAO, DRC, ACF/ACSAD).
- ✓ Field visits made by EU-JRDP staff.
- ✓ Ad-hoc studies carried out by FAO[7].
- ✓ EU-JRDP survey (88 questionnaire analysis) carried out in 2020 (July).
- ✓ Data analysis of information collected by DRC, FAO and ACF/ACSAD:
- ✓ Group discussions conducted by DRC's consultant with beneficiaries in 2019. Scope of the group discussion: i) to investigate Environmental Impact Assessment (EIA) practices and evaluate its effectiveness; ii) to draft recommendations for scaling up the best practices including improvement of agricultural practices. Number of DRC beneficiaries interviewed: 15% (2019).
- ✓ Analysis of official data, which were collected from the Sustainable Development Centre for Matrouh Recourses (SDCMR) and its four technical support centres located in the four concerned districts of Matrouh's Governorate.

[5] Source: Inventory Report of Available Water Harvesting Techniques in The North West Costal Zone" carried out by FAO in 2019.

[6] Source: EU-JRDP - FiYIR, December 2019.

[7] Inventory report of available water harvesting techniques in the North Western coastal zone of Matrouh. (2017) and Land use and land cover changes in the North Western coastal zone of Matrouh. (2019)

Results of the study/conclusions: driving forces for each axis of intervention

First axis - development of new wadis and rehabilitation of existing wadis

Results

Results from the group discussions conducted by DRC's consultant[8] and SDCMR with households (extended families of 17.5 members):

- ✓ The decrease of soil erosion is reducing land losses in the surface layers of soils and, consequently, lands have better productivity. Land degradation, from 50% (before rehabilitation) is reduced to 25% (after rehabilitation).
- ✓ Preserving the rainwater and preventing torrential flows that are causing damages, had a positive impact on the environmental ecosystem in the *wadis* and surrounding areas.
- ✓ The increase in the number of concrete dykes inside the *wadis*, was reflected positively on the increase in the area suitability for agricultural use (+91%) and plant productivity increased (+22%) and, consequently, on the income.
- ✓ The rehabilitation or the construction of *wadis* can be considered a best practice of sustainable management of natural resources.
- ✓ The increase in the number of new cisterns inside the wadis, was reflected positively on the increase in the area for agricultural use and, consequently, on the income of the beneficiaries.
- ✓ The livestock production is not directly affected by the development of *wadis*.

Results from the group discussions conducted by EU-JRDP with households (88 questionnaire analysis with extended families of 17.5 members):

Practices used for the sustainable management of natural resources

Practices used for the sustainable management of natural resources	% (Before)	% (After)
Is the intervention effective to preserve rainwater inside the *wadis* and prevent torrents to cause damages?	0	89
Is the water in the wadis stored for the period needed?	11	78
Is your family and neighbors effectively participating in digging wells and building dams?	11	44

Number of dykes owned by household in the wadis (average)

Number of dykes owned by household	Number Before project	Number After Project
Concrete dykes	0	135
Rock fill dykes	81	0
Earth fill dykes	54	0

[8] Source: EIAS study. DRC, 2017

Degree of satisfaction of existing dykes (rock and earth fills):

Degree of satisfaction	Very satisfied %	Satisfied to some extent %	Not satisfied %
Rock fill dykes	11	22	67
Earth fill dykes	22	56	22

Degree of satisfaction of new dykes (concrete):

Degree of satisfaction	Very satisfied %	Satisfied to some extent %	Not satisfied %
Concrete dykes inside the *wadis*	55	44	1

Conclusions

The intervention was effective i) to preserve rainwater inside the *wadis* and prevent torrents to cause damages; ii) the water inside the *wadis* was stored for a sufficient period of time to grow the traditional crops (e.g. olives, figs, watermelons); iii) the family and neighbors effectively participated in digging wells and building dykes; iv) the number of wells and dykes owned by the households in the *wadis* increased; v) the farmers, previously not satisfied of the traditional rock and earth dykes), prefer by far the concrete dykes introduced by the project; vi) the cisterns for agricultural use constructed inside the *wadis* are instrumental for emergency irrigation.

Meanwhile, the storage period of the water inside the wadis is still not yet sufficient to guaranty high crop productivity. Women empowerment is not to a significant level yet, and this is related to the culture, customs and habits of the Bedouin people living in the region.

Second axis – construction or rehabilitation of cisterns, Roman wells and reservoirs

Results:

Results from the group discussions conducted by DRC's consultant[9] and SDCMR with households (extended families of 17.5 members):

- ✓ The most relevant social benefit is related with the increased availability of water for home consumption.
- ✓ Drinking water costs were reduced by 87% per household and the time to collect and access water was reduced from 2.14 hours to 28 minutes.
- ✓ The intervention increased personal hygiene and reduced pollution and disease.
- ✓ The increase of water availability for home consumption are increasing incomes at family level (e.g. home gardening).

[9] Source: EIAS study. DRC, 2017

Results from the group discussions conducted by EU-JRDP with households (88 questionnaire analysis with extended families of 17.5 members):

Water use (destination):

Water use (destination)	% (Before)	% (After)
Which proportion of water is used for drinking purposes?	N/A	61
Which proportion of water is used for other family use (e.g. washing)?	N/A	32
Which proportion of water is used for agricultural use?	N/A	6
Which proportion of water is used for animal consumption?	N/A	1

Degree of satisfaction of cisterns for agricultural use:

Degree of satisfaction	Very satisfied %	Satisfied to some extent %	Not satisfied %
New cistern for agricultural use	67	33	0

Water adequacy[10]:

Water adequacy	% (Before)	% (After)
Is the water sufficient to satisfy your drinking demand?	22	100
Is the water sufficient to satisfy your washing and cleanliness demand?	56	89
Is the water sufficient to satisfy your needs for drinking water for livestock?	78	78
Is the water sufficient to satisfy the crop minimum requirements?	0	67

Number of cisterns and reservoirs owned by household:

Number of cisterns and reservoirs owned by household	Number Before project	Number After Project
How many cisterns do you have?	9	12
How many reservoirs?	0	4

Needs expressed by local population (expectations)

Expectations	% Before project	% After Project
Construction of a new cistern and increased water availability	N/A	35
Construction of a new cistern	N/A	3
Increase water capacity of the existing cisterns	N/A	17
Better water quality	N/A	3
Increased water availability and better water quality	N/A	1
More water availability from different sources	N/A	41

[10] Sufficiency and suitability of water that is physically and continuously available to satisfy the water demands

Conclusions

The water from cisterns is mainly used for drinking purposes (61%) and for other family use (32%). The livestock production is not directly affected by the development of cisterns. The water is sufficient to satisfy the drinking demand. The degree of satisfaction of cisterns for agricultural use is very high among local population. The number of cisterns and reservoirs owned by the household increased significantly. The increase of water availability for home consumption is satisfying the drinking demand at local level. The availability of water meets nowadays the demand for washing and cleanliness. The water is sufficient for emergency irrigation of crops cultivated in the home gardens.

Meanwhile, there is still a demand from local population to increase water availability from different sources and to focus more on the rehabilitation of existing cisterns. Women empowerment is not to a significant level yet, and this is related to the culture, customs and habits of the Bedouin people living in the region.

Third axis – provision of agricultural services to farmers and social aspects

Results

Results from the group discussions conducted by DRC's consultant[11] and SDCMR with households (extended families of 17.5 members):

The services provided by DRC and FAO resulted in a significant increase in crop productivity of the main crops cultivated in the *wadis* (e.g. 20% and 30% productivity increase for figs and olives respectively) and related incomes. The distribution of olive seedlings is by far the most relevant activity.

Results from the group discussions conducted by EU-JRDP with households (88 questionnaire analysis with extended families of 17.5 members):

Availability of farm equipment and machinery in the wadis

Availability of farm equipment and machinery	Before Project	After Project	
		Rented	Owned
Agricultural tractor equipped with its components	0	6	2
Water trailer	1	6	1
Loader	0	1	0
Well digger	0	1	0
Fruit collectors	0	1	0
Spray motor	1	3	2

[11] Source: EIAS study. DRC, 2017

Degree of satisfaction of farmers cultivating lands inside the wadis:

Degree of satisfaction	Satisfied to some extent %	Very satisfied %	Not satisfied %
Training in agricultural production	33	67	0
Training in livestock husbandry	44	55	1
Water availability for agriculture	11	67	22
Agricultural job opportunities available in the *wadis*	0	100	0

Degree of confidence vis-à-vis of services provided

The level of confidence	% Confidence Before	% Confidence After
Technical support units of the sustainable development center	0	78
Veterinary units in the district or the governorate	0	11
Agricultural services in the district or the governorate	0	0

Conclusions

The most relevant social benefit is related with the generation of job opportunities in agriculture. The technical support provided by the technicians from SDCMR and its four technical support centres increased the level of confidence of local communities vis-à-vis of local institutions. The availability of farm equipment and machinery in the wadis increased significantly.

Meanwhile, the trainings provided by the actions was below expectation; the time of distribution of olive seedlings need to be improved. The sustainability of providing free services to farmers needs to improve. Women empowerment is not to a significant level yet, and this is related to the culture, customs and habits of the Bedouin people living in the region.

The low knowledge and skills of the beneficiaries in weed, diseases and insect resistance and control impacted negatively on the production for both figs and olive crops.

Some of distributed olive seedling have been exposed to infection with diseases and insects especially in the first year of cultivation and consequently in losses in seedling.

The main driving forces per each intervention axis

The main driving forces for each axis of intervention (cf. also table 1 in the following page), are summarised here below:

- ✓ First axis - development of new wadis and rehabilitation of existing wadis:
  - The rehabilitation and development of new wadis had a positive impact on agricultural production in terms of increasing both land and crop productivity.
  - The improvement of infrastructural works in the wadis encourage families to settle down in the new *wadis*.
  - The works carried out inside the wadis, increased the efficiency of natural resources management and improved livelihood conditions both immediately after implementation and at long-term basis.
  - The intervention had a positive impact on social aspects (e.g. household income increased, social stability enhanced, local community participation increased,

confidence of beneficiaries toward local authorities enhanced, woman empowerment increased.

- Land losses because of erosion was reduced from 50% (before rehabilitation) to 25% (after rehabilitation).

✓ Second axis - construction or rehabilitation of cisterns, Roman wells and reservoirs

- The construction or rehabilitation of cisterns had a positive impact on the increase of water availability for home consumption and on the reduction of water costs.
- The intervention had a positive impact on the incomes at family level and improved the livelihood conditions at family level.
- The intervention had a positive impact on social aspects (e.g. the social stability was enhanced, the local community participation increased and the confidence of beneficiaries toward local authorities was enhanced, woman empowerment increased).

✓ Third axis - provision of agricultural services to farmers and social aspects:

- The provision of services to farmers were instrumental for increasing crop productivity in both old & new *wadis* and are facilitating the re-introduction of traditional crops and therefore are preserving biodiversity and encouraging farmers to register their crops as Geographical Indication (GI).
- The intervention had a positive impact on economic aspects (e.g. crops net revenues increased because crop productivity was increased, and production costs were lower).
- The intervention had a positive impact on social aspects (e.g. participation increased and the confidence of beneficiaries toward local authorities enhanced, woman empowerment increased).

Table 1: Driving forces per each intervention axis

Sector	Axis 1: Developing/rehabilitating new wadis	Axis 2: construction or rehabilitation of cisterns, Roman wells and reservoirs	Axis 3: Agricultural Services and social aspects
Agricultural impact	The decrease of land losses in the surface layers of soils are increasing land productivity Lands were brought into production and crops cultivated inside the *wadis* have higher productivity. The productivity of crops cultivated in rehabilitated *wadis* increased (+ 30/50%)	The increase in the number of new cisterns inside the wadis, was reflected positively on the increase in the area for agricultural use and, consequently, on the income of the beneficiaries	Services provided to farmers are instrumental for increasing crop productivity Services during the first year of production shall be provided by DRC for free as part of the land reclamation process and require heavy machinery not available at small farmers' level. Services after year1 to be provided at cost
	The improvement of infrastructural works in the wadis encourage families to settle down in the new *wadis* The works carried out inside the wadis, increased the efficiency of natural resources management	The provision of sources of supplemental irrigation through cisterns for rain-water harvest is increasing water availability for agriculture use	Services provided for free during the first year of production (e.g. land levelling, removal of rocks, construction of cisterns reduce production costs at farmers level Services to farmers are facilitating the re-introduction of traditional crops and preserving biodiversity and encouraging farmers to register crops as GIs
	The works of construction/rehabilitation of *wadis* are improving livelihood conditions both immediately after implementation and at long-term basis	The works of construction/rehabilitation of cisterns are improving livelihood conditions both immediately after implementation and at long-term basis	N/A
Economic Impact	Household income increased thanks to the i) Creation of temporary jobs, ii) Increase of crop production (more yield = more jobs) iii) Production of summer (cash) crops, iv) Reduce of production costs	Household income increased thanks to i) the improvement of sufficiency of water for emergency irrigation, ii) the reduction of watering costs, ii) the availability of water near the family houses (reduction of transportation costs)	Crops net revenues increased by increasing crop productivity and reducing production costs
Social Impact	N/A	The increased water availability for home consumption is satisfying the drinking demand at local level as well as the availability of water is meeting nowadays the demand for washing and cleanliness demand	The increased water availability for agricultural use is improving the sufficiency of water for emergency irrigation of main crops cultivated in the home gardens
	Social stability enhanced	Social stability enhanced	Social stability enhanced
	Local community participation increased	Local community participation increased	Local community participation increased
	Confidence of beneficiaries toward local authorities enhanced	Confidence of beneficiaries toward local authorities enhanced	Confidence of beneficiaries toward local authorities enhanced
	Woman empowerment increased especially because of better harvesting practices for figs and olives	Woman empowerment increased especially because of home gardening and associated nutritional aspects	Woman empowerment increased especially because of better harvesting practices for figs and olives
Environmental Impact	Soil erosion rate reduced (land losses from 50% - before rehabilitation was reduced to 25% - after rehabilitation)	The intervention increased personal hygiene and reduced pollution/diseases	Soil fertility improved
	Sustainable management of *wadis* improved	Sustainable management of cisterns improved	Plant health improved
	Biodiversity sustained by reduction of soil erosion		Soil infection reduced by removing weeds and plant residuals Biodiversity sustained by cultivation of local adapted varieties

Lessons learnt (positives and negatives) per axis

Capitalization of lessons learned (positives and negatives) are important to amend legislations and regulatory framework and improve sustainability at policy, regulatory, legislative, and environmental levels.

First axis - development of new wadis and rehabilitation of existing wadis

Positive lessons learnt (positive issues coming up):

- ✓ The construction/rehabilitation of *wadis* are not only contributing to increase the land availability for agricultural use, crop productivity and incomes but also having a positive impact in the reduction of soil erosion and land degradation.
- ✓ The construction/rehabilitation of dykes and cisterns inside the *wadis* are preventing rainwater to be wasted and providing small quantity of waters for agricultural use.
- ✓ The water collected and stored in the cisterns are used in agricultural production as auxiliary or back-up irrigation (e.g. for spraying pesticides, emergency irrigation during transplanting seedlings).

Negative lessons learnt (what did not go as expected):

- ✓ The missing of maintenance plan during project planning caused poor coordination during maintenance operation.
- ✓ Capitalization of lessons learned (positives and negatives) are important to amend legislations and regulatory framework and improve sustainability at policy, regulatory, legislative, and environmental levels.

Second axis – construction or rehabilitation of cisterns, Roman wells and reservoirs

Positive lessons learnt (positive issues coming up):

- ✓ The construction/rehabilitation of cisterns for human consumption are not only contributing to satisfy the demand for drinking purposes but had also an impact on incomes, personal hygiene and reduced pollution and disease.
- ✓ The construction/rehabilitation of cisterns are preventing rainwater to be wasted in the sea.

Negative lessons learnt (what did not go as expected):

- ✓ Capitalization of lessons learned (positives and negatives) are important to amend legislations and regulatory framework and improve sustainability at policy, regulatory, legislative, and environmental levels.

Third axis – provision of agricultural services to farmers and social aspects

Positive lessons learnt (positive issues coming up):

- ✓ Cultivating local adapted varieties of olive trees like (Shmalay) and figs (Sultany) led to prevent deterioration of biodiversity and save local diversity.
- ✓ Cultivating summer crops (e.g. watermelon) as cash crop in wadis led to improving soil characteristics and helped in social stability.
- ✓ The provision of services to farmers are contributing to increase income, reduce soil erosion and land degradation and economic and social aspects (e.g. jobs creation).

Negative lessons learnt (what did not go as expected):

- ✓ Buying few tractors of big power centrally managed for providing services to farmers increased the travel time for the tractors to move from one *wadi* to another (long distances).
- ✓ When cost/benefit analysis for the services provided to farmers is not carried out, it is difficult to establish a mechanism for cost recovery of expenses.

- ✓ Capitalization of lessons learned (positives and negatives) are important to amend legislations and regulatory framework and improve sustainability at policy, regulatory, legislative, and environmental levels.

Recommendations for scaling up

General recommendations:

- ✓ The three axes are well integrated and shall be scaled up together.
- ✓ If funds are not enough to scale the three axes together, better to prioritize the rehabilitation of existing wadis (activities in the existing wadis are more efficient in increase of marginal level of production and this reflects positively on the social and economic returns of local beneficiaries and the payment for agricultural services).

First axis - development of new wadis and rehabilitation of existing wadis

Specific recommendations:

- ✓ To prioritize *wadis* to be rehabilitated based on i) soil fertility and ii) land morphology criteria. The third criteria of choice shall be the population density. For Matrouh for instance give priority to Barrani district since soil fertility is higher compared to other districts and land morphology is more adapted to agricultural use and Marsa Matrouh and Ras El-Hekmah because these two districts have higher population density.
- ✓ To construct more dykes per each Km of *wadi* (in both new and existing).
- ✓ To increase the number of cisterns (e.g. from 2 per Km of length of rehabilitated *wadi* to 3-4) and related capacity (e.g. from 100-150 m^3 to 200-300 m^3) for agricultural use inside the *wadis.* The above applies for both new and existing *wadis*.
- ✓ To protect *wadis* (those with conflicts with animal elders) with fences made with local available materials to protect plants from being eaten by animals.
- ✓ To plant trees (e.g. acacias) in the wadis of large catchment area. The trees, along with other fodder crops, can be planted on the plateau to avoid animals inside the agricultural crops.

Second axis – construction or rehabilitation of cisterns, Roman wells and reservoirs

Specific recommendations:

- ✓ To rehabilitate more roman wells and to construct more cisterns to have additional water available for humans and other uses.
- ✓ To prepare data base on roman wells.
- ✓ To adopt the following preventive measures: i) to maintain the cleanliness of the water catchment collection area around the cistern, ii) to clean and maintain / replace the mesh regularly to prevent any solid contaminants from entering the cistern, iii) to keep the cistern closed all time to protect it from any pollutants, iv) to keep all livestock away of the water catchment area around the cistern, v) to clean the sedimentation basin in regular basis to prevent mud and any organic material from entering the cistern, vi) to clean the bucket used to extract the water from the cistern every time, vii) to make water analysis in regular basis (at least once a year).
- ✓ To organise awareness campaigns to spread basic water treatment measures: i) to filter the water with appropriate material locally available before drinking, ii) to store drinking water in a tank before using it for at least 48 hours, iii) to boil the drinking water for three minutes When water is used for cooking, boiling is not required).

- ✓ To spread water treatment practices in case of contamination (e.g. to use dry chlorine or iodine).

Third axis – provision of agricultural services to farmers and social aspects

Specific recommendations:

- ✓ To increase the number and quality of trainings aiming at raising the degree of agricultural skills in terms of best practices for rain-fed agriculture.
- ✓ To prioritize training in agricultural best practices, controlling weeds and insects, integrated pest management, promotion of traditional GI products.
- ✓ To distribute olive seedling in September and just before the rainy season. This will lower the incidence of disease and increase the survival rate of seedlings during transplanting.
- ✓ To distribute seedlings and other planting materials obtained from already locally adapted species.
- ✓ To prioritize the distribution of organic fertilizers locally made.
- ✓ To purchase small tractors and small equipment to be available at local level. Small tractors shall be equipped in order to work inside olives and figs orchards for better control of weeds. However, high power tractors are still needed for basic land reclamation and levelling in new *wadis*.
- ✓ To set up a mechanism for payment of services provided by DRC/SDCMR. Said mechanism shall be agreed with beneficiaries.
- ✓ To guaranty a close follow ups of farmers especially during the planting seasons and in case of outbreaks of insects (e.g. fruit flies). The follow ups shall prioritize the new wadis since farmers have less knowledge in agricultural practices.
- ✓ To improve women empowerment through training courses on the processing of agricultural products (e.g. jams) to increase household income.
- ✓ To prepare a maintenance plan for machinery and other agriculture services.
- ✓ To enhance farmers' associations to improve marketing opportunities and registration of products under GI.