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LIFE Integrated Water Resources Management
Task Order No. 802
EPIQ II: Contract No. EPP-T-802-03-00013-00

Task 6: Improved Waste Water Reuse Practices

ECONOMIC FEASIBILITY STUDY OF USING TREATED WASTEWATER IN IRRIGATION

Report No. 33

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Prepared by:
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ABBREVIATIONS AND ACRONYMS

AAU	Agricultural Administrative Unit
AED	Academy for Educational Development (a US-based entity providing USAID-funded assistance regarding environmental education and awareness)
APRP	Agricultural Policy Reform Program
ARC	Agricultural Research Center
BCM/yr	Billion Cubic Meters per year
BCWUA	Branch Canal Water User Association
CD	Central Directorate
CDA	Community Development Association
CF	Crude Fiber
CP	Crude Protein
CTO	Cognizant Technical Officer (the USAID person responsible for supervising a technical assistance contractor)
CY	Calendar Year
DAI	Development Alternatives, Inc. (a Washington DC-based consulting firm)
ECNO	Egyptian Company for Natural Oils
EEAA	Egyptian Environmental Affairs Agency
EEPP	Egyptian Environmental Policy Program (a USAID-funded program aimed at achieving environmental policy reform)
ENCO	The Egyptian Company for Natural Oils
EPADP	(MWRI) Egyptian Public Authority for Drainage Projects
EPIQ	Environmental Policy and Institutional Strengthening Indefinite Quantity Contract
ET	Evapotranspiration
GIS	Geographic Information System
gm	gram(s)
GOE	Government of Egypt
GPS	Global Positioning System
GW	Groundwater
GWS	Groundwater Sector
HD	(Aswan) High Dam
IAS	Irrigation Advisory Service
IBRD	International Bank for Reconstruction and Development (World Bank)
ID	Irrigation Department
IDS	Irrigation and drainage system
IIIMP	Integrated Irrigation Improvement and Management Project
IIP	Irrigation Improvement Project
IRG	International Resources Group (a Washington DC-based consulting firm that is prime contractor for the IWRMP)
IRR	Internal Rate of Return
IRs	Intermediate Results
IRU	MWRI Institutional Reform Unit
IS	Irrigation Sector of the MWRI
IT	Information Technology

IWMD	Integrated Water Management District
IWMU	MWRI Integrated Water Management Unit
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resource Management Project
kg	kilogram(s)
LAN	Local Area Network
LIFE	Livelihood and Income from the Environment (project)
LOE	Level of Effort
M&E	Monitoring and Evaluation
m^3	cubic meter(s)
MALR	Ministry of Agriculture and Land Reclamation
MED	MWRI Mechanical & Electrical Department
MIC	MWRI Ministry Information Center
MISD	Matching Irrigation Supply and Demand
MOE	Ministry of Education
MOH	Ministry of Housing
MOU	Memorandum of Understanding
MSEA	Ministry of Sate for Environmental Affairs
MWRI	Ministry of Water Resources and Irrigation
NGO	Non governmental Organization
NP	Net Profit
NPV	Net Present Value
NWRC	(MWRI) National Water Research Center
O&M	Operation and Maintenance
OJT	On-the-Job Training
PM&E	Performance Monitoring and Evaluation
R/C	Return/Cost
RSC/WP	Red Sea Coastal/Water Project (USAID Red Sea Coastal and Improved Water Resource Management Project)
RWP	Relative Water Supply
SIRs	Sub-intermediate Results
SOs	Strategic Objectives
STTA	Short-term Technical Assistance
TA	Technical Assistance
TDN	Total Digested Nutrients
TFOF	Tanta for Flax and Oil Flax
TOR	Terms of Reference
USAID	United States Agency for International Development
WCU	MWRI Water Communication Unit
WDC	MWRI Central Water Distribution Center
WPRP	Water Resources Results Package
WQU	MWRI Water Quality Unit
WUA	Water User Association

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EXECUTIVE SUMMARY

OBJECTIVES

The objective of this study was multi-faceted. Foremost, the objective was to explore the market opportunities for a number of crops irrigated by treated wastewater in the Luxor area. These crops are approved by the Egyptian Code for Reuse of Treated Wastewater. Two markets were identified: the local market in the Luxor area, and the regional market. Some crops were thought to be marketed nearby, such as cut flowers. Other crops were perceived as hard to market in Luxor, including flax, mulberry, jatropha, and jojoba. A secondary objective was to examine the financial feasibility of growing these crops.

To address these objectives, a rapid market survey—consisting of questionnaire-based interviews of owners of cut flowers shops and crops specialists, as well meetings with agricultural officials and large-scale farmers—was made.

ACTIVITIES

Activities completed as part of fulfilling the above objectives included:

- Interviewing downstream segments of the cut flowers chain, including cut flowers producers and sellers and hotel and Nile cruise staff in Luxor and in Aswan to assess whether a market exists
- Assessing the possible market for fruit nurseries with large-scale farmers
- Identifying regional markets for jojoba, *Jatropha*, flax, and silk with the help of crop specialists
- Weighing the possibility of growing Code-approved crops in Luxor's climate with crop specialists
- Meeting with specialists in the silk worm industry to assess the financial viability of this field
- Analyzing data about agricultural activity in the Luxor area to identify prevailing trends in cultivating fruit crops
- Conducting financial analyses for crops that proved to be locally or regionally marketable.

The outcome of these activities and analyses was selection of cut flower and fruit nurseries, and production of silk, sorghum, flax, and jojoba, based on marketability.

KEY FINDINGS

The study looked at both the potential or real market and the financial feasibility of producing these crops.

Market

- A promising market exists for the cut flowers industry in Luxor due to Luxor hotels and Nile cruise ships requiring a sustained and significant need for supplies of flowers. Aswan is likely to be a promising cut flowers market as well. Most flowers for the growing tourism industry there are currently imported from Cairo.
- There is likely to be great demand for fruit tree seedlings throughout the rest of this decade due to the rapid horizontal expansion of agriculture into desert lands around Luxor and Aswan. Citrus, mango, grapes, and wind breaks trees are most in demand. However, quality tree stock is an essential prerequisite for sustainability in this progressively growing market.
- A promising market already exists for flax grown utilizing treated wastewater for irrigation. The major national buyer has agreed to renew their contract for this season's harvest with the Livelihood and Income from the Environment–Integrated Water Resources Management (LIFE-IWRM) Demonstration Site in Luxor. According to the firm's chemical and biological assessment, oil

extracted from flax irrigated with treated wastewater has the same composition as normally grown flax. In addition, flax fibers and cake were found to be uncontaminated by heavy metals or pathogenic organisms.

- A significant national market for silk does exist, as Egypt produces only 1.6 percent of its silk needs.
- There is no local market for *Jatropha* at present; however, there could be a promising exporting market. Bio-fuel is one of the expected products from jatropha. Local market data are not available to justify its feasibility for bio-fuel. The Luxor experimental Man-Made Forest sells recently jatropha seeds for seedlings at a price of 10 LE/kg Although *Jatropha* is a crop highly advocated by many parties as a solution to biofuel feedstock, there is no significant amount of reliable scientific data on the crop in terms of commercial application. It implies that one should be diligent when evaluating the crop potential in a specific area for commercial cultivation. Another implication is although it is very reasonable to expect significant crop yields from *Jatropha* carcass per hectare, it is imperative to ensure that the botanical and agricultural assumptions surrounding the projected crop yield are sound.
- Independent local buyers have created a promising market for Jojoba. Competition could push prices up to world levels to the benefit of producers. A potential local jojoba-based pharmaceutical industry could further increase demand on jojoba, promoting jojoba cultivation.
- Sorghum can readily be marketed in the very local market.

<u>Financial Feasibility</u>

- The following enterprises were found to be financially viable: cut flower and fruit nurseries; silk, flax, and jojoba production. All showed positive net present value and an acceptable internal rate of return. Jatropha crop recently started to have a market for the yield at the existing experimental scale in Luxor man-made forest. This is the first year that the forest managed to sell a part of the yield at LE10 per kg for planting purposes. However, no more data as a commercial crop is available for financial analysis.
- Though these enterprises are financially viable, they vary significantly as regards to financial measures, as shown in table 1.
- Flax, sorghum, jatropha and jojoba require a relatively low capital investment and small operating budget.
- Cut flower and fruit nurseries and natural silk production yield the highest net present value; however, these produce the lowest profit among alternatives.
- Jojoba cultivation is not highly profitable unless the crop is sold as oil. Selling jojoba in the form of seeds, particularly to the major local seed buyer, ECNO, would entail a significant loss.
- To be financially viable, sorghum has to be grown on free land due to low estimated returns.
- Flax, a bulky crop, is highly sensitive to transportation expenses, which constitute about 76 percent of total operating expenses. Moreover, it has to be shipped to Met Hebiesh, Tanta, Gharbia Governorate—800 km north of Luxor. Innovative shipping methods, such as by Nile or train, could significantly increase revenues. Establishment of a flax processing facility in Upper Egypt would promote large scale-commercial cultivation of flax in there, provided it was technically approved.
- A natural silk production (Sericulture) project is the most sensitive to fluctuations in costs and revenues, to the extent that a 10 percent decrease in revenue would nearly erode profits. Silk production has a very low ratio of revenues to costs—the lowest among all profitable projects.

Table 1 Financial Performance of Selected Projects

(Jatropha was not listed due to lack of local commercial data)

Indicator	Flower & Nurseries	Natural Silk	Jojoba	Sorghum	Flax
Total Initial Capital Cost including Land price (LE/Feddan)	228,500	359,574	15,000	7,630	5,348
Operational cost (LE/yr or Season)	219,800	104,955	6,035	661	2,782
Annual revenue (LE)	243,000	209,250	8,400	1,600	5,000
Profit Ratio (%)	54.20	45.05	39.93	19.30	61.50
NPV of Net Profit over 20/10 years	281,575	120,912	51,009	-3,170.00	3,987.00
Internal Rate of Return IRR (%)	36.8	27.1	73.4	-1.23	56.72
Payback period (years)	2.7	3.7	1.4	---	1.80
Return/Cost (R/C)	1.18	1.11	3.08	0.69	1.22
Minimum Economic Size of a Farm	5 Feddans	5 Feddans	one feddan	one feddan one season	one feddan one season
Comments & Recommendations	It is more feasibly economic for large size enterprises	It is not recommended for small or medium enterprises	Full revenues starts from yr 3 assuming selling the harvest in the form of oil at 70LE/L not in the form of seeds price of ECNO.	Would be profitable if land is gratitude yielding an R/C of 1.17 and an NPV of 1068.	

Remarks:

- Jojoba operating costs is calculated here as the sum of the operating expenses of the first three years (till the first year of harvest).
- Jojoba Annual Revenue is based on a oil production value of 70LE/L.
- Jojoba profitability ratio is based on the first received revenue, which is supposed to be in the third year.
- Note that revenues are escalating in subsequent years, therefore this indicator should not be highly regarded with this particular enterprise. In addition revenue is not discounted.

- profit ratio= annual revenue/ total investment
- The author assumes the project life for the following enterprises is 10 years: jojoba, sorghum and flax.

RECOMMENDATIONS

The study recommends:

1. On a small scale, the following enterprises were found to be financially viable: cut flower and fruit nurseries, and silk, flax, and jojoba production. Any of these are recommended for commercial adoption in the Luxor area under the specific conditions of a hot, dry climate; sandy soil; and utilizing treated wastewater for irrigation.
2. Flax projects have financially proven success on 1-feddan based units and could provide a proper model for small scale investors. Flax production, technically approved, would be more profitable if shipping costs were reduced, which could easily be achieved if processing facilities to be established in Upper Egypt, which in turn would promote larger scale cultivation of flax.
3. Jojoba projects have financially proven success on 1-feddan based units and could provide a proper model for small scale investors.
4. Jojoba could yield more profit if intercropped with another approved crop by the Egyptian Code of Reuse of Treated Wastewater for agriculture and also to be technically possible. Two crops together would yield an enormous Internal Rate of Return (IRR) that would be reflected in a significant reduction in their prices—when produced on a large scale—that would support a considerable competitive advantage for their affiliated industries.
5. Fruit nurseries projects offer a very high net present value and appear to be very lucrative alternative. However, these projects require significant initial capital. It could be feasible for small or medium scale level investors. It is more feasible for large scale investment. These projects could be implemented on a smaller level, although they would be less efficient.
6. Sorghum, though yielding a negative net present value, looks to be an ideal alternative with low initial capital outlay for the small investor. When and if land is distributed at no cost, sorghum cultivation could contribute positively to establishing a solid livestock production industry, conditional on securing clean water for the animals.
7. Though there is a considerable market for cut flowers in Luxor and Aswan, it is probably not large enough to support several cut flower nurseries. The recommendation, therefore, is to combine cultivation of cut flowers with fruit and windbreak tree nurseries, and other related productions.
8. Air conditioned greenhouses seem to be an unwise investment except for the export market. The short distance between agricultural lands and Luxor Airport, the air conditioned perishable terminal to be established soon at the airport, and moderate winter temperatures could constitute a sound basis for a promising export cut flowers industry in Luxor, conditional on the availability of direct shipping lines to Amsterdam or Belgium and other Middle East Markets.
9. Natural silk projects offer a very high net present value and appear to be a very lucrative alternative. However, these projects require significant initial capital, and might not be feasible alternatives for small- or medium-level investors. These projects could be implemented on a smaller level, although they would be less efficient. Note too, that natural silk production projects have a relatively long period for payback, possibly eliminating them as feasible alternative for medium scale investors. Natural silk production projects have a relatively long period of payback; hence they might not be a feasible alternative for

medium-scale investors. While silk production yields the lowest IRR among all studied projects with positive Net Present Value (NPV), silk is probably the easiest to market, which is always the most difficult part of the production process. Marketing silk is straightforward, with only one recognized market outlet that is easily accessed in Egypt. On the contrary, nursery projects need ceaselessly intensive marketing efforts to reach the volume of sales that ensures accomplishing the economic return, which could be difficult in the face of competition. From a national perspective, silk production is the best alternative for a number of reasons: (1) it is labor intensive, contributing positively to alleviating massive unemployment in Upper Egypt; (2) it creates added value, directly benefiting rural people in very poor areas; and (3) there is no chance for endangering human health and safety in its production. The final product is natural silk. Flax fibers, on the other hand, are exposed to a series of heat and chemical treatments during processing before being made into fabrics and garments.

10. To be economical as a biofuel, *Jatropha* needs to be cultivated on a large scale, thousands of feddans, and shipped to a refining facility in a country with an insufficient domestic supply of fossil-based fuels. It might also be commercially cultivated for export purposes only, but has to be exported in the form of processed oil, and various byproducts such as glycerin, cake animal feeds, and organic fertilizers. *Jatropha* best fit within a fully integrated business model that incorporates the whole supply chain, including producer, processor, and exporter. Moreover, it would best for *Jatropha* to be intercropped during early years of cultivation with non-perennial crops such as flax or sorghum—if that is technically possible. At this point, *Jatropha* needs more intensive applied agronomy and marketing research work.
11. Applied experimentation on a proper scale of the financially viable crops is required for verification before models are disseminated or commercially applied.
12. Although it is beyond the scope of this study, it is strongly recommended that a project to develop public awareness be implemented. This would provide specialized training to landlords and laborers about handling treated wastewater, and distribute educational materials to laborers working on farms using treated wastewater for irrigation. State monitoring should be rigorously applied to ensure that crops and activities are in conformity with the Egyptian Code of Reuse of Treated Wastewater, and irrigation water is used efficiently.
13. On a wider platform, Egypt needs to incorporate basic water resource concepts, including the importance of wastewater, its applications, and necessary precautions of utilization, in school programs. Due to expected future water scarcity, wastewater is a vital resource for Egypt. Efficient water resource management mandates that treated wastewater be used to ensure that its economic return is optimized while taking into consideration the public health implications of using this water.

<u>ASSUMPTIONS</u>

This study assumes:

1. Quality of treated water is—and will continue to be—acceptable from a technical and a health and safety standpoint to grow the selected crops. The continuous use of treated wastewater for irrigation may result in degrading impacts on lands by increasing the content of heavy metals and pathogenic organisms in the soil, and consequently, in the saleable produce.
2. Irrigation water is delivered to the farm gate at no cost, i.e., the government shall bear the cost of delivering the treated wastewater from the facility to a pipe for each 5-feddan piece of land. The costs of installing a treated wastewater network or of paying for delivery of treated wastewater by truck are too high to encourage investors, particularly small investors, to initiate projects. It is assumed here that

bearing such a cost is included under the social responsibility of the government towards preserving the health of its citizens.

3. The government should charge services fees for water irrigation to ensure financial sustainability of treatment facilities in order to maintain high quality treatment service that is of crucial importance. However, water service fees are ignored in this report for two reasons: (1) identifying the exact fees is complicated and requires a special study; and (2) it is assumed that such fees would not significantly affect the financial performance of the projects.
4. Land is priced at LE 5,000/feddan. Unlike other economic studies that advocate no charge for land, this study assumed a land value that is comparable to the commercial price of land in the area surrounding the site project to reflect full financial viability of projects under focus.
5. Markets will continue to be sizable for cut flowers, fruit, sorghum, jojoba, and natural silk throughout the life period of the assumed projects.
6. Crops selected are scientifically approved to be successfully cultivated in Luxor area. However, prior applied experimentation for practical verification might be essential, especially for flax.
7. Obtained results are proper in light of the assumptions made; i.e. results are correct as long as assumptions are valid.

1. INTRODUCTION

Egypt's growing population creates upward pressure on per capita cultivated lands, which recently has declined to 0.19 feddans per capita. This extremely poor level of land dependency indicates how urgently expansion of cultivated land is needed. Maintaining such a low ratio of cultivated land per capita will inevitably exert stress on current land resources and cause excessive deterioration of that land presently under agricultural use. Moreover, it will eventually lead to a dramatic increase in prices of agricultural commodities and materials. This increase will severely affect the accessibility to and availability of food staples for the majority of the Egyptian population.

Reclaiming desert land—about 96 percent of the country's total area—is one of the possible ways to overcome the food gap. Availability of suitable lands for reclamation is not an issue; water availability is the most crucial limiting factor. Egypt's annual share of Nile water has long been fixed at 55.5 billion cubic meters (BCM)/year. It has been estimated that the annual demand for water will reach as high as 61.5 BCM by the year 2025. Thus, Egypt has to consider other sources of water for irrigation to meet the increase in demand.

The National Water Policy relies on reusing agricultural drainage or treated wastewater. Four BCM of drainage water is currently reused. As the discharge of the effluent from sanitary wastewater into the Nile is increasingly posing an environmental hazard, use of treated wastewater in agriculture is becoming part of the solution to the growing problem of river pollution.

The health and safety impacts of using treated wastewater have been the focus of detailed examination and monitoring over the last 2 decades. Eventually, studies produced the Egyptian Code on Wastewater Reuse, recommending particular crops that could be cultivated utilizing treated wastewater.

Crops recommended by the Egyptian Code are scientifically approved to have no adverse heath impacts; however, whether these crops can, technically and financially, be cultivated successfully under different circumstances was left for further local research.

1.1 OBJECTIVES

This report primary analyzes the feasibility of developing a treated wastewater irrigation-based farming industry in Luxor. It examines the market possibility and financial feasibility of growing some of those approved crops using treated wastewater.

The objective of this report is to gather and analyze data, and present as many enterprises that produce marketable goods and are financially possible within the location (Luxor) and within the type of water irrigation constraints found there.

The conclusions contained in this report are based on best judgments; we make no guarantees or assurances that the projections or conclusions will be realized as stated. It is our objective to provide our best effort, and to express opinions based on our evaluation.

1.2 METHODOLOGY

The methodology used in this study is centered on three analytical techniques: descriptive analysis, market survey, and financial analysis. Descriptive analysis has been conducted to infer a general trend of cultivation of specific crops in the area of Luxor using secondary data gathered from the Directorate of Agriculture in Luxor. Market surveys have been carried out to explore the existence for possible markets for traditionally uncommon crops either in the area of Luxor or nationwide. Financial analysis has been utilized to investigate the feasibility of Code-accepted, technically approved, and marketable crops grown under the climate conditions found in Luxor.

1.3 DATA

This study is based on a compilation of primary and secondary data gathered from various sources, including market agents, such as hotels, cut flower sellers, and nursery owners. Records from the Luxor demonstration site were examined along with those from other agriculturists. As well, local agricultural officials, large-scale farmers, crops specialists, and businessmen were interviewed.

Although we judge these sources to be reliable, it is impossible to authenticate all data. The analyst does not guarantee the data and assumes no liability for any errors in fact, analysis, or judgment.

The secondary data used in this study are the most recent available data at the time the report was prepared.

1.4 REPORT STRUCTURE

Chapter 2 outlines the market study for a number of crops that are approved by the Egyptian Code of Reuse of Treated Wastewater. Chapter 3 presents the financial feasibility for possibly marketable crops. Chapters 4 and 5 outline key findings and recommendations. The report concludes by identifying specific uses and applications for this study.

2. MARKET STUDY

Attempts were made to identify the existence of markets for a wide range of crops that are listed in the Egyptian Code of Reuse of Treated Wastewater for irrigation purposes. These crops are classified into five categories: ornamental nursery products, fruits nursery, fiber crops, industrial oil crops, and forest trees. Forest trees are excluded because their returns are only achieved over the extremely long term.

2.1 CUT FLOWER NURSERY

In Luxor, products of this agro-activity are typically sold to tourism facilities such as hotels and Nile cruise ships. There is also a low level of domestic demand due to both cultural and financial reasons. This study focused on the needs of the tourism industry, identifying the supply chain. The analysis of possible markets for locally grown flowers in Luxor included field surveys and a study of the area economy.

The field survey of the cut flower market in Luxor included interviewing existing producers, suppliers, and buyers to estimate the current demand for cut flowers and how such flowers were being sourced. This survey assisted in determining the size of the cut flower and fruit seedling market in Luxor.

Cut Flower Supply Chain for the Tourism Industry in Luxor and Aswan

Hotels and Nile cruise ships source their cut flowers in different ways. They either purchase directly from local flowers shops or they have their own nurseries. In Luxor, there are five flowers shops, and three of them have their own nurseries. The variety of cut flowers commonly cultivated is limited due to dominant high temperatures year around. Flowers cultivated include annuals, sunflowers, and roses. Each shop secures its needs of cut flowers mainly by sending one of its employees to Greater Cairo once a week to purchase needed flowers from well-known nurseries with which they are familiar.

Demand for cut flowers, according to survey, has been fairly stable, with a slight downward trend over the period of the last 5 years due to:

- The majority of the 5-star hotels have been under increasing pressure to achieve cost savings, and one way they accomplish this is to reduce their purchases of cut flowers.
- There is a growing trend on the part of these hotels to rely on their own nurseries for cut flowers.
- The increase in the price of cut flowers is in part due to the rising cost of shipping from Greater Cairo. Luxor lacks a well-stocked nursery that could provide for these hotels various needs.

Luxor has about 277 Nile cruise ships and 30 hotels (nine are 5-star, six are 4-star, and 15 are 3-star and below). Accurate results could be obtained by surveying every buyer, but since this was not possible, we have attempted to select a number of each major hotel class to establish acceptable levels of representation.

On average, a hotel will use 6–8 bouquets in its restaurant twice a week. A bouquet might normally contains eight baladi (or local) roses, two Bird of Paradise stems, three gladioli stems, three carnations, two stems of lilies, and annual flowers. The total monthly need for cut flowers for 15 hotels, for restaurant decoration alone, is estimated to be 7,680 domestic roses, 1,920 Bird of Paradise stems, 2,880 gladioli, 2,880 carnations, 1,920 lily stems, and annual flowers.

Flower shops were surveyed as well. The five shops in Luxor source their needs from major nurseries in Great Cairo via weekly shopping trips. On average, each weekly trip for each shop brings back 800 domestic roses, 400 gladioli, 150 Bird of Paradise stems, 100 tuberose stems, 150 lily stems, and 400 carnations. The monthly needs of flowers for shops in Luxor are estimated at 16,000 domestic roses, 8,000 gladioli, 3,000 Bird of Paradise stems, 2,000 tuberose stems, 3000 lily stems, and 400 carnations.

Cut flowers, turf grasses (green landscapes), ornamental palms, and palm trees are identified as the best-selling ornamental products. These are in high demand in Luxor, Aswan, and Hurghada.

In Aswan, there are about 25 hotels and 277 Nile cruise boats, which are shared between Aswan and Luxor. Consequently, Aswan is also a potential market for the cut flower industry.

Exporting cut flowers is another potential market. High temperatures year around, proximity to an international airport, and the proposed air conditioned perishables terminal at the airport, may provide a solid basis for an export-oriented cut flower industry.[1]

2.2 FRUIT TREE NURSERY

No fruit tree nurseries are located in the Luxor area; but two distributors purchase seedlings from nurseries, mostly located in Lower Egypt, to resell them, either immediately or after further cultivation. These distributors sell seedlings at a profit margin of 15–30 percent. Most newly reclaimed land is planted with fruit trees, as their cultivation is easier in terms of services and supervision, compared with growing vegetables. Most of the large-scale producers purchase fruit tree seedlings from well-known nurseries in Lower Egypt. According to the interviews, most large-scale farms have land that is still uncultivated, which is likely to be planted with fruit trees. The most demanded fruit trees are citrus, mango, palm varieties, and grapes. Annex 2, table A2-8 shows recent prices for the most common fruit tree seedlings in Luxor.

Demand trends for fruits seedlings in the Luxor area could readily be identified if time series data on land planted with fruit trees, newly reclaimed land, and the potential for further horizontal expansion were available, which is not the case. However, according to the Land Reclamation Office of the Directorate of Agricultural in Qena, there are around 363,000 feddans located over eight areas that have been reclaimed very recently (annex 1, table A1-1). That land, once it is ready to be planted, will create a huge demand for fruit tree seedlings. Moreover, the Aswan area represents another potential market, as there are around 10,000 feddans included in the ongoing progressive expansion plan. In addition, there are around 95,000 feddans that have been already reclaimed and are being cultivated in Wadi el-Saaida (30,000 feddans) and the El-Nokra Valley (65,000 feddans), as shown in annex 1, table A1-2.

Due to the trend to plant newly reclaimed land with fruit trees, sale of the seedlings is expected to enjoy thriving demand over the upcoming 5 years due to the considerable expansion in land reclamation from Qena and Aswan. Although there seems to be excellent market potential for fruit tree nurseries in Luxor, quality is a major restricting factor. Large-scale producers in particular do not want to sacrifice quality for low cost seedlings. The market is likely to be restricted to high quality seedling suppliers and distributors. However, there will be a market for conventional nurseries serving mainly small-scale producers.

2.3 JOJOBA

Jojoba is a perennial oil crop that could be successfully cultivated under arid conditions. While yet not very well known, jojoba oil is rich and is used in manufacturing some medicines and creams that proved successful locally and abroad. Jojoba oil has been under intensive scientific scrutiny to examine its characteristics for use as a biofuel for high performance engines and as a lubricant.

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[1] The construction of this terminal is scheduled to start soon.

A promising market for jojoba was identified in the course of this study. There are currently a number of independent buyers and oil processors in Egypt—enough to establish a real market. The major buyer, which introduced the commercial use of jojoba to the Egyptian market is The Egyptian Company for Natural Oils (ECNO).[2] ENCO has established a pharmaceutical industry based mainly on producing jojoba-based medicines and creams. ECNO is importing seeds to meet its steadily growing needs. The most crucial constraint factor for expansion for ECNO is limited raw materials. Jojoba is currently cultivated on about 1,000 feddans in Egypt. ECNO needs up to 3,000 tons of oil to operate at full capacity. This amount of oil could be produced from as many as 7,000–7,500 feddans.

ECNO has been purchasing locally-produced jojoba seeds at 80 percent of world market prices. The application of such a policy, in addition to the existence of other buyers investigating other uses for jojoba oil, ensures the elimination of the monopoly that often dominates markets for newly-introduced commodities.

2.4 JATROPHA

Jatropha curcas is a valuable multi-purpose crop that alleviates soil degradation, desertification, and deforestation. It can be used in soap production and as bio-energy to replace petrol-diesel.

Jatropha is a drought-resistant perennial crop. It grows well in marginal/poor soil and is easy to plant. It grows relatively quickly and has a life span of 50 years. *Jatropha* produces seeds with an oil content of 37 percent. The oil can be combusted as fuel without being refined. It burns with a clear, smoke-free flame, and has been tested successfully as fuel for simple diesel engines. The by-product is cake, which is used in processing rich organic fertilizer and potentially in animal feeds.

It is a small tree or shrub with smooth, gray bark, which exudes whitish colored, watery latex when cut. Normally, it grows between 3 and 5 meters in height, but can attain a height of up to 8 or 10 meters under favorable conditions. *Jatropha* is a highly adaptable species. Its strength as a crop comes from its ability to grow on very poor, dry land. It is recommended, from an economic standpoint, to be cultivated in marginal lands.

Jatropha curcas has the potential to become one of the world's key energy crops. Crude oil extracted from the seeds of the *jatropha* plant can be refined into bio-diesel, as oil characteristics are very favorable for biofuel. *Jatropha* is not yet as well known as a biofuel crop as corn or sugarcane, but *jatropha* may have the highest energy payback of any biofuel. Moreover, unlike corn or sugarcane, *jatropha* is a perennial, yielding oil seed for decades after planting, and can be grown without irrigation in arid conditions where corn or sugarcane would never thrive. More importantly, *jatropha* is a highly adaptable species.

Crude *jatropha* oil is inedible and its price is not distorted by competing food uses. Apart from other applications and potential uses of *jatropha*—medicinal, animal feed, and soap—the growing interest and demand is primary focused on the applications of producing biofuel. On a small-scale, biofuel has to be produced and sold locally to be economically viable. In general, efficient use of byproducts ensures that growing and processing *jatropha* is economically viable and energy efficient.

No local market for *jatropha* was identified. A firm has recently been established with the main objective of refining plant oils into biofuel. At the beginning the firm sought to establish a local *jatropha* industry through

[2] Other major buyers are Abo Elyazeid Oil in Nubaria, and potentially Dena Farm on the Cairo–Alexandria Desert Road. Producers of ready-to-use herbs (*Al-Aatarien*) are another major market for jojoba oil, but as a whole, not individually.

vast cultivations of the plant in various locations: 1,500 feddans in the Suez area, 5,000 feddans near Luxor, and 1,000 more in Aswan. They expected to establish a highly advanced processing facility in Ain Sokhna. The firm has already begun cultivation of *jatropha* in Suez. We were not able to interview a representative of the firm, but it was said that the firm discovered that producing a biofuel from *jatropha* in Egypt would not be economical due to the high state subsidy provided for fossil fuels. Thus, the firm switched their plans to importing vegetables oils to produce biofuels for export.

Egypt does not seem to have a relative advantage in producing *jatropha*. Local seed price would be around LE0.49/kilogram, derived from a world price for crude oil of about $320/ton f.o.b. LE0.49/kg is too low to even cover operating costs. However, with processing seeds into something other than crude oil, obtaining direct by-products such as cake for animal feeds and glycerin, an export-based *jatropha* industry could be established on an economic basis.[3]

There are still some inherent problems with *jatropha* that require intensive research work. These include:

1. *Jatropha* oil is hydroscopic—it absorbs water and needs nitrogen blanketing on steel tanks. One issue that is quite clear is because *jatropha* is high in acid, it has the tendency to degrade quickly, particularly if not handled properly through the supply chain.
2. Right from the time of expelling, the oil needs to be stored under conditions that prevent undue degradation. Exposure to air and moisture must be minimized; hence the need for nitrogen blanketing on the tanks.
3. The range of fatty acids present in the various seeds will differ, but the oil and bio-diesel that is produced must be acceptable. However, this assumes that oil is fully degummed. The degumming may well be more of a problem than making bio-diesel.
4. Seeds begin to degrade as soon as they are picked, so careful storage and handling is required. In the warm humid atmosphere of countries such as Ghana, the degradation of seeds can be rapid. Even in the U.K. seed storage is a problem. Recently, a U.K. importer had samples of rapeseed that had been harvested and stored in wet weather. The analysis showed that they had 28 percent free fatty acid. The free fatty acid must not increase above 2 percent.

There might be a huge potential for *jatropha* in the future.

2.5 SORGHUM

There is usually a lucrative market for green summer forage for livestock. The yield from the experimental sorghum project conducted at the LIFE–Luxor demonstration site during last season was easily sold at market prices. The sorghum buyer stated that the market is highly demanding and able to consume more and more, to the extent that he would be interested to buy any additional harvest.

[3] We do believe that the biofuel industry should be located near the consumption area to minimize high transportation costs that would increase the cost of this already expensive fuel. For this reason, it is common to find that biofuel facilities are located in nations and regions with low domestic production of fossil fuel, such as Northern Europe, East Asia, the United States, and Brazil, and the biofuel is distributed and sold in the local market. In other words, it is only economical to import crude vegetable oil to process it into biofuel when it will be sold in the neighborhood rather to export it to other areas of the world.

Moreover, it is likely that large-scale sorghum cultivation would motivate intensive local livestock production. Lack of adequate green summer fodder enforces small-scale farmers and producers to reduce production intensity in summer time to avoid buying expensive dry feed.

It has observed that farmers in the surrounding rural area regard sorghum that has been irrigated with treated wastewater irrigation as "rich forage" as compared with "white sorghum" that was irrigated by canal water. This would certainly encourage the cultivation of sorghum under treated wastewater irrigation.

Sorghum is provided to livestock either in green form or as hay. Sorghum can be harvested three or four times during the season, with a possibility of a fifth time—around the first of May—in early plantings. Moreover, it is planted once a season, not twice, as for forage corn. A comparison between sorghum and forage corn, currently the leading green summer forage in Egypt, is outlined in table 2. Clearly, sorghum is richer in nutrients and produces a larger harvest.

Table 2 Nutrition Characteristics of Sorghum and Forage Corn

	Forage Corn (*Darawa*)	**Sorghum**
Dry matter yield (ton/feddan)	5	8
Percentage of dry matter	22.5	22.5
Percentage of crude protein (CP)	8.5	5.5-10.5
Percentage of crude fiber (CF)	25.2	25.5
Percentage of total digested nutrients (TDN)	52	77

2.6 FLAX

Flax has long been known for dual purposes: fiber and oil. Both have enjoyed stable demand. Flax has a range of important by-products that are involved in processing other important products such as animal feeds (based on flax cake) and wood (made from flax tow).[4] Flax fibers are used in manufacturing boat sails, fire hoses, and linen fabrics. Oil is either used for human consumption (edible) or for industrial purposes.

There are two major buyers of flax in Egypt: Tanta for Flax and Oil Flax (TFOF), and Shobra Menis village in Gharbia Governorate. The LIFE–IWRM Project secured a contract with TFOF, by which the firm supplies the project with seeds and takes the yield if it is up to required standards. Last year, the flax cultivation experiment at the Luxor Demonstration Site was not successful. The yield was low and plants were short, less than 120-cm in length. Three reasons were identified for the failure: late planting, insufficient water as irrigation was provided through a drip system, and unleveled soil. Quality of this year's production will determine, to a large extent, whether TFOF will continue to accept flax grown under treated wastewater irrigation from the Luxor project.

Flax cultivated lands increased between 2001–04, from 9,505 to 40,789 feddans. All the flax is grown in the Delta. Beginning in 2004, flax was introduced to the New Valley and Nubaria, in a limited area of 329 feddans. The area cultivated with flax was sharply decreased in 2005, to 16,345 feddans, which could be attributed to

[4] When pure flax fiber is produced from flax straw by combing with steel combs, the short fibers or tow are left behind; these short fibers are traded as flax tow or pluckings. Tow comprises the random fibers arising as waste from the processing of stalk fibers. Lower grade, unretted flax straw is converted into flax tow by tow finishing.

low prices received by farmers in 2004. The low price was probably justified by the huge increase in supply due to a sharp increase in flax grown in 2004 as compared with 2003—some 32 percent more land and 35 percent larger harvest between 2003 and 2004.

Processed flax is either exported or diverted for local consumption, which is relatively fixed and not likely to increase. However, the export market is wide open and expanding, particularly for high quality products and by-products such as the Egyptian flax-originated products, which enjoy a good reputation worldwide. It could be inferred that the flax processing capacity for export purposes is working at maximum capacity. Increasing the area where flax is cultivated by several thousand feddans would likely cause a sharp decrease in prices yet again that would discourage flax producers to plant it during the following year, and to cease growing it entirely after awhile. Apparently internal demand for flax is highly correlated with export activities; thus, establishing a solid flax cultivation industry would require promoting the export-oriented flax processing industry.[5]

Other fiber crops such as sisal were not found to be commercially grown in Egypt, except for tilt, which is commercially cultivated but on a small scale, with a total cultivated area of merely 1,000 feddans in northern governorates as it is a typical winter crop.

2.7 SILK

Natural silk is one the finest natural fibers. It has a growing world demand by consumers of all classes. World production exceeded 100,000 tons in 1999. China is the world's largest producer of silk, with a total contribution of 75 percent of the world's production.

Silk production has always been given special attention by developing nations because it is considered to be one of the most valuable agro-industrial activities. It creates high value added and enormous job opportunities, both within the farming sector and at the industrial processing level. In Egypt, silk production should be given special attention not only because of these reasons but also because local production does not meet domestic consumption requirements even though proper climate conditions prevail.

Mulberries grow well in marginal land with marginal water irrigation, and could contribute to current aggressive plans for expanding the utilization of marginal water, particularly on marginal lands.

When countries are first considered natural silk production, they are advised—as a first step—to fabricate locally produced silk into goods that are directed towards the domestic market. This avoids competition from major silk-producing countries such as China, Japan, Indonesia, and South Korea.

Most of the local production of natural silk uses traditional techniques. However, with developing technology for producing silk by the Silk Research Department of the Egyptian Agricultural Research Center (ARC), investors, co-ops, and agencies have started new silk production projects.

Silk production could be efficiently carried out on a small scale basis that best fits with rural women, young graduates, and small investors. Such production would significantly increase quantity, quality, and job opportunities, contributing to the well being of rural people.

[5] Identifying the reasons that currently hold back the export performance of the flax processing industry goes beyond the scope of this study.

A good market was identified for natural silk. Silk farm outputs are either sold in the form of cocoons or raw silk. A by-product is dry leaves of the mulberry bushes. Egypt produces just 4 tons of raw silk annually, while it consumes as much as 250 tons a year. Apparently there is room for the expansion of this valuable industry.

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The objective of this part of the report has been to present as many market components as reasonably possible and identify future market trends. It is concluded that sizable local or regional markets exist for the following crops and products: cut flowers, fruit tree seedlings, silk, jojoba, sorghum, and flax. *Jatropha* only has an export market, and that seems steadily expanding. The conclusions contained herein are based on the best judgments of the analyst, and are not guaranteed that the projections or conclusions will be realized as stated.

3. FINANCIAL ANALYSIS

Using treated wastewater in irrigation has become a vital component in Egypt's water policy, especially to meet the needs of horizontal land expansion. Treating wastewater has become of crucial importance to human health and safety to reduce the volume of wastewater that is simply discharged into drains and canals. The Government of Egypt (GOE), to safeguard human health, recently restricted the application of treated wastewater to five categories of crops that can be safely irrigated with treated wastewater.

However, it is important to assess the possibility for widespread cultivation of such scientifically approved crops. Would growing these crops be financially viable? Are they saleable? Do markets exist?

This chapter analyzes the financial performance of five crops that could be cultivated in Luxor in the land near the wastewater treatment facility located in Luxor by the Manmade Forest. It examines the following financial indicators:

- Net Present Value (NPV) of net profits
- Revenues
- Costs
- Annual nominal profits
- Internal Rate of Return (IRR)
- Simple payback period.

In addition, sensitivity analyses were conducted to assess the impact of potential changes in costs, revenues, and the cost of land on the projects' profitability.

Markets were identified for the produce from five crops: sorghum, flax, fruit tree and cut flower nurseries, natural silk, and jojoba. The financial analyses for these enterprises will be examined in the rest of this section. Little financial analysis could be carried out on *jatropha*, as neither local secondary nor primary data is available.

Analyses are based on 5-feddan units for each crop, except for flax, jojoba, and sorghum, where feasibility is examined on 1-feddan basis. Assumption of relatively small farms for such agricultural projects is based on recognition of the importance of the small-scale investor class. Promoting small investors to undertake such projects would support the treated wastewater-based farming industry in Luxor.

To make such financial analyses, it was necessary to make several assumptions:

- Land costs LE5,000/feddan, which covers the cost of reclamation
- Irrigation water is supplied to the farm gate at no cost
- For a period of 10–20 years, there is no charge for irrigation water
- 1:1 dept: equity ratio is assumed to be secured by a 7 percent interest rate, 5-year term loan furnished by the Bank of Development and Agricultural Credit
- Discounted rate is assumed to be 18 percent over 20 years for the fruit tree and cut flower nurseries and natural silk projects, and 10 years for the other projects
- No borrowing is assumed with flax and sorghum because of their small start up capital needs
- Replacement costs are assumed according to projected economic life of fixed capital assets
- Each 5-feddan unit is assumed to be irrigated using a drip irrigation system at a total cost of LE50,000–55,000, including a pumping unit

- Flax is an exception, as it is recommended to irrigate flax using surface irrigation, assuming permissibility, to ensure acceptable production, in terms of fiber quality.

3.1 CUT FLOWER AND FRUIT TREE NURSERIES

Cut Flowers

Flowers are, no doubt, one of God's most gorgeous creations. 'Cut flowers' refers to a group of flowers or blossoms that could be commercially cut to be used in decoration. Cut flowers are classified into three groups according to growth behavior:

1. Annuals, which could be either summer or winter plants. Winter plants include: *Antirrhinum, Callistephus, Delphinum, Mathiola, Calendula, Statica,* and *Helichrysum*. Summer annual plants include *Tagetes, Zinnia*, and *Amaranthus*.
2. Flowering pot plants such as *Azaleas, Diatom, Begonias, Bromeliads, Alameda, Amanas, Cord line, Croton, Dieffenbachia, Dracaena, focus, Pelargonium, Philodendron, Shefflera, Scindapsus, Yucca, Bougainvillea glabra, Ipomea palmata (I. Pes-caprae),* and *Jasminum officinale grandiflorum*.
3. Shrubs such as roses, orchids, *Cassia artemisoides, Cestrum diurnum, Euphorbia pulcherrima, Hibiscus rosa-sinensis, Jasminum sambac, Myrtus communis, Nerium oleander, Plumeria acutifolia, Tecoma stans, Thevetia nereifolia, Vitex agnus*, and others.

All types of cutting flowers produce charming, attractive flowers that maintain freshness for some time after being cut. Some of these cannot be grown during hot weather. Only types of cut flowers that do need not air conditioned greenhouses have been mentioned.

Fruit Tree Nurseries

Fruit tree seedlings most demanded in Luxor are citrus, mango, palms, and grapes. Others, such as lemon, guava, and domestic apples enjoy modest demand. These fruits should be intensively planted in nurseries to be established in Luxor.

It is not necessary for fruit tree nurseries to be in air conditioned greenhouses. Seedlings could grow under either open shade or in greenhouses. Seedlings are sold when they are at least 9 months old, and prices rise as seedlings get older.

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The proposed nursery project provides two main products, cut flowers and fruit trees, to ensure yield, stability, and market sustainability. Types and varieties produced are ones that are assumed to be those that sell well in Luxor and Aswan.

Estimates for construction costs for greenhouses and buildings are based on primary data on the construction costs of similar establishments in the nursery located in the Faculty of Agriculture, Assuit University.

Value of purchased plants and seeds varies from one nursery to another according to management style, which determines quantities, types, and varieties; purchasing locations; the price of inputs; and quality. Estimates on revenues are based on assumptions made after interviewing several owners of nurseries. Revenues differ considerably among nurseries due to management competence, which in turn affects production capacity, adopted marketing strategy, and output prices. Thus, the accurate study of the financial performance of nurseries should be taken case by case. We just attempted to make an acceptable generalization.

Financial indicators are shown in table 3, along with the results of the sensitivity analysis. The financial analysis for the nursery shows high positive NPV of the net profit over the 20-year project life, with revenues significantly exceeding the capital and operating costs, and a high IRR. Values of the previous indicators evidently present high profitability perspective. Note that the nursery project is highly sensitive to changes in costs and revenues. A 10 percent increase in costs reduces the NPV by around 55 percent, while a decrease of 10 percent in revenues leads to a reduction in the NPV by 65 percent. Granting the land would cause a limited increase of around 7.5 percent.

Hagan and El Hakim estimated an NPV of LE 23,120,546 at 18 percent discount rate over 10 years for a 60-feddan project.[6] The estimated IRR was 159 percent, which is fantastic. The project could reclaim its capital costs in about 0.6 year.

Table 3 Financial Performance for Cut Flower/Fruit Tree Nursery

Indicator	Value
NPV of net profit (LE)	281,575
IRR (%)	36.818
Payback period (years)	2.7
R/C	1.18
NPV of NP assuming an increase of total expenses by 10 percent (LE)	126392
NPV of NP with revenues being reduced by 10 percent (LE)	98,235
NPV of NP if land is granted	302,761

3.2 NATURAL SILK PRODUCTION

Natural silk production (sericulture) is carried out in two separate, but interrelated, processes. The first process is on the farm, growing mulberry bushes and producing raw silk. The second incorporates fabricating the raw silk into fabrics and garments. The quality of final outputs is greatly influenced by the quality of the raw silk received, which in turn depends on the level of applied techniques. Only advanced techniques yield raw silk to process into final products that could be readily marketed locally or exported in the form of products such as women's veils and scarves and men's ties.

The farming side of natural silk production, which is the one of the interest in this study, includes:

- Mulberry cultivation
- Egg production
- Rearing worms and producing cocoons
- Reeling cocoons
- Silk spinning.

6 Ross E. Hagan and Nadine El Hakim, 2002. Use of Wastewater in Egypt.

Thus, the assumed project consists of two major parts: cultivation of mulberry bushes and rearing silk worms.

In mulberry cultivation, 7,000 seedlings can be cultivated in one feddan, irrigated by a drip system. A feddan gives as much as 14 tons of leaves/harvest with a total of three harvests per year.

Silk worms are reared in two places. At early stages, eggs are kept in a separate, air conditioned room apart from the greenhouse. This room accommodates the first three stages of the life cycle of silk worms. The last two stages are passed in a fully equipped greenhouse of 9 × 60 meters.

Five boxes of eggs could be reared nine times a year on a 5-feddan unit. Returns and costs are all primary data. Further income could be gained if mulberry leaves were dried and exported at LE4/kilogram.[7]

Financial indicators are shown in table 4, along with the results of the sensitivity analysis. The financial analysis of natural silk production shows high positive NPV over the 20-year project life, and an acceptable IRR. Values of the previous indicators present the profitability perspective, although the project is sensitive to changes in costs and revenues. A 10 percent increase in costs reduces the NPV dramatically, while a decrease of 10 percent in revenues would nearly erode profitability. Free land would cause a significant increase of around 17 percent.

Table 4 Financial Performance for Natural Silk

Indicator	Value
NPV of net profit (LE)	120,912
IRR (percent)	27.14
Payback period (years)	3.7
R/C	1.11
NPV of NP assuming an increase of total expenses by 10 percent (LE)	18,700
NPV of NP with revenues being reduced by 10 percent (LE)	3,200
NPV of NP if land is granted	142,098

3.3 JATROPHA

As local data on *jatropha* cultivation costs and revenues is not available, potential revenue of cultivation is estimated using available comparable data. Table 5 shows that the yield per feddan per year is up to 3.2 tons of *jatropha* seed, which contain around 37 percent oil. At $320 per crude oil ton, this would translate into sales of crude *jatropha* oil of LE1,742/feddan/year. Of potentially equal value is the yield of glycerin from jatropha seeds. Up to 7 percent of jatropha seeds are made up of glycerin, which sells for up to $2,000 per ton. This translates into glycerin sales of up to LE1,647 per year / feddan.

[7] Not much information is available on where and to whom to export dried leaves, as this niche market is limited and information is yet restricted to a few sericulture projects in Egypt.

Table 5 Financial Performance for *Jatropha*

Notes	Item	Value
1	Seed yield (tons/feddan)	3.2
2	Jatropha crude oil (tons/feddan)	1.18
3	World value of crude oil (LE/feddan)	2,178
4	Local value of crude oil (LE/feddan)	1,742
5	Local value of seeds (LE/feddan)	1,568
6	Local seeds price (kg/LE)	0.49
7	Glycerin (tons/feddan)	0.224
8	World value of glycerin (LE/feddan)	2,576
9	Local value of glycerin (LE/feddan)	1,674.4
10	Total revenue (LE/feddan)	3,416.4
11	Total revenue per seeds yield (LE/kg)	1.07
12	Capital cost	17,100
13	Operating cost	N.A.
14	Net revenue	N.A.

Notes:

1. It is assumed that plants can reach the specified level of productivity after five years of plantation
2. The oil content is assumed to be 0.37 percent
3. World price of crude jatropha oil is $320/ton
4. Local price of crude oil is obtained by assuming 20 percent of the world price as margin for exporters
5. Local value of seeds is calculated as 90 percent of the local value of oil after subtracting 10 percent as processing costs
6. Obtained by dividing item 5 over item 1
7. Glycerin is 7 percent of seeds content
8. Obtained by multiplying world price for glycerin ($2,000/ton) times item 7
9. Obtained by deducting 35 percent of world value for glycerin per feddan (20 percent for exporters and 15 percent for processing)
10. Total revenue is the sum of the local value of crude oil (4) and local value of glycerin (9)
11. Obtained by dividing item (11) over (1)
12, Capital cost is the sum of the following cost items: LE5,000/feddan price, LE5,000 drip system, LE4,000 pumping unit, LE2, 00 seedlings cost, and planting cost of LE1,000 LE
13. In US dollars
14. Local data on those two items is not available
15. Conversion rate of US$1.00 to LE5.75 has been applied.

The question is whether revenues would cover total cost within 10 years of project life. This requires identifying the total costs, capital required, and operating expenses—and local, relevant data has been hard to locate. Exporting seeds would most probably be unprofitable as the estimated local received price, LE0.49/kg, is likely to be too low to cover operating costs, including harvesting costs, LE0.20/kg, transportation expenses, LE0.125/kg, plus irrigation and maintenance expenses and pests control.

3.4 JOJOBA

Jojoba is a shrub that grows to a height of 5 meters, and lives for more than 100 years. It can grow under arid conditions thanks to flat, gray-green, leathery leaves and a deep root system. The plant is saline-resistant and thrives in light soil, as it needs good drainage. Jojoba grows successfully on newly reclaimed desert lands in Egypt.

Jojoba is cultivated to extract high value, non-greasy, odorless oil, which is classified as a liquid wax. There are two economic parts of jojoba: leaves and fruits. Antibacterial and nematode substances are extracted from the leaves. Seeds are compressed to extract anti-oxidant oil that is used in pharmaceuticals, beauty creams, cosmetics, lubricants, polishes, soaps, and pesticides, and are the most economic part of the plant. The peel of the fruit is also used to produce medicinal substances, soil composts, and anti-nematodes. Seed cakes are used in a number of ways, including foods and organic fertilizers.

Jojoba requires modest amounts of irrigation water, ranging between 1,600-3,600 cubic meters (m^3) /feddan. As jojoba is planted in ridges, drip irrigation systems are ideal for irrigation. In general, jojoba needs little care, as its requirements for fertilizers and pesticides are relatively low.

Plants give fruits starting from the third year—300–400 grams (gm) per tree—increasing to 1–1.5 kilograms (kg) by the eighth year, producing a total of 700–900 kg of seeds/feddan.

Production is either sold as seeds or as oil. Profit margin for oil is assumed to be higher. Seed price has been decreasing from LE16.25/kg to as low as LE10/kg since 2005. Predicting future price trends is not possible. Jojoba oil is currently priced between LE25–30/kg, delivered to the major local buyer, ECNO; otherwise it is assumed to be in the range of LE70–75/kg sold to other buyers including herbs merchants.

Financial indicators are shown in table 6 for an assumed one feddan of jojoba, along with the results of the sensitivity analysis. The financial analysis of jojoba, based on the prices set up by ECNO for seeds and oil shows negative NPV over the 10-year project life due to less than unit return/cost ratio, which indicates that future returns are not enough to compensate for the considerable initial negative revenues in the first 4 years. As the sensitivity analysis reveals, jojoba losses could easily be worse if cost of and returns from seeds sales were changed by 10 percent, but the change in returns has much more impact which gives a proxy picture of how worse could be the situation if prices are assumed at the current level LE 10-12 per kg.

On the other hand, the analysis of jojoba sold as oil at assumed commercial prices—LE70/kg—shows high positive NPV, with returns three times higher than costs yielding. That is an extremely high IRR value—73.4 percent. Changing cost by 10 percent does not lead to a significant change in NPV; however, a similar change in revenues results in considerable impact on NPV.

Hagan and El Hakim estimated a positive NPV, at 18 percent discount rate over 15 years, of LE2,033,418 for a 60-feddan project. IRR was calculated as 43 percent, enabling a payback period of 4 years. It hard to compare between the obtained results and the results of Hagan and El Hakim due to variations in assumed project life, and estimated revenues and operating expenses.

Table 6 Financial Performance for Jojoba

Indicator	Value
Product is sold as seeds at LE16.25/kg	
NPV of net profit (LE)	-1,852
IRR (percent)	15.75
Payback period (years)	6.3
R/C	0.92
NPV of NP if costs increased by 10 percent (LE)	-3,029
NPV of NP with assumed decrease in revenues by 10 percent (LE)	-4,115
Output is sold as oil	
NPV of net profit if oil is sold at LE30/kg	-9,326
IRR (percent)	4.3
Payback period (years)	
R/C	0.62
NPV of net profit if oil is sold at LE70/kg	51,009
IRR (percent)	73.4
Payback period (years)	1.4
R/C	3.08
NPV of NP with a reduction in revenues by 10 percent (LE), assuming oil is sold at LE70/kg	43,461
NPV if costs are increased by 10 percent, assuming oil is sold at LE70/kg	49,738

3.5 FLAX

Flax is one of the oldest fiber crops that humans have used to produce cloths. Linen fabrics were found in ancient Egyptian tombs dating back 5,000 years.

Flax is an annual plant that ranges between 50–120 cm in length and 1.5–3 mm in diameter according to cultivar type and environmental conditions. In Egypt, flax is grown for both fiber and oil, contributing to a number of important local industries. Fine, soft, and long fibers are utilized in producing linen fabrics such as leno, or mixed with cotton, while rigid fibers are used in manufacturing household linens, boat sails, fire hoses, currency, and printing papers.

Two types of oil are extracted from flax seeds: edible oil (domestically known as hot or *zet al-har*), and boiled oil that is utilized in manufacturing paints and polishes. The woody material left after extracting fiber (called tow), is used in producing some types of manufactured woods. Half of domestically produced fibers and fiber products are exported, as is flax cake. Domestic production contributes 50 percent of local consumption of flax oil.

Recent local research documented the success of cultivating flax in newly reclaimed lands in the East Delta and Nubaria regions. It was shown that plants grown on such new lands yield finer fibers compared with those from flax grown on old lands. Horizontal expansion of land for growing flax is planned for these regions to alleviate the local consumption gap and further promote exports of fiber and fiber products.

Flax is grown in rows, making drip irrigation systems not applicable. In addition, drip irrigation was found not effective, as it did not supply sufficient water to growing plants in the experiment carried out by LIFE–IWRM at Luxor Demonstration Site in 2006. Therefore, in the financial analysis no costs for a drip irrigation system are assumed. In addition, no costs are assumed for pest and disease control, or for fertilizers, due to the rich irrigation water applied.

The main harvest consists of hay, which averages 4 tons/feddan. Flax seeds are in the range of 730–820 kg/feddan. Price for the flax harvest is determined by the quality of fibers, as is the price for the seeds.

Figures for production of hay and seeds are based on primary data gathered as an output of an experiment conducted near Luxor Wastewater Treatment facility in 1999.[8] The production obtained from the experimental fields was 4.2 tons/feddan, which is slightly higher than the national average. (Note that some agronomists question the possibility of growing flax in Upper Egypt due to both the wide differences between daytime and night temperatures, and to the low average humidity.) Cost estimates are hybrid between secondary and primary data.[9] Output prices are collected from the major local buyer, Tanta for Flax and Oil Flax (TFOF).

Financial indicators are shown in table 7 with the results of the sensitivity analysis. The financial analysis for flax shows positive—through relatively low in absolute value—NPV over the 10-year project life, with a high return/cost ratio that indicates high revenues as compared with costs. As the sensitivity analysis reveals, flax's profitability is sensitive to the amount of harvested hay and seeds, as a decrease of 25 percent will turn it into a losing project. Significant reductions in transportation expenses would double the NPV several times.

Table 7 Financial Performance for Flax

Indicator	Value
NPV of net profit (LE)	3,987
IRR (percent)	56.72
Payback period (years)	1.8
R/C	1.22
NPV of NP with procurement price goes down 13.3 percent (LE)	2,189
NPV of NP with production of harvest and seeds reduced by 25 percent (LE)	-1,631
NPV of NP in case of 10 percent reduction in revenues	1,740
NPV of NP in case of 10 percent increase in costs (LE)	3,563
NPV of NP if transportation costs to decrease by LE1,000	8,481
NPV of NP if transportation costs to decrease by LE2,000	12,975

[8] M. Saber, 2001. 'The Reuse of Wastewater for Irrigation in Southern Upper Egypt.' The Sixth Occasional Report. Scientific Research and Technology Academy. Joint Branch of Water and Drainage Research.

[9] Primary data refers to data collected from the experiment conducted in LIFE's project site near the wastewater treatment facility in Al-Gabal, Luxor in 2005–06.

2.6 SORGHUM

Sorghum is summer green forage, a hybrid between corn and Sudan grass. This hybrid is characterized by intensive tiller rings and large leaves with a possible yield of 45–50 tons/feddan over the season. It has a high content of protein (10–14 percent).

Sorghum is given to livestock either in green form or as hay. Plants could be harvested three to four times during the season, with a possibility of a fifth harvest if planted in early May.

It is grown on ridges and could be irrigated using drip system. Half of the drip irrigation cost is assumed as sorghum is a seasonal crop. The harvest price is determined according to demand and supply. Prices for green forages, particularly in the summer, are unlikely to decline and have been rising over the last 4 decades. This trend is likely to continue due to shortages in supply.

Data on production costs is based primarily on secondary data, while primary data was the source for estimating returns and chemicals (no fertilizers or pesticides were applied).

Financial indicators are shown in table 8, along with the results of the sensitivity analysis. The financial analysis for sorghum shows negative NPV over the 10-year project life, with a lower than unit revenue/cost ratio that indicates a total loss situation. As the sensitivity analysis reveals, sorghum will yield a positive NPV if land is gratuitous, yielding an encouraging high IRR.

Table 8 Financial Performance for Sorghum

Indicator	Value
NPV of net profit (LE)	-3,170
IRR (percent)	-1.23
R/C	0.69
NPV of NP when land is free	1,068
IRR (percent)	37.30

4. KEY FINDINGS

The study looked at both the potential or real market and the financial feasibility of producing these crops.

4.1 MARKET

- A promising market exists for the cut flower industry in Luxor due to Luxor hotels and Nile cruise ships requiring a sustained and significant need for supplies of flowers. Aswan is likely to be a promising cut flowers market as well. Most flowers for the growing tourism industry there are currently imported from Cairo.
- There is likely to be great demand for fruit tree seedlings throughout the rest of this decade due to the rapid horizontal expansion of agriculture into desert lands around Luxor and Aswan. Citrus, mango, grapes, and wind breaks trees are most in demand. However, quality tree stock is an essential prerequisite for sustainability in this progressively growing market.
- A promising market already exists for flax grown utilizing treated wastewater for irrigation. The major national buyer has agreed to renew their contract for this season's harvest with the Livelihood and Income from the Environment–Integrated Water Resources Management (LIFE-IWRM) Demonstration Site in Luxor. According to the firm's chemical and biological assessment, oil extracted from flax irrigated with treated wastewater has the same composition as normally grown flax. In addition, flax fibers and cake were found to be uncontaminated by heavy metals or pathogenic organisms.
- A significant national market for silk does exist, as Egypt produces only 1.6 percent of its silk needs.
- There is no local market for *Jatropha* at present; however, there could be a promising exporting market. Bio-fuel is one of the expected products from jatropha. Local market data are not available to justify its feasibility for bio-fuel. The Luxor experimental Man-Made Forest sells recently jatropha seeds for seedlings at a price of 10 LE/kg Although *Jatropha* is a crop highly advocated by many parties as a solution to *Jatropha* feedstock, there is no significant amount of reliable scientific data on the crop in terms of commercial application. It implies that one should be diligent when evaluating the crop potential in a specific area for commercial cultivation. Another implication is although it is very reasonable to expect significant crop yields from *Jatropha* carcass per hectare, it is imperative to ensure that the botanical and agricultural assumptions surrounding the projected crop yield are sound.
- Independent local buyers have created a promising market for Jojoba. Competition could push prices up to world levels to the benefit of producers. A potential local jojoba-based pharmaceutical industry could further increase demand on jojoba, promoting jojoba cultivation.
- Sorghum can readily be marketed in the very local market.

4.2 FINANCIAL FEASIBILITY

- The following enterprises were found to be financially viable: cut flower and fruit nurseries; silk, flax, and jojoba production. All showed positive net present value and an acceptable internal rate of return.
- Though these enterprises are financially viable, they vary significantly as regards to financial measures, as shown in table 1.
- Flax, sorghum, jatropha and jojoba require a relatively low capital investment and small operating budget.

- Cut flower and fruit nurseries and natural silk production yield the highest net present value; however, these produce the lowest profit among alternatives.
- Jojoba cultivation is not highly profitable unless the crop is sold as oil. If jojoba cultivation expanded and product may increase than the market needs, selling jojoba in the form of seeds, particularly to the major local seed buyer, ECNO, would entail a significant loss.
- To be financially viable, sorghum has to be grown on free land due to low estimated returns.
- Flax, a bulky crop, is highly sensitive to transportation expenses, which constitute about 76 percent of total operating expenses. Moreover, it has to be shipped to Met Hebiesh, Tanta, Gharbia Governorate—800 km north of Luxor. Innovative shipping methods, such as by Nile or train, could significantly increase revenues. Establishment of a flax processing facility in Upper Egypt would promote large scale-commercial cultivation of flax in there, provided it was technically approved.
- A natural silk production (Sericulture) project is the most sensitive to fluctuations in costs and revenues, to the extent that a 10 percent decrease in revenue would nearly erode profits. Silk production has a very low ratio of revenues to costs—the lowest among all profitable projects.

Table 9 summarizes the financial feasibility of growing each of the recommended crops. Note that *jatropha* was not found viable primary due to a lack of relevant data.

Table 9 Summary of Financial Analysis

(Jatropha was not listed due to lack of local commercial data)

Indicator	Flower & Nurseries	Natural Silk	Jojoba	Sorghum	Flax
Land Cost (Le/feddan)	5,000	5,000	5,000	5,000	5,000
Irrigation System	35,000	55,000	2,000	2,500	-
Land preparation	5,000	61,000	1,700	85	98
Infrastructure facilities & other capital cost	163,500	162,324	2,300		
Seedlings	150,000	56,250	4,000	45	250
Total Initial Capital Cost including Land price (LE/Feddan)	228,500	359,574	15,000	7,630	5,348
Operational cost (LE/yr or Season)	219,800	104,955	6,035	661	2,782
Annual revenue (LE)	243,000	209,250	8,400	1,600	5,000
Profit Ratio (%)	54.20	45.05	39.93	19.30	61.50
NPV of Net Profit over 20/10 years	281,575	120,912	51,009	-3,170.00	3,987.00
Internal Rate of Return IRR (%)	36.8	27.1	73.4	-1.23	56.72
Payback period (years)	2.7	3.7	1.4	---	1.80
Return/Cost (R/C)	1.18	1.11	3.08	0.69	1.22
Minimum Economic Size of a Farm	5 Feddans	5 Feddans	one feddan	one feddan one	one feddan one

Indicator	Flower & Nurseries	Natural Silk	Jojoba	Sorghum	Flax
				season	season
Comments & Recommendations	It is more feasibly economic for large size enterprises	It is not recommended for small or medium enterprises	Revenues estimated to be collected starting from yr 3 assuming selling the harvest in the form of oil at 70LE/L not in the form of seeds sold at 12LE/kg as current purchasing price of ECNO.	Would be profitable if land is gratitude yielding an R/C of 1.17 and an NPV of 1068.	

Remarks:

- Jojoba operating costs is calculated here as the sum of the operating expenses of the first three years (till the first year of harvest).
- Jojoba Annual Revenue is based on an oil production value of 70LE/L.
- Jojoba profitability ratio is based on the first received revenue, which is supposed to be in the third year.
- Note that revenues are escalating in subsequent years; therefore this indicator should not be highly regarded with this particular enterprise. In addition revenue is not discounted.
- profit ratio= annual revenue/ total investment
- The author assumes the project life for the following enterprises is 10 years: jojoba, sorghum and flax.

5. RECOMMENDATIONS

The study recommends:

1. The following enterprises were found to be financially viable: cut flower and fruit nurseries, and silk, flax, and jojoba production. Any of these are recommended for commercial adoption in the Luxor area under the specific conditions of a hot, dry climate; sandy soil; and utilizing treated wastewater for irrigation.
2. Flax projects have financially proven success on 1-feddan based units and could provide a proper model for small scale investors. Flax production, technically approved, would be more profitable if shipping costs were reduced, which could easily be achieved if processing facilities were established in Upper Egypt, which in turn would promote larger scale cultivation of flax.
3. Jojoba projects have financially proven success on 1-feddan based units and could provide a proper model for small scale investors.
4. Jojoba could yield more profit if intercropped with another approved crop by the Egyptian Code of Reuse of Treated Wastewater for agriculture and also to be technically possible. Two crops together would yield an enormous Internal Rate of Return (IRR) that would be reflected in a significant reduction in their prices—when produced on a large scale—that would support a considerable competitive advantage for their affiliated industries.
5. Fruit nurseries projects offer a very high net present value and appear to be very lucrative alternative. However, these projects require significant initial capital. It could be feasible for small or medium scale level investors. It is more feasible for large scale investment. These projects could be implemented on a smaller level, although they would be less efficient.
6. Sorghum, though yielding a negative net present value, looks to be an ideal alternative with low initial capital outlay for the small investor. When and if land is distributed at no cost, sorghum cultivation could contribute positively to establishing a solid livestock production industry, conditional on securing clean water for the animals.
7. Though there is a considerable market for cut flowers in Luxor and Aswan, it is probably not large enough to support several cut flower nurseries. The recommendation, therefore, is to combine cultivation of cut flowers with fruit and windbreak tree nurseries, and other related productions.
8. Air conditioned greenhouses seem to be an unwise investment except for the export market. The short distance between agricultural lands and Luxor Airport, the air conditioned perishable terminal to be established soon at the airport, and moderate winter temperatures could constitute a sound basis for a promising export cut flowers industry in Luxor, conditional on the availability of direct shipping lines to Amsterdam or Belgium and other Middle East Markets.
9. Natural silk projects offer a very high net present value and appear to be a very lucrative alternative. However, these projects require significant initial capital, and might not be feasible alternatives for small- or medium-level investors. These projects could be implemented on a smaller level, although they would be less efficient. Note too, that natural silk production projects have a relatively long period for payback, possibly eliminating them as feasible alternative for medium scale investors. Natural silk production projects have a relatively long period of payback; hence they might not be a feasible alternative for medium-scale investors. While silk production yields the lowest IRR among all studied projects with positive Net Present Value (NPV), silk is probably the easiest to market, which is always the most difficult part of the production process. Marketing silk is straightforward, with only one recognized market outlet that is easily accessed in Egypt. On the contrary, nursery projects need ceaselessly intensive marketing

efforts to reach the volume of sales that ensures accomplishing the economic return, which could be difficult in the face of competition. From a national perspective, silk production is the best alternative for a number of reasons: (1) it is labor intensive, contributing positively to alleviating massive unemployment in Upper Egypt; (2) it creates added value, directly benefiting rural people in very poor areas; and (3) there is no chance for endangering human health and safety in its production. The final product is natural silk. Flax fibers, on the other hand, are exposed to a series of heat and chemical treatments during processing before being made into fabrics and garments.

10. To be economical as a biofuel, Jatropha needs to be cultivated on a large scale, thousands of feddans, and shipped to a refining facility in a country with an insufficient domestic supply of fossil-based fuels. It might also be commercially cultivated for export purposes only, but has to be exported in the form of processed oil, and various byproducts such as glycerin, cake animal feeds, and organic fertilizers. Jatropha best fit within a fully integrated business model that incorporates the whole supply chain, including producer, processor, and exporter. Moreover, it would best for Jatropha to be intercropped during early years of cultivation with non-perennial crops such as flax or sorghum—if that is technically possible. At this point, Jatropha needs more intensive applied agronomy and marketing research work.
11. Applied experimentation on a proper scale of the financially viable crops is required for verification before models are disseminated or commercially applied.
12. Although it is beyond the scope of this study, it is strongly recommended that a project to develop public awareness be implemented. This would provide specialized training to landlords and laborers about handling treated wastewater, and distribute educational materials to laborers working on farms using treated wastewater for irrigation. State monitoring should be rigorously applied to ensure that crops and activities are in conformity with the Egyptian Code of Reuse of Treated Wastewater, and irrigation water is used efficiently.
13. On a wider platform, Egypt needs to incorporate basic water resource concepts, including the importance of wastewater, its applications, and necessary precautions of utilization, in school programs. Due to expected future water scarcity, wastewater is a vital resource for Egypt. Efficient water resource management mandates that treated wastewater be used to ensure that its economic return is optimized while taking into consideration the public health implications of using this water.

6. USES AND APPLICATIONS

Although this report represents the best available attempt to identify current market status and future market trends, most markets are continually being affected by demographic, economic, and developmental changes. Further, this report has been conducted with respect to the LIFE–IWRM's development objectives of promoting use of treated wastewater on 1,300 feddans of the Al-Gabal area near Luxor. Consequently, this report focuses on determining the current market capacity to support those particular objectives via selected Code-approved crops and products, and to assess the financial viability of those crops and products that proved to be marketable. For these reasons, the conclusions and recommendations in this study are applicable, to a large extent, to the proposed site identified herein, and only for the potential uses for that site as dictated by the Egyptian Code on Reuse of Treated Wastewater for Irrigation. Generalization of conclusions and recommendations is not advised.

Market survey and financial analysis identifies four potentially promising fields of investments: cut flower and fruit tree nurseries; silk production, flax, and jojoba.

ANNEXES

Annex 1: Data on Reclaimed Lands in Luxor and Aswan

Table (A1-1): Newly reclaimed lands in Qena Governorate

Location	Area (feddan)
West El-Marashda	50000
El-Marashda	38300
Neseem Valley (Esna)	3300
Hegaza	3700
Kaft	5500
South Esna	1800
Kena Valley	150000
El-Lakita valley	100000
Total	**352600**

Source: Directorate of Agriculture, Land Reclamation Office, Qena

Table (A1-2): Projected reclaimed lands in Aswan

Reclamation Location	Area (feddans)
South East Abo Grawel Valley	450
Grawel Valley	720
Valley South East Nagaa El Wehda	240
South Aasbet El Manoura Valley	120
South East Nagaa El Dobkat Valley	1200
South East Al Hebel Valley	2400
South East El Zankata	2400
South Al Madamoud Valley	1400
South East Tiba city	720
Total	**9650**

Source: Directorate of Agriculture, Land Reclamation Office, Aswan

Annex 2: Financial Sheet of Cut flowers and Fruits Nursery

Table (A2-1): Financial analysis for a 5-feddan fruits and cut flowers Nursery

NPV NP = 281,575		**R/C= 1.18**		**IRR= 36.818%**	
Discount Rate= 0.18		**NPV Revenues= 1,833,401**		**NPV Costs= 1,551,827**	
Sensitive = 1		**1**		**1**	
Net Profit	**Revenues**	**Total Expe.**	**Opert. Expens.**	**Investment**	**Year**
-278818	224150	502968			1
88532	363000	274468			2
88532	363000	274468			3
88532	363000	274468			4
88532	363000	274468			5
135560	363000	227440			6
143200	363000	219800			7
143200	363000	219800			8
143200	363000	219800			9
143200	363000	219800			10
100560	363000	262440			11
143200	363000	219800			12
143200	363000	219800			13
143200	363000	219800			14
138200	363000	224800			15
135560	363000	227440			16
143200	363000	219800			17
143200	363000	219800			18
143200	363000	219800			19
363000	582800	219800			20
2380190	**7340950**	**4960760**	**4960760**	**0**	**Total**

Table (A2-2): Sensitivity analysis assuming cost increase by 10%

NPV NP= 126392		R/C= 1.07		IRR= 25.104%	
Discount Rate= 0.18		NPV Revenues= 1833401		NPV Costs= 1707009	
Sensitive _	1		1.1	1	
Net Profit	**Revenues**	**Total Expen.**	**Opert. Expens.**	**Investments**	**Year**
-329114.8	224150	553264.8			1
61085.2	363000	301914.8			2
61085.2	363000	301914.8			3
61085.2	363000	301914.8			4
61085.2	363000	301914.8			5
112816	363000	250184			6
121220	363000	241780			7
121220	363000	241780			8
121220	363000	241780			9
121220	363000	241780			10
74316	363000	288684			11
121220	363000	241780			12
121220	363000	241780			13
121220	363000	241780			14
115720	363000	247280			15
112816	363000	250184			16
121220	363000	241780			17
121220	363000	241780			18
121220	363000	241780			19
341020	582800	241780			20
1884114	**7340950**	**5456836**	**5456836**	**0**	**Total**

Table (A2-3): Sensitivity analysis assuming revenues reduction by 10%

NPV NP= 98235		**R/C= 1.06**		**IRR= 24.032%**	
Discount Rate= 0.18		**NPV Revenues= 1650061**		**NPV Cost= 1551827**	
Sensitive =	**0.9**		**1**	**1**	
Net Profit	**Revenues**	**Total Expen.**	**Opert. Expens.**	**Investment**	**Year**
-301233	201735	502968			1
52232	326700	274468			2
52232	326700	274468			3
52232	326700	274468			4
52232	326700	274468			5
99260	326700	227440			6
106900	326700	219800			7
106900	326700	219800			8
106900	326700	219800			9
106900	326700	219800			10
64260	326700	262440			11
106900	326700	219800			12
106900	326700	219800			13
106900	326700	219800			14
101900	326700	224800			15
99260	326700	227440			16
106900	326700	219800			17
106900	326700	219800			18
106900	326700	219800			19
304720	524520	219800			20
1646095	**6606855**	**4960760**	**4960760**	**0**	**Total**

Table (A2-4): Sensitivity analysis assuming land is granted

NPV NP= 302761		**R/C= 1.20**		**IRR= 39.982%**	
Discount Rate= 0.18		**NPV Revenue= 1833401**		**NPV Cost= 1530640**	
Sensitive =	**1**		**1**	**1**	
Net Profit	**Revenues**	**Total Expen.**	**Opert. Expens.**	**Investments**	**Year**
-253818	224150	477968			1
88532	363000	274468			2
88532	363000	274468			3
88532	363000	274468			4
88532	363000	274468			5
135560	363000	227440			6
143200	363000	219800			7
143200	363000	219800			8
143200	363000	219800			9
143200	363000	219800			10
100560	363000	262440			11
143200	363000	219800			12
143200	363000	219800			13
143200	363000	219800			14
138200	363000	224800			15
135560	363000	227440			16
143200	363000	219800			17
143200	363000	219800			18
143200	363000	219800			19
363000	582800	219800			20
2405190	**7340950**	**4935760**	**4935760**	**0**	**Total**

Table (A2-5): Capital costs for 5-feddan nursery project, including cut flowers, fruits and wood seedlings, (LE)

Item	**Value**
Land cost and preparation expenses	30000
Greenhouses	
Woody greenhouses	20000
Plastic greenhouses	18000
Shady	5000
Buildings	
Storage	10000
Offices	15000
Irrigation system	35000
Pumping water machine	25000
Tools and equipment	10000
Small tractor	50000
Fences and hedges	10500
Working capital	219800
Total	**448300**

Table (A2-6): Annual operating costs for the nursery project, (LE)

Items	**Cost**
Plants and seeds	150000
Pots	10000
Fertilizers	5000
Soil	7000
Irrigation	500
General expenses	5000
Labor	40800
Maintenance	1500
Total	**219800**

Note: labor refers to permanent and on call labor

Table (A2-7): Estimated annual revenues for the nursery project, (LE)

Items	**Value**
Fruits seedlings	45000
Shrubs seedlings	10000
Climbers & creepers	10000
Plant Hedges	15000
Palms	10000
Pine trees	8000
Broad leaves trees	10000
Cut flowers	75000
Pots plants	15000
Turf graces	45000
Total	**243000**

Table (A2-8): Price list of fruits and winds breaks seedlings in Luxor, (LE)

Fruit	**Price**
Mango	15
Domestic Limon	2
Oranges & Mandarin	6
Grapes	22
Domestic apples	13
Guava	2
Limon	6
Eucla	1.5
Kaya	10
Poinciana	17
Ficus	15 & 25

Annex 3: Financial Sheet of Natural Silk Production Project

Table (A3-1): Financial analysis of 5-feddan natural silk production project

NPV NP= 120912		**R/C =**	**1.11**	**IRR=**	**27.14%**
Discount Rate=	**0.18**	**NPV Revenues =**	**1177117**	**NPV Cost**	**1056205**
Sensitive =	**1**		**1**	**1**	
Net Profit	**Revenues**	**Total Expen.**	**Opert. Expens**	**Investments**	**Year**
-184848	274430	459278	0	459278	1
16129	209250	193121	0	193121	2
16129	209250	193121	0	193121	3
16129	209250	193121	0	193121	4
16129	209250	193121	0	193121	5
103475	209250	105775	0	105775	6
122695	209250	86555	0	86555	7
122695	209250	86555	0	86555	8
122695	209250	86555	0	86555	9
122695	209250	86555	0	86555	10
-35479	209250	244729	0	244729	11
122695	209250	86555	0	86555	12
122695	209250	86555	0	86555	13
122695	209250	86555	0	86555	14
122695	209250	86555	0	86555	15
103475	209250	105775	0	105775	16
122695	209250	86555	0	86555	17
122695	209250	86555	0	86555	18
122695	209250	86555	0	86555	19
172480	259035	86555	0	86555	20
1573264	**4299965**	**2726701**	**0**	**2726701**	**Total**

Table (A3-2): Sensitivity analysis of silk production with costs increased by 10%

NPV NP=18,700		**Rate R/C = 1.02**		**IRR= 19.15%**	
Discount Rate= 0.18		**NPV Revenue= 1,177,117**		**NPV Cost= 1,158,417**	
Sensitive =	**1**		**1.1**	**1**	
Net Profit	**Revenues**	**Total Expenses**	**Ope.Cost**	**Investment**	**Year**
-230775.8	274430	505205.8			1
-3183.1	209250	212433.1			2
-3183.1	209250	212433.1			3
-3183.1	209250	212433.1			4
-3183.1	209250	212433.1			5
94819.5	209250	114430.5			6
114039.5	209250	95210.5			7
114039.5	209250	95210.5			8
114039.5	209250	95210.5			9
114039.5	209250	95210.5			10
-44134.5	209250	253384.5			11
114039.5	209250	95210.5			12
114039.5	209250	95210.5			13
114039.5	209250	95210.5			14
114039.5	209250	95210.5			15
94819.5	209250	114430.5			16
114039.5	209250	95210.5			17
114039.5	209250	95210.5			18
114039.5	209250	95210.5			19
163824.5	259035	95210.5			20
1320255.3	**4299965**	**2979709.7**	**2783096**	**196614**	**Total**

Table (A3-3): Sensitivity analysis of silk production assuming a reduction of 10% in revenues

NPV Net Profit= 3,200		**Rate R/C = 1.00**		**IRR= 18.22%**	
Discount Rate= 0.18		**NPV Revenues = 1,059,405**		**NPV Cost= 1,056,205**	
Sensitive =	**0.9**		**1**	**1**	
Net Profit	**Revenues**	**Total Expen.**	**Opert. Expens**	**Investments**	**Year**
-212291	246987	459278			1
-4796	188325	193121			2
-4796	188325	193121			3
-4796	188325	193121			4
-4796	188325	193121			5
82550	188325	105775			6
101770	188325	86555			7
101770	188325	86555			8
101770	188325	86555			9
101770	188325	86555			10
-56404	188325	244729			11
101770	188325	86555			12
101770	188325	86555			13
101770	188325	86555			14
101770	188325	86555			15
82550	188325	105775			16
101770	188325	86555			17
101770	188325	86555			18
101770	188325	86555			19
146576.5	233131.5	86555			20
1143267.5	**3869969**	**2726701**	**2530087**	**196614**	**Total**

Table (A3-4): Sensitivity analysis of silk production with price of lands is zero

NPV Net Profit= 142,098		**Rate R/C= 1.14**		**IRR= 29.85%**	
Discount Rate= 0.18		**NPV R= 1,177,117**		**NPV C= 1,035,019**	
sensitive =	**1**		**1**	**1**	
Net Profit	**Revenues**	**Total Expen.**	**Opert. Expens.**	**Investments**	**Year**
-159848	274430	434278			1
16129	209250	193121			2
16129	209250	193121			3
16129	209250	193121			4
16129	209250	193121			5
103475	209250	105775			6
122695	209250	86555			7
122695	209250	86555			8
122695	209250	86555			9
122695	209250	86555			10
-35479	209250	244729			11
122695	209250	86555			12
122695	209250	86555			13
122695	209250	86555			14
122695	209250	86555			15
103475	209250	105775			16
122695	209250	86555			17
122695	209250	86555			18
122695	209250	86555			19
172480	259035	86555			20
1598264	**4299965**	**2701701**	**2505087**	**196614**	**Total**

Table (A3-5): Capital cost for a 5-feddan natural silk project, mulberry cultivation and rearing silk worms, (LE)

Items	Value
First: Mulberry cultivation (5 feddans)	
Land leveling and preparation	4500
Digging holes and planting seedlings	56500
Mulberry seedlings	52500
Mother seedlings	3750
Irrigation system	55000
Land cost	25000
Operating capital for mulberry cultivation	22200
Second: rearing silk worms	
Hatching room and rearing small stages	20000
Accommodate management room	20000
Greenhouse Metal frame	16000
Plastic sheets for greenhouse	2640
Material for shading	5000
Up level irrigation system in greenhouse	1500
2 Desert coolers	20000
Heater and air gun	20000
Air filtration	23954
Fabrics	1080
Thermometer	150
Rearing trays	10000
Silk wiper removal machine	5000
Leaves cutting machine	4000
Water pump	3500
Italian sprayer	6500
Trolley	3000
Working capital for 9 runs	82755
Total	**464529**

Table (A3-6): Operating capital for mulberry cultivation, (LE/ 5-feddans)

Item	**Value**
Grafting expenses	8750
Make up seedlings	5250
Irrigation	5200
Super phosphate	600
Ammonium Nitrate	400
Organic fertilizers	2000
Total	**22200**

Table (A3-7): Operating capital for rearing 25 eggs boxes of silk worms, one run (LE)

Item	**Cost (LE)**
25 eggs boxes	2250
Mulberry leaves	4375
Labor	480
Leaves gathering	640
Electricity and power	500
Transferring cocoons and larva	300
Greenhouse maintenance	250
Greenhouse disinfection	300
Lime stone for larva disinfection	100
Total	**9195**

Table (A3-8): Annual operating expenses of growing mulberry for years beyond the first year, LE/5-feddan

Items	**Value (LE)**
Fertilizers	1,840
Organic fertilizers	400
Irrigation	500
Weeding	800
Pesticides	300
Total	**3800**

Note: gathering leaves harvest is not accounted for as it is counted with the silk worms rearing process, however, it should be accounted for if leaves to be sold outside the project.

Table (A3-9): Revenues of one run of 25 eggs boxes of silk worms (LE)

Item	**Value (LE)**
- healthy cocoons	
25 boxes X 39kg X 23LE	22425
- Defected cocoons	
25 boxes X 1kg X 8LE	200
- Larva debris	625
Total Revenue	**23250**

Note: dried leaves could be exported at 4LE/kg creating other source of income

Annex 4: Financial Sheet of Jojoba Project

Table (A4-1): Financial analysis of a jojoba enterprise

NPV NP	**-1852**	**R/C =**	**0.92**	**IRR=**	**15.748%**
Discount Rate= 0.18		**NPV R=**	**22623**	**NPV C= cost**	**24475**
Sensitive =	**1**		**1**	**1**	
Net Revenue	**Revenues**	**Total Cost**	**Ope. Cost**	**Investments**	**Year**
-16730	0	16730	1730	15000	1
-1935	0	1935	1935	0	2
-95	2275	2370	2370	0	3
1790	4514	2724	2724	0	4
2901	5964	3063	3063	0	5
4574	7899	3325	3325	0	6
7153	10478	3325	3325	0	7
8673	12573	3900	3900	0	8
12738	15153	2415	2415	0	9
12890	17410	4520	4520	0	10
31959	**76266**	**44307**	**29307**	**15000**	**Total**

Table (A4-2): Sensitivity analysis of jojoba production with costs increased by 10%

NPV NP= -3029		**R/C= 0.88**		**IRR=**	**14.322%**
Discount Rate= 0.18		**NPV Rev =22623**		**NPV Cost =25651**	
Sensitive	**1**		**1.1**	**1**	
Net	**Revenues**	**Total**	**Ope.**	**Investments**	**Year**
-16903	0	16903	1903	15000	1
-2128.5	0	2128.5	2128.5	0	2
-332	2275	2607	2607	0	3
1517.6	4514	2996.4	2996.4	0	4
2594.7	5964	3369.3	3369.3	0	5
4241.5	7899	3657.5	3657.5	0	6
6820.5	10478	3657.5	3657.5	0	7
8283	12573	4290	4290	0	8
12496.5	15153	2656.5	2656.5	0	9
12438	17410	4972	4972	0	10
29028.3	**76266**	**47237.7**	**32237.7**	**15000**	**Total**

Table (A4-3): Sensitivity analysis of jojoba production with revenue decreased by 10%

NPV =	**-4115**	**R/C =**	**0.83**	**IRR=**	**12.744%**
Discount Rate = 0.18		**NPV revenue=20361**		**NPV Cost= 24475**	
Sensitive =	**0.9**		**1**	**1**	
Net	**Revenues**	**Total**	**Ope.**	**Investments**	**Year**
-16730	0	16730	1730	15000	1
-1935	0	1935	1935	0	2
-322.5	2047.5	2370	2370	0	3
1338.6	4062.6	2724	2724	0	4
2304.6	5367.6	3063	3063	0	5
3784.1	7109.1	3325	3325	0	6
6105.2	9430.2	3325	3325	0	7
7415.7	11315.7	3900	3900	0	8
11222.7	13637.7	2415	2415	0	9
11149	15669	4520	4520	0	10
24332.4	**68639.4**	**44307**	**29307**	**15000**	**Total**

Table (A4-4): Financial analysis of jojoba enterprise if oil is sold at 30LE/kg

NPV NP= -9326		**R/C = 0.62**		**IRR= 4.245%**	
Discount Rate = 0.18		**NPV R =**	**15149**	**NPV C=**	**24475**
Sensitive =	**0.9**		**1**	**1**	
Net	**Revenues**	**Total**	**Ope.**	**Investments**	**Year**
-16730	0	16730	1730	15000	1
-1935	0	1935	1935	0	2
-858	1512	2370	2370	0	3
300	3024	2724	2724	0	4
933	3996	3063	3063	0	5
1967	5292	3325	3325	0	6
3695	7020	3325	3325	0	7
4524	8424	3900	3900	0	8
7737	10152	2415	2415	0	9
7144	11664	4520	4520	0	10
6777	**51084**	**44307**	**29307**	**15000**	**Total**

Table (A4-5): Financial analysis of jojoba enterprise if oil is sold at 70LE/kg

NPV NP= 51009		**R/C = 3.08**		**IRR =**	**73.363%**
Discount Rate= 0.18		**NPV R=**	**75484**	**NPV C=**	**24475**
Sensitive	**1**		**1**	**1**	
Net	**Revenues**	**Total**	**Ope.**	**Investments**	**Year**
-16730	0	16730	1730	15000	1
-1935	0	1935	1935	0	2
1550	3920	2370	2370	0	3
75316	78040	2724	2724	0	4
7297	10360	3063	3063	0	5
10395	13720	3325	3325	0	6
14875	18200	3325	3325	0	7
17940	21840	3900	3900	0	8
23905	26320	2415	2415	0	9
25720	30240	4520	4520	0	10
158333	**202640**	**44307**	**29307**	**15000**	**Total**

Table (A4-6): Sensitivity analysis assuming a 10% increase in jojoba costs

NPV NP = 4973		**R/C= 2.93**		**IRR =**	**69.262%**
Discount rate= 0.18		**NPV R= 75484**		**NPV C= 25746**	
Sensitive	**1**		**1**	**1.1**	
Net	**Revenues**	**Total**	**Ope.**	**Investments**	**Year**
-18230	0	18230	1730	16500	1
-1935	0	1935	1935	0	2
1550	3920	2370	2370	0	3
75316	78040	2724	2724	0	4
7297	10360	3063	3063	0	5
10395	13720	3325	3325	0	6
14875	18200	3325	3325	0	7
17940	21840	3900	3900	0	8
23905	26320	2415	2415	0	9
25720	30240	4520	4520	0	10
156833	**202640**	**45807**	**29307**	**16500**	**Total**

Table (A4-7): Sensitivity analysis assuming a 10% decrease in revenues of jojoba

NPV NP= 43461		**R/C =**	**2.78**	**IRR=**	**67.369%**
Discount Rate= 0.18		**NPV R= 67936**		**NPV C= 24475**	
Sensitive	**0.9**		**1**	**1**	
Net Revenue	**Revenues**	**Total Cost**	**Ope. Co**	**Investments**	**Year**
-16730	0	16730	1730	15000	1
-1935	0	1935	1935	0	2
1158	3528	2370	2370	0	3
67512	70236	2724	2724	0	4
6261	9324	3063	3063	0	5
9023	12348	3325	3325	0	6
13055	16380	3325	3325	0	7
15756	19656	3900	3900	0	8
21273	23688	2415	2415	0	9
22696	27216	4520	4520	0	10
138069	**182376**	**44307**	**29307**	**15000**	**Total**

Figure (A4-8) Capital costs of jojoba (LE/feddan)

Item	**Cost**
Infrastructure	2300
irrigation system	2000
planting	1700
seeds and seedlings	4000
Land cost	5000
Total capital Cost	15000

Table (A4-9): Operating costs for jojoba (LE/feddan)

Year / Item	1	2	3	4	5	6	7	8	9	10
labor	630	660	690	727	765	802	840	882	962	970
irrigation	500	525	550	580	608	638	670	703	738	775
fertilizing and pesticides	360	425	600	630	660	700	735	770	810	850
maintenance	240	300	390	507	660	695	730	765	805	845
harvesting			140	280	370	490	650	780	940	1080
Total expenses	1730	1935	2370	2724	3063	3325	3625	3900	4415	4520

Table (A4-10): Feddan revenues of jojoba

Year / Item	1	2	3	4	5	6	7	8	9	10
Seeds production (Kg)	0	0	140	280	370	490	650	780	940	1080
Production value, at 16.25LE/kg (LE)			2275	4514	5964	7899	10478	12573	15153	17410
Production value at current price, 10LE/kg, (LE)			1400	2800	3700	4900	6500	7800	9400	10800
Oil production (kg)			56	112	148	196	260	312	376	432
Production value of oil at 30LE/kg (LE)			1680	3360	4440	5880	7800	9360	11280	12960
Production value of oil at 70LE/kg (LE)			8400	16800	22200	29400	39000	46800	56400	64800

Note: All data on jojoba is derived from a financial study on jojoba carried out

Annex 5: Financial Sheet on Flax Project

Table (A5-1): Financial analysis of a flax enterprise

NPV NP= 3987		R/C= 1.22		IRR=	56.716%
Discount Rate= 0.18		NPV R =	22470	NPVC= 18484	
Sensitive	I		I	I	
Net	Revenues	Total	Ope.Cost	Investments	Year
-3170	5000	8170	3170	5000	1
1830	5000	3170	3170	0	2
1830	5000	3170	3170	0	3
1830	5000	3170	3170	0	4
1830	5000	3170	3170	0	5
1830	5000	3170	3170	0	6
1830	5000	3170	3170	0	7
1830	5000	3170	3170	0	8
1830	5000	3170	3170	0	9
1830	5000	3170	3170	0	10
13300	**50000**	**36700**	**31700**	**5000**	**Total**

Table (A5-2): Sensitivity analysis if flax main product's price decreased to 750 L.E/ton

NPV NP= 2189		R/C =	1.12	IRR=	37.824%
Discount Rate= 0.18		NPV= 20673		NPV C= 18484	
Sensitive	I		I	I	
Net	Revenues	Total	Ope.	Investments	Year
-3570	4600	8170	3170	5000	1
1430	4600	3170	3170	0	2
1430	4600	3170	3170	0	3
1430	4600	3170	3170	0	4
1430	4600	3170	3170	0	5
1430	4600	3170	3170	0	6
1430	4600	3170	3170	0	7
1430	4600	3170	3170	0	8
1430	4600	3170	3170	0	9
1430	4600	3170	3170	0	10
9300	**46000**	**36700**	**31700**	**5000**	**Total**

Table (A5-3): Sensitivity analysis if flax main and by-products production to decrease by 25%

NPV NP= -1631		**R/C =**	**0.91**	**IRR=**	**3.463%**
Discount rate= 0.18		**NPV R= 16853**		**NPV C= 18484**	
sensitive	**1**		**1**	**1**	
Net	**Revenues**	**Total**	**Ope.Cost**	**Investments**	**Year**
-4420	3750	8170	3170	5000	1
580	3750	3170	3170	0	2
580	3750	3170	3170	0	3
580	3750	3170	3170	0	4
580	3750	3170	3170	0	5
580	3750	3170	3170	0	6
580	3750	3170	3170	0	7
580	3750	3170	3170	0	8
580	3750	3170	3170	0	9
580	3750	3170	3170	0	10
800	**37500**	**36700**	**31700**	**5000**	**Total**

Table (A5-4): Sensitivity analysis if flax revenues to decrease by 10%

NPV NP= 1740		**R/C =**	**1.09**	**IRR=**	**33.560%**
Discount Rate = 0.18		**NPV R= 20223**		**NPV C= 18484**	
Sensitive	**0.9**		**1**	**1**	
Net	**Revenues**	**Total**	**Ope.Cost**	**Investments**	**Year**
-3670	4500	8170	3170	5000	1
1330	4500	3170	3170	0	2
1330	4500	3170	3170	0	3
1330	4500	3170	3170	0	4
1330	4500	3170	3170	0	5
1330	4500	3170	3170	0	6
1330	4500	3170	3170	0	7
1330	4500	3170	3170	0	8
1330	4500	3170	3170	0	9
1330	4500	3170	3170	0	10
8300	**45000**	**36700**	**31700**	**5000**	**Total**

Table (A5-5): Sensitivity analysis if flax costs to increase by 10%

NPV NP= 3563		R/C =	1.19	IRR=	48.439%
Discount Rate= 0.18		NPV R= 22470		NPV C= 18907	
Sensitive	1		1	1.1	
Net	Revenues	Total	Ope.Cost	Investments	Year
-3670	5000	8670	3170	5500	1
1830	5000	3170	3170	0	2
1830	5000	3170	3170	0	3
1830	5000	3170	3170	0	4
1830	5000	3170	3170	0	5
1830	5000	3170	3170	0	6
1830	5000	3170	3170	0	7
1830	5000	3170	3170	0	8
1830	5000	3170	3170	0	9
1830	5000	3170	3170	0	10
12800	**50000**	**37200**	**31700**	**5500**	**Total**

Table (A5-6): Sensitivity analysis if transportation expenses to decrease by 1000 LE

NPV NP= 8481		R/C =	1.61	IRR=	130.343%
Discount Rate= 0.18		NPV R= 22470		NPV C= 13989	
Sensitive	1		1	1	
Net	Revenues	Total	Ope.Cost	Investments	Year
-2170	5000	7170	2170	5000	1
2830	5000	2170	2170	0	2
2830	5000	2170	2170	0	3
2830	5000	2170	2170	0	4
2830	5000	2170	2170	0	5
2830	5000	2170	2170	0	6
2830	5000	2170	2170	0	7
2830	5000	2170	2170	0	8
2830	5000	2170	2170	0	9
2830	5000	2170	2170	0	10
23300	**50000**	**26700**	**21700**	**5000**	**Total**

Table (A5-7): Sensitivity analysis if transportation expenses to decrease by 2000 LE

NPV= 12975		R/C =	2.37	IRR=	327.350%
Discount Rate= 0.18		NPV R= 22470		NPV C= 9495	
Sensitive	I		I	I	
Net	Revenues	Total	Ope.Cost	Investments	Year
-1170	5000	6170	1170	5000	1
3830	5000	1170	1170	0	2
3830	5000	1170	1170	0	3
3830	5000	1170	1170	0	4
3830	5000	1170	1170	0	5
3830	5000	1170	1170	0	6
3830	5000	1170	1170	0	7
3830	5000	1170	1170	0	8
3830	5000	1170	1170	0	9
3830	5000	1170	1170	0	10
33300	**50000**	**16700**	**11700**	**5000**	**Total**

Table (A5-8): Capital and operating costs for flax (LE/feddan)

Items	**Costs**
Capital Costs	
Land costs	5,000
Irrigation system	
Operating costs	
Soil preparation	98
Plantation	30
Seeds	250
Farming services	63
Fertilizing	
Irrigation	98
Maintenance of irrigation	
Plant protection	
Harvesting	140
Transporting harvest Tanta	2400
General expenses	91
Total operating costs	3170

Table (A5-9): Flax revenues (LE/feddan)

Harvest (ton/feddan)	4
Price (LE/ton)	850
Value of main production (LE)	3400
By product (kg/feddan)	800
Price (LE/kg)	200
Value of by-product (LE/feddan)	1600
Total revenue (LE/feddan)	5000

Annex 6: Financial Sheet of Sorghum

Table (A6-1): financial analysis for a sorghum enterprise

NPV NP= -5288		R/C =	0.58	IRR=	-6.921%
Discount Rate= 0.18		NPV R= 7191		NPV C= 12479	
Sensitive	I		I	I	
Net Rev	**Revenues**	**Total**	**Ope.Cost**	**Investments**	**Year**
-9291	1600	10891	891	10000	1
709	1600	891	891	0	2
709	1600	891	891	0	3
709	1600	891	891	0	4
709	1600	891	891	0	5
709	1600	891	891	0	6
709	1600	891	891	0	7
709	1600	891	891	0	8
709	1600	891	891	0	9
709	1600	891	891	0	10
-2910	**16000**	**18910**	**8910**	**10000**	**Total**

Table (A6-2): financial analysis for a sorghum enterprise assuming no cost for land

NPV NP= -1051		R/C =	0.87	IRR=	8.768%
Discount Rate= 0.18		NPV R= 7191		NPV C= 8242	
Sensitive	I		I	I	
Net Rev	**Revenues**	**Total**	**Ope.Cost**	**Investments**	**Year**
-4291	1600	5891	891	5000	1
709	1600	891	891	0	2
709	1600	891	891	0	3
709	1600	891	891	0	4
709	1600	891	891	0	5
709	1600	891	891	0	6
709	1600	891	891	0	7
709	1600	891	891	0	8
709	1600	891	891	0	9
709	1600	891	891	0	10
2090	**16000**	**13910**	**8910**	**5000**	**Total**

Table (A6-3): financial analysis for sorghum assuming an irrigation system cost of 2,500LE/feddan

NPV NP= -3170		R/C =	0.69	IRR=	-1.228%
Discount Rate= 0.18		NPV R= 7191		NPV C= 10360	
Sensitive	1		1	1	
Net Rev	Revenues	Total	Ope.Cost	Investments	Year
-6791	1600	8391	891	7500	1
709	1600	891	891	0	2
709	1600	891	891	0	3
709	1600	891	891	0	4
709	1600	891	891	0	5
709	1600	891	891	0	6
709	1600	891	891	0	7
709	1600	891	891	0	8
709	1600	891	891	0	9
709	1600	891	891	0	10
-410	16000	16410	8910	7500	Total

Table (A6-4): financial analysis for a sorghum enterprise assuming an irrigation system cost of 2,500LE/feddan and no land cost

NPV NP= 1068		R/C =	1.17	IRR=	37.304%
Discount Rate= 0.18		NPV = 7191		NPV C= 6123	
Sensitive	1		1	1	
Net Rev	Revenues	Total	Ope.Cost	Investments	Year
-1791	1600	3391	891	2500	1
709	1600	891	891	0	2
709	1600	891	891	0	3
709	1600	891	891	0	4
709	1600	891	891	0	5
709	1600	891	891	0	6
709	1600	891	891	0	7
709	1600	891	891	0	8
709	1600	891	891	0	9
709	1600	891	891	0	10
4590	**16000**	**11410**	**8910**	**2500**	**Total**

Table (A6-5): Capital and operating costs for sorghum cultivation (LE/feddan)

Items	Costs
Capital Costs	
Land cost	5,000
Irrigation system	5,000/2,500
Operating costs	
Soil preparation	85
Plantation	25
Seeds	45
Farming services	130
Fertilizing	
Irrigation	200
Maintenance of irrigation	100
Plant protection	
Harvesting	135
General expenses	71
Total operating costs	791

Table (A6-6): Sorghum revenue (LE/feddan)

Number of harvests	4
Harvest value (LE)	400
Production value (LE)	1600

Annex 7: List of Contacts

Aadel Khaled	Contract Dept., TFFO
Aayad Thabet	LIFE, Luxor Project Coordinator
Awad Basily	Manger of the Industrial Forest, Luxor
Ahmed Mosa	Producer, Luxor
Emad Ismaile	Agronomy Dept., Cairo University
Hani Sheta	Entomology Dept., Cairo University
Hassan S. Aabas	Horticultural Dept., Assuit University
Mahmoud A. Abdel-Nabi	Manager of Silk Promotion Project, Diarot, Assuit
Mohamed Abdellah	Agronomy Dept., Cairo University
Mohamed Abdel-Wahab	Herbs Dept., Desert Research Institution
Nabil El-Moogi	CEO, ECNO
Salah El-Serafi	Entomology Dept., Cairo University
Salah Hefni	Plant Protection Dept, Assuit University
Taher Yehia	Horticultural Dept., Cairo University
Zienab, and others	Employees at the LIFE's Luxor project
Zienhom R. Soliman	Agricultural Animal Dept., Cairo University