*Assiut J. of Agric. Sci., 40 (4)(136-159)*

# Economic Feasibility Study for Silk Production Under Egyptian Conditions

**By**

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**Key words:** Ethrel, *Punica granatum*, $GA_3$, fruit set, fruit splitting)

**Abstract :** Silk production has been always given special recognition by developing nations being considered as one of the most valuable agro-industrial activities since it creates high value added and enormous job opportunities either within the farm sector or at the industrial processing level. In Egypt, silk production should have special attention not only because of the above mentioned reasons but also because local production does not meet the domestic consumption requirements although dominant climate conditions are proper. Pre-feasibility studies should carry out before implement the natural silk projects, this due to the High-cost investment of these types of projects.

Because of the limited research conducted in this area, the study aims to: highlight the technical aspects of raising silkworms and cocoons production in terms of calculation and assessment of indicators of financial viability of setting up such projects and sensitivity analysis of changes that may occur or threaten the viability of the projects.

The results of the financial assessment of the (Sericulture) project for the production of natural silk cocoons according to the criteria used in the feasibility study showed along with the results of the sensitivity analysis. The financial analysis shows high positive net present value of the net profit over the twenty years 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. Though, the project is small sensitive to change in costs and revenues. (Sericulture) project has relatively a small period of payback.

## Introduction

**Silk** is produced in more than 20 countries. While the major producers are in Asia, sericulture industries have been established in Brazil, Bulgaria, Egypt and Madagascar. Sericulture is labour-intensive About 1 million workers are employed in the **silk** sector in China. Sericulture provides income

**Received on**:18/11/2009 **Accepted for publication on**: 12/12/2009

**Referees**: Prof.Dr. M.A.AboNahoul Prof.Dr. Ahmed M. Abo EL- Naga

for 700 000 households in India, and 20 000 weaving families in Thailand. Silk

production has been always given special recognition by developing nations being considered as one of the most valuable agro-industrial activities since it creates high value added and enormous job opportunities either within the farm sector or at the industrial processing level. In Egypt, silk production should be given special attention not only because of the above mentioned reasons but also because the local production does not meet the domestic consumption requirements although dominant climate conditions are proper.

Silk was considered the third most popular raw material for textiles in Egypt after linen and wool. Silk fabrics were known in Egypt since the Ptolemaic era. Silk was imported from India and China before Egypt started producing it locally in the sixth century AD.

Mulberry can grow well in new reclaimed lands, and marginal lands with marginal irrigated water, thus it could valuably contribute towards carrying out the current aggressive plans of expansion the utilization of marginal water, particularly in marginal lands.

**Study Problem and Objectives:**

As with any other agricultural product, development of Silk production project inevitably requires consideration of its economic viability. It should be noted that little research has thus far been done in this area. So the objective of the present study is:

- to cover the fundamental principles which are most common and directly applicable to silkworm breeding.
- trying to ascertain, to some degree, the economic and financial viability of Silk Production Project. This requires dynamic financial evaluation methods which consider the value of money over time since, as mentioned above, these are economic activities with a time horizon of more than one year.

The first concern of this work is to explore the market existence for Silk production. While the second is to calculate the viability of the indicators, once we have made the necessary general and specific assumptions.

**Methodology & Data**

The methodology used in this study is centered on three analytical techniques: descriptive analysis, market, and financial analysis. Descriptive Analysis has been conducted to infer a general trend of cultivation of Mulberry trees using secondary data. Market analysis has been carried out to explore the existence for possible market for traditionally uncommon production of natural Silk. Financial analysis has been utilized to investigate the feasibility of implementation of the project under the climate conditions of new land.

The indicators and how they are formulated. **Juan Fco., *et. al.* (2002) and Yaser A. Diab (2006).**

- **Net Current Value** (NCV) is the difference between the cost of investment, which comprises both the cost of the planting proper and the discounted payments of the so-called training period, and the discounted cash flows, which represent the difference between receipts and payments. The formula used to obtain this value is the following:

$$NCV = -(k_0 + \sum_{n-1}^{1} \frac{C_n}{(1+r)^n}) + \sum_{n-2}^{20} \frac{q_n p_n - C_n}{(1+r)^n}$$

where:
$K_0$ = cost of investment.
$C_n$= payments made throughout the life of the investment.
$q_n$ = production achieved.
$p_n$ = price.
r = discount rate.

- **Benefit Cost Ratio (B/C),** which is defined as the ratio of the total present value of benefits to the total present value of the costs during the service life of the project. A project is accepted for investment if B/C ratio is greater than or equal to unity and rejected otherwise.

$$B/C\ Ratio = \frac{\sum_{n-1}^{1} \frac{q_n p_n}{(1+r)^n} + \sum_{n-2}^{20} \frac{q_n p_n}{(1+r)^n}}{\sum_{n-1}^{1} \frac{C_n}{(1+r)^n} + \sum_{n-2}^{20} \frac{C_n}{(1+r)^n}}$$

where:
$C_n$= payments made throughout the life of the investment.
$q_n$ = production achieved.
$p_n$ = price.
r = discount rate.

- **Internal Rate of Return** (IRR), which is defined as the interest rate that, as a discount rate, would give an NCV of zero.

$$0 = -\left(k_0 + \sum_{n-1}^{1} \frac{C_n}{(1+IRR)^n}\right) + \sum_{n-2}^{20} \frac{q_n p_n - C_n}{(1+IRR)^n}$$

where: $K_0$ = cost of investment.
$C_n$ = payments made throughout the life of the investment.
$q_n$ = production obtained.
$p_n$ = price.
IRR = internal rate of return.

- **Recovery Period** (RP), which is defined as the time needed to recover the cost of the investment.

$$RP = H \text{ where } k_0 = \sum_{n-1}^{1} \frac{C_n}{(1+r)^n} + \sum_{n-2}^{H} \frac{q_n p_n - C_n}{(1+r)^n}$$

where: $K_0$ = cost of investment.
$C_n$ = payments made throughout the life of the investment.
$q_n$ = production achieved.
pn= price.
H = recovery period.
r = discount rate.

Lastly, our results will be subjected to sensitivity analysis, with a view to predicting the evolution of the aforementioned indicators under various price scenarios.

This study is based on a compilation of primary and secondary data gathered from various sources, including market agents, crops specialists, and businessmen. The secondary data used in this study are the most recent available data at the time of the study preparation.

**Technical Study**

- **Rearing programme**

The programme of silkworm rearing in a farm is determined by the following consideration:

✓ Conditions of mulberry growth and yield of mulberry leaf.

✓ Availability of expertise for rearing silkworm.

✓ Facilities for rearing silkworms. i.e. suitable buildings and equipment.

The volume of silkworm rearing to be undertaken is determined by the availability of leaf. This is calculated by estimating the yield of mulberry trees in the previous crops and during the corresponding season of the previous years. It can be safely estimated that 8,000 to 10,000 kg of leaves can be harvested per Fedan per Year under conditions of optimum agronomic practices. It has been estimated that to rear one box or 20,000 eggs 600-650 kg of leaves are required for spring rearing. **Krishnawami, *et. al.*,(1979a).**

**The facilities required for silkworm rearing are a rearing space or houses, and rearing equipment.**

**1- Rearing houses:**

Rearing house must be constructed in a north- south direction in temperate and sub-tropical regions, so that maximum sunlight and heat is available to warm up the rearing rooms adequately. Preferably with the thatched roofing, mud walls or any roofing must not reflect heat on the biological body growth of silkworm. **Hussein(2005)**. The rearing house is partition into four convenient rooms in one of which, by maintaining high temperature and humidity, the young age silkworms are reared. The rooms are provided with an adequate number of windows and doors to ensure good ventilation for rearing older silkworms. **Krishnawami, *et. al.*, (1979a).** The rearing house are Shown in (**Fig**. 1).

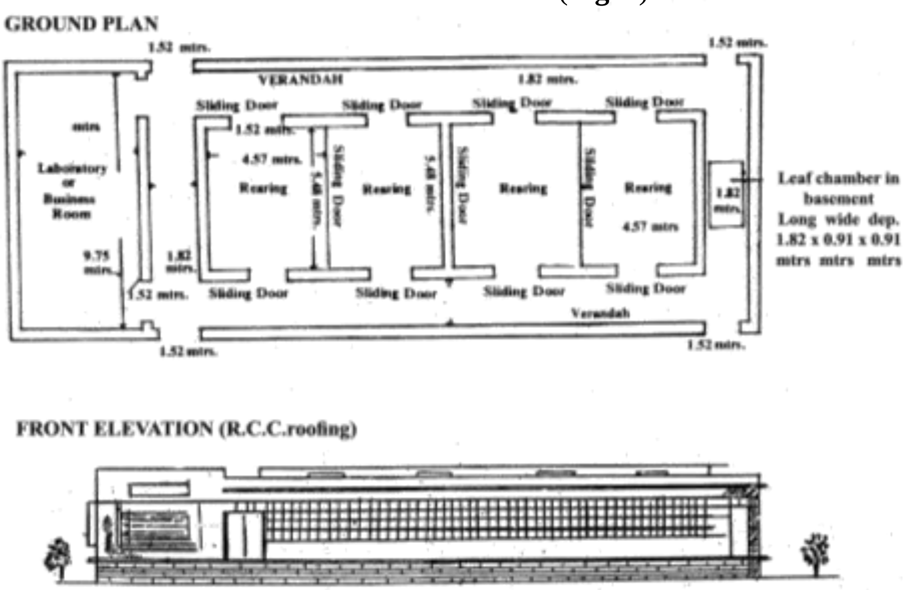


**Fig.1: Plans of building for rearing operations**

**2-Rearing Equipments:**

The following equipments are required for silkworm rearing.

1) Bed cleaning nets 2) Formalin 3) Sprayer 4) Mats 5)Leaf preservation chamber 6) Chopping board 7) Chopping knife 8) Chop sticks 9) Feathers 10) Ant wells 11) Foam pads 12) Paraffin Paper 13) Hygrometer 14) Thermometer 15) Bed cleaning net 16) Wash basin 17) Feeding basins 18) Plastic buckets/Mugs 19) Rearing stands 20) Rearing trays 21) Feeding stand 22) Mountages. ( Fig. 2)

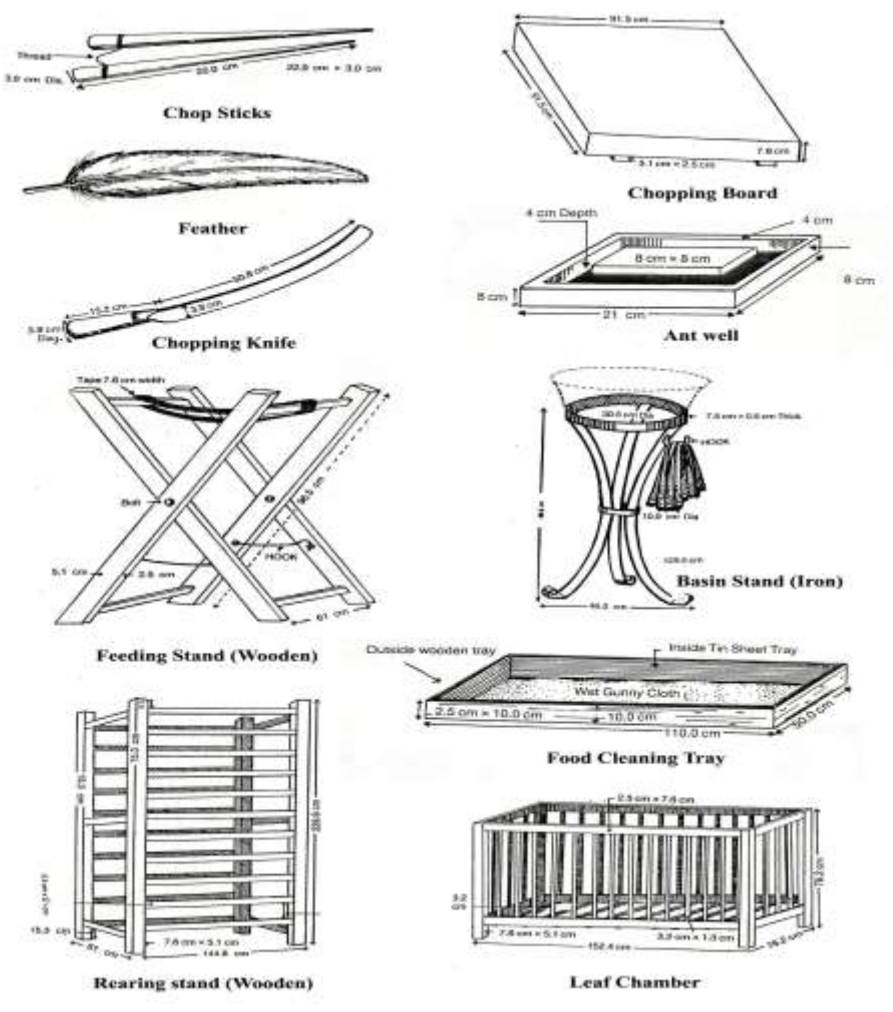


**Fig.2 : Equipment for silkworm rearing.**

**3-Disinfection:**

Disinfection is a process of destructing the disease casual organisms. There is a possibility of carrying the pathogens or germs through the rearing equipment if there is any disease attack in the previous crop. Therefore, disinfection is necessary to protect the crop from disease attack. Before taking up rearing, all the rearing equipments including the rearing house should be disinfected thoroughly. There are various methods of disinfection like physical and chemical. Physical disinfections are Sun drying, Steaming. In chemical disinfection, all the rearing equipment as well as the rearing house should be thoroughly disinfected with 2% formalin and dried. " Formaldehyde" available commercially as a 40percent strong solution should be diluted to the required strength and used at the rate of 800 ml to 10m² . After spraying the room is kept closed for 15-20 hours, then the doors and windows are opened and the room kept open for approximately 24 hours for all traces of formaldehyde to disappear. According to **Krishnawami, *et. al.*,(1979a)**,**Dingle et. al.,(2005) and Hussein(2005).**

**4-Climatic requirements: -**

Under ideal conditions silkworm completes cocoon formation in 24-28 days from the day of hatching. However, there is variation in number of days due to fluctuation in temperature and humidity. As the temperature increases the development of larvae activates.

**Table 1 : The following required temperature/humidity/spacing should be provided, Krishnawami, *et. al.*,(1979a):**

| S. No. | Stage | Temperature C° | Humidity % | Spacing (m²) | |
|---|---|---|---|---|---|
| | | | | At the beginning of each age | At the end |
| 1 | 1st Instar | 26-28 | 85-90 | 0.2 | 0.8 |
| 2 | 2nd Instar | 26-28 | 85-90 | 1.0 | 2.0 |
| 3 | 3rd Instar | 25-26 | 80-85 | 2.0 | 4.5 |
| 4 | 4th Instar | 24-25 | 70-75 | 5.0 | 10.0 |
| 5 | 5th Instar | 23-24 | 70 | 10.0 | 20.0 |

The larval development will be maximum during the 5th Instar after 4th moult. Generally the moulting period delays due to fluctuation in climatic conditions. Temperature plays an important role in the development of larva. Larva under goes four moults in case of tetramoulters with in a span of 26-28 days to spin the cocoon. **Krishnawami, *et. al.*,(1979a) and Hussein(2005)**.

**5-Leaf requirement:**

Silkworm attains nearly 10,000 times of weight starting from hatching to spinning stage, therefore, feeding quality leaf plays an important role in the development of silkworm and the production of quality cocoons. Samokhvalova et al. (1966) found that, summer young leaves of the mulberry tree gave the best results with respect to viability, cocoon weight, tength of realed silk, productivity, and silk yield. When larvae were fed on mature leaves, a thinner thread was formed. Young leaves in summer contain a high amount of nitrogen, and mineral salts (K and Ca), as well as soluble carbohydrates, compared to young leaves, in spring. Verma and Atwal (1968) stated that larvae of B. mori reared on leaves from seedling varieties of mulberry developed more quickly and produce more silk than those reared on leaves from grafted varieties. The lower rate of larval development on grafted varieties was associated with decreased larval and pupal weights.

The young age worms are fed with tender, succulent leaves which contain sugar, less amount of fibre, starch, but high moisture and protein that are suitable for chawki worms. Hence, the top tender leaves of mulberry plant are used to feed the young age worms. The late age worms are fed with matured leafs available at the bottom of the mulberry trees.

The leaf during its feeding time should not contain dust particles or water droplets on the surface of leaf. Disease attacked, wrinkled, weak leaves, poor quality leaves should not be fed to the worms. Feeding bottom matured leaves to chawki worms, tender leaves to mature worms should be avoided.

**Table 2: Leaf Requirement for rearing of 20,000 eggs of silkworm, Krishnawami, *et. al.* (1979a)**:

| S. No. | Silkworm Stage | Quantity of mulberry leaf Required (Kgs) |
|---|---|---|
| 1 | 1st Instar | 1-2 |
| 2 | 2nd Instar | 5-6 |
| 3 | 3rd Instar | 20-25 |
| 4 | 4th Instar | 80-90 |
| 5 | 5th Instar | 450-475 |
| Total | | 550-600 |

The requirement of leaf will differ from race to race. **Hassanein *et al*. (1972)** found that, the degree of food assimilation and the quantities of secreted silk differ properly from one race to another when fed on the same variety of mulberry.

The consumption of leaf also varies with season. During summer the quantity of leaf required will be a little higher since, drying of leaf will be faster hence additional feeding may be required. **Sudo and Okajima ( 1981**).

- **Process of rearing**

**1) Incubation :**

The eggs should be kept in cooler places at $25^0$C temperature and 80% humidity, lesser the humidity poorer the hatching percentage or more the temperature weak the larva and poorer the hatch percentage.

For uniform hatching all the egg cards or loose eggs should be kept in dark and cooler atmosphere. On the day of pin head or blue egg stage all the eggs are covered with a black sheet or kept in black box and known as black boxing. On the day of hatching all the eggs are suddenly exposed to bright light in the early morning at around 8 A.M. so that 95% hatching can be achieved. It should be ensured that hatching should take place uniformly. With proper maintenance of temperature and humidity development of larvae will be uniform. **Anonymous (2002) and Dingle, *et. al.*,(2005)** .

**2) Brushing :**

Brushing is transferring of newly hatched larvae into rearing trays. The newly hatched larvae after one hour of hatching get ready to feed on mulberry leaf. They are fed with finely chopped tender mulberry leaf. Chawki worms are fed with tender leaves with high moisture content. The brushing of newly hatched larvae can be done in various methods.

Newly hatched larvae can be covered with a net and chopped mulberry leaf can be sprinkled over the net. The larvae slowly crawls on to the net and start to feed on the mulberry leaf. Then transfer into rearing tray by gently tapping the net, this method is more convenient in case of the loose eggs.

In case of egg cards, the egg cards are placed in the rearing trays and chopped mulberry leaf is sprinkled over the newly hatched larvae, the larvae crawls on to the mulberry leaf later and the cards are removed.

Care should be taken not to touch the newly hatched larvae with hands while providing proper spacing, instead chop sticks are used to spread the worms in the rearing tray. **Anonymous (2002) and Dingle, *et. al.*,(2005)**

**3) Spacing :**

Larval growth will be very fast in the silk worms during the early stages. Too much crowd in the rearing tray results in increase in humidity, heat, fermentation of litter which results in un-hygienic conditions, wastage of leaf and under development of silkworm. The number of trays and space required for each instar will increase. (Table 1) . To overcome this situation, we allowed around 200-250 newly hatched larvae in the rearing tray, but the larval numbers were reduced to 150-200, 100-125, 50-60 and 15-20 larvae per single tray, for the 2nd, 3rd, 4th and 5th instar larvae, respectively. **Dingle, *et. al.*,(2005)**

Spacing should be given simultaneously at the time of bed cleaning or feeding and care should be taken not to disturb the worms very frequently.

**4) Bed Cleaning :**

Silkworm after moulting leaves the exuviae. All the leaf fed to silkworm may not be consumed. Dried leaves, rejected leaf in the bed, silk worms excreta, dead worms, diseased larvae all will increase the humidity, fermentation, temperature in the bed. If proper bed cleaning is not done in time it leads to various complications viz. Ill health of larvae, disinterest of the larvae to fed due to unhygienic conditions, ultimately worms becomes weak. Bed cleaning in silkworm rearing tray is done by various methods like using of paddy husk, straw, and bed cleaning net. During $1^{st}$ instar bed clearing should be done once during pre-moulting, during $2^{nd}$ instar – twice, once after moult and before next moult. During $3^{rd}$ instar thrice i.e. after moult, before next moult and once in the middle. During $4^{th}$ and $5^{th}$ stage once in a day in case of shelf rearing. However, in case of floor rearing or shoot rearing once in each instar. **Krishnawami, *et. al.* (1979a).**

**5) Feeding:**

Not only the nutritive value but also the number of feeds in each instar plays a major role in the cocoon built. Three to four feeds are given to the silkworm. In a day the last feeding i.e., during the night should be a little more since the duration for the next feeding will be longer. During moulting period no feeding should be given. Before settling to moult and immediately after moult, first feeding should not be heavy. Feeding tender leaves to young age worms is essential. As the larval growth advances the mature leaf can be fed. **Ahmad *et. al,* (2006)** found that, feeding just after moulting showed highest performance than increased of feeding interval after $3^{rd}$ moulting for the larval weight, length and breadth at both 4th and 5th instar larva.

Maximum leaf is consumed during $5^{th}$ instar only. During this stage only the maximum growth of silk gland can be noticed. It is estimated that 50% of the total weight will be increased in the $5^{th}$ instar itself, **Ito (1967**).

More number of feedings are given during summer since moisture content in the leaf will not be sufficient during summer and leaves will dry very easily.

**6) Mounting:**

At this stage silkworm becomes matured completely and ready to spin into cocoon. These silk worms after 5 days of $4^{th}$ moult becomes yellowish and translucent, stops feeding on mulberry leaves, starts to search for a corner and try to crawl on the feeding trays further liquid like substance oozes out of the mouth from the spinneret. These movements clearly indicate to transfer the mature larvae into the mountages. **Dingle, *et. al.* (2005).**

Transferring of matured silkworm on to the mountage or cocoon frames is called "mounting". This is an important and skilled operation. Any deviation in identification of maturity of worms adversely effect on cocooning.

During mounting though, selection of ripen worms is not a difficult task, but, due care is needed. Most of rearers pick up ripen worms with hands to transfer them on to mountage. However this is laborious and due care is needed while handling the mature worms. A few rearers use rearing nets, in some parts, rearers use mulberry branches to separate the matured worms. As the matured worms stop feeding they crawl on to the twigs searching for a support to spin the cocoon.

During mounting care should be taken to use the right type of chandrike in convenient size and shape. There are different types of chandrike that are used for the purpose of mounting.

1. Plastic mountage
2. Bamboo made chandrike
3. Straw mountage
4. Bottle brush
5. Revolving mountage, etc.

These are used as supports for the silkworms to spin cocoons. In India they are made of bamboo usually 1.8m long and 1.2m wide. Over a mat base, tapes 5-6cm wide woven out of bamboo are fixed in the form of spirals leaving a gap of 5-6 cm . They are also called chandrikes . In Japan mountages called revolving mountages or turning cocooning frames are used. **Krishnawami, *et. al.*,(1979a) and Hussein(1997).**

In our country most of rearers use casuarina branches as mountages, while in U.S.S.R. brush-type local weeds are used as mountages and are placed in the rearing beds for the worms to crawl up on and spin the cocoons. **Hussein (1997 & 2005)**.

### 7) Cocooning:

The matured silkworm spins the outer protective covering called cocoon and remains in dormant stage inside as pupa.

After mounting the ripen worms in chandrike the larvae sticks on to the mountage by oozing out the silk fluid which will harden immediately after coming in contact with air and sticks itself to the mountage. It starts to ooz out the silk by continuous movement of its head in a very specific manner to form the silk filament in the shape of arithmetic.

During the spinning process, a silkworm larva spins a cocoon around itself for 48-72 hours. They takes 4 – 5 days to finish their cocoon spinning and hardening of the cocoons, depending upon the silkworm strain and climatic conditions provided. **Krishnawami *et. al.* (1979b) and Dingle *et. al.* (2005).**

The Cocoon will have three layers.

a. Outer floss

b. Middle compact layers

c. Inner pelade

The outer floss layer which will be 8-10% of weight of cocoon though formed of a continuous filament, is not reelable. The floss percentage varies from race to race. The middle order compact layer only is reelable and is a continuous filament easily reelable and the inner pelade layer is not reeled. **Krishnawami *et. al.* (1979b)**

**8) Harvesting of Cocoons:**

Harvesting of cocoons is done on the fifth day of spinning. Whereas seed cocoons should be harvested on eighth day or ninth day of spinning depending upon atmospheric temperature. . They were cleaned from attached flosses (upper layer of loose silk) by hand and then kept in a separate plastic container. **Dingle *et. al.* (2005).**

Harvesting should not be done immediately after pupation. Further, harvesting should be done before the moth emerges out. Too many days delay in harvesting will result in formation of pierced cocoons due to emergence of adult moth. **Krishnawami *et. al.* (1979a).**

**9) Stifling and Conditioning of Cocoons :**

This is the last stage of rearing process. Cocoons in their fresh condition with the pupae alive in them cannot be stored for a long time as the living pupae are soon transformed into moths, generally within 8-10 days in a warm climate and 10-12 days in very cold climate, which emerge from the cocoons by piercing the shell through one end. Cocoons from which moths have emerged are called pierced cocoons. They are useless for reeling raw silk because the continuity of the bave in them is broken. Reeling cocoons, therefore, have to be subjected to a process of stifling with the object of killing the pupae inside without in anyway interfering with the structure of the silk shell around it. Cocoons can be stifled by several methods but the popular methods in reeling industry are:

- Sun drying.
- Steam stifling.
- Hot air conditioning.

Although sun drying is simple and cheap, it is not suitable for modern reeling, and also steam stifling only kills the pupa inside and does not dry it. Therefore, in the sericulturaly advanced countries, stifling of cocoons by steam has been largely replaced by hot air which also dries the stifled cocoons, in all the modern silk reeling factories. This method of stifling and drying the cocoons is known as hot air conditioning. Hot air conditioning is carried out in chambers of special design for a required period with the object of killing the pupae and drying it either fully or partially to the desired degree of dryness. **Krishnawami *et. al.* (1979b)**.

**Economic facts & Market Study**

Global **silk** production rose from around 100 000 tonnes in 2000 to 150 000 tonnes in 2006, Silk is a traditional Asian agricultural product, and the Asian regions are the primary supplier of silk to the world. Among all silk producing countries China produces about 70% of the world's **silk**, followed by Brazil, India, Thailand and Viet Nam, with minor production in Turkmenistan and Uzbekistan. India, Italy and Japan are the main importers of raw **silk** for processing. The unit price for raw **silk** is around twenty times that of raw cotton.

From the data presented in Tables number 3,4,5 we can study the trends of the world production from fresh cocoons and raw silk during the period of 2001-2006 and its foreign trade.

**Table 3: Fresh cocoons production in the world (tones) during 2001-2007**

| COUNTRY | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|
| **Brazil** | 9916 | 10238 | 9966 | 8005 | 7146 | 8051 | 8617 |
| **Bulgaria** | 52 | 50 | 0.3 | | 42 | 65 | 55 |
| **Cambodia** | 11 | | | | | | |
| **China** | 512700 | 560000 | 480000 | 547100 | 584220 | | 683381 |
| **Colombia** | 67 | 0 | | | | | |
| **Egypt** | 15 | 14 | 0 | | 7.9 | 8.2 | 14 |
| **Georgia** | | | | | | 3.1 | |
| **Greece** | 40 | 60 | 60 | 70 | 70 | 100 | 104 |
| **India** | 126136 | 139700 | 129948 | 120027 | 126261 | 135462 | |
| **Indonesia** | 749 | 691 | | | | | |
| **Iran** | 5000 | 3500 | 3200 | | 2543 | | 1665 |
| **Italy** | 1 | | 1 | 3.5 | 3 | - | 6 |
| **Japan** | 1031 | 880 | 776 | 683 | 626 | 505 | 433 |
| **Korea S.** | | | 3.3 | 3.4 | | | |
| **Madagascar** | | 106 | | | | | |
| **Philippe** | 17 | 28 | 23 | 22 | 14.4 | 16 | 9 |
| **Romania** | 2 | 3 | 3 | 4 | 4 | 4 | 4 |
| **Syria** | | | 15 | 11.5 | 5.5 | 3 | 2.5 |
| **Thailand** | 3473 | | 10500 | 10650 | | 10100 | 1785 |
| **Turkey** | 47 | 100 | 169 | | 170 | 350 | 130 |
| **Vietnam** | 22000 | 21000 | | | | | |
| **Total** | **681239** | **736370** | **634664.6** | **686579.4** | **721112.8** | **1546673** | **696205.5** |

Source: http://www.inserco.org/uk/Freshcocoonsproductionfrom2007.php

Exports Raw silk
*Brazil : including thrown silk (454 t for 2005 / 392 t for 2006 / 241 t for 2007)
* Italy : plus 532 t of thrown silk
Imports Raw silk
* Italy : plus 2559 t of thrown silk

Many developing countries of the regions are, therefore, undertaking intensive efforts to rehabilitate their skill industries, while some have recently embarked upon sericulture for the first time. Natural silk is one of the finest natural fibers. It has been enjoying a growing world demand from consumers of different classes, backgrounds, and concerns.

Newly introduced countries in the natural silk production are advised, as a first step, to fabricate locally produced silk into goods that are directed towards the domestic market to avoid sever competition in the world market from major silk producing countries such as China, Japan, Indonesia and South Korea. Most of the local production of natural silk in Egypt is produced using traditional techniques. However, with developing advanced techniques of producing silk by the Silk Research Department of the ARC, investors, coops, and agencies started to carry out silk production projects. Silk production could be efficiently carried out on a small scale basis best fits with rural women, young graduates and small investors, which in turn will significantly increase production quantity and quality, and job opportunities, contributing considerably to the well being of rural people.

Good market was identified for natural silk. Silk farm outputs are either sold in the form of cocoon or raw silk. Another by-product was identified which is the dry leaves. Egypt produces just 4 tones of raw silk annually, while it consumes as mush as 250 tones a year, apparently there is good room for expansion this valuable industry.

## 6. Financial Analysis

This section analyzes the financial performance of natural silk project that could be established in the desert land. In more detail, this study estimates the following financial indicators: Net Current Value (NCV) of net profits, Revenues, Costs, Annual Nominal Profits, Benefit-Cost Ratio (B/C ratio), Internal Rate of Return (IRR), and simple Recovery Period (RP). In addition, sensitivity analysis is conducted to assess the impacts of potential changes in costs, revenues, and land cost on project's profitability.

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

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

Thus, the assumed project consists of two major parts, cultivating mulberry and rearing silk worms. As for the mulberry cultivation, 7,000 seedlings are cultivated in a feddan, and to be irrigated by a drip system. A feddan gives as high as 14 tones/harvest with a total of three harvests a year. As for the other part of the project, silk warms are reared in twp places. At early stages, eggs are kept in a separate air conditioned room apart from the greenhouse. It accommodates the first three stages of the life circle of silk worms. The last two stages are reared in a fully equipped greenhouse with a size of 9*60 meter.

As for yield, five eggs boxes could be reared five times a year on a five-feddan unit. Returns and costs are all primary data. Further income could be gained if mulberry leaves are dried and exported at 4 LE/kg.

Sizable markets were identified for the project. The financial analysis of this enterprise is to be examined in the rest of this section.

Projects are based on 5-feddan units. Assuming relatively small scale size of projects is based on our recognition of the importance of the small scale-investors class.

Lands are priced at 5,000 LE/feddan to cover the total cost of reclamation. As regards to finance,1:1 Dept: Equity ratio is assumed to be secured by a 7% interest rate, 5-year term loan . Discounted rate is assumed to be range between 7% 18%. Replacement costs are assumed according to projected economic life of fixed capital assets. Each five-feddan unit is assumed to be irrigated using drip irrigation system with a total cost of 3,000 LE.

The selected profitability indicators were determined according to Hypothesis of non-inflationary markets.

**Parameters (Investment and production costs):**

For conducting the project financial analysis, investment and production costs were calculated and shown in Tables 6, 7, 8, 9, 10.

**Table (6): Investment costs for the natural silk project, mulberry cultivation and rearing silk worms (LE)**

| Items | Value |
|---|---|
| **First: Mulberry cultivation (5 feddans)** | |
| Digging holes and planting seedlings | 3000 |
| Mulberry seedlings | 52000 |
| Mother seedlings | 3750 |
| Irrigation system | 15000 |
| Land cost | 45000 |
| Operating capital for mulberry cultivation | 6500 |
| **Subtotal** | **125250** |
| **Second: rearing silk worms** | |
| Hatching room and rearing small stages | 10000 |
| 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 | 10000 |
| Rearing materials | 11970 |
| Fabrics | 1080 |
| Thermometer | 150 |
| Rearing trays | 8000 |
| Silk wiper removal machine | 5000 |
| Leaves cutting machine | 1000 |
| Water pump | 3500 |
| Italian sprayer | 6500 |
| Trolley | 2000 |
| **Subtotal** | **104340** |
| **Total** | **229590** |

Source :(1) Authors, based on data provided by the Mulberry Silkworm Breeders consulted, 2007 price.

(2) Authors, based on consultations with experts

**Table (7): Operating capital for mulberry cultivation (LE/ 5-feddans)**

| Item | Value |
|---|---|
| Grafting expenses | 1000 |
| Make up seedlings | 500 |
| Irrigation | 2000 |
| Super phosphate | 600 |
| Ammonium Nitrate | 400 |
| Organic fertilizers | 2000 |
| **Total** | **6500** |

Source: Authors, based on data provided by the Mulberry Silkworm Breeders consulted, 2007 price.

**Table (8): Operating capital for rearing 25 eggs boxes of silk worms, one run (LE)**

| Item | Cost |
|---|---|
| 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** |

Source: Authors, based on data provided by the Mulberry Silkworm Breeders consulted, 2007 price.

**Table (9): Annual operating expenses of growing mulberry for years beyond the first year, LE/feddan**

| Items | Value |
|---|---|
| Fertilizers | 1840 |
| Organic fertilizers | 400 |
| Irrigation | 500 |
| Weeding | 800 |
| Pesticides | 300 |
| **Total** | **3840** |

Source: Authors, based on data provided by the Mulberry Silkworm Breeders consulted, 2007 price.

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 (10): Revenues of one run of 25 eggs boxes of silk worms (LE)**

| **Item** | **Value** |
|---|---|
| - 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 4 LE/kg creating other source of income

## Results

### Financial Feasibility

The financial feasibility for natural silk project and possibly marketable was examined. As presented in tables numbers (11), (12), the following results were obtained:

The financial analysis of the natural silk production in case of a 7% interest rate, 5-year term loan shows high positive net current value over the twenty years project life in all cases of different discount rates, and high low ratio of benefits to costs, and an accepted IRR also short bay back period comparing with the project without loan. Values of the previous indicators evidently present profitability perspective.

**Table (11): Financial performance of natural silk project with loan**

| **Indicator** | **Natural silk project** | |
|---|---|---|
| | **IRR** | **46.96%** |
| | **Recovery Period** | **2.3** |
| **Discount rate** | **NCV** | **B / C** |
| 7 % | 573608 | 1.65 |
| 10% | 420236 | 1.56 |
| 13% | 312776 | 1.48 |
| 15% | 258633 | 1.44 |
| 18% | 195874 | 1.37 |

Source: Calculated by the outher for data in tables 6, 7, 8, 9, and 10

**Table (12): Financial performance of natural silk project without loan**

| Indicator | Natural silk project | |
|---|---|---|
| | IRR | 27.315% |
| | Recovery Period | 3.6 |
| **Discount rate** | **NCV** | **B / C** |
| 7 % | 496113 | 1.58 |
| 10% | 340761 | 1.47 |
| 13% | 231829 | 1.37 |
| 15% | 176941 | 1.31 |
| 18% | 113364 | 1.22 |

Source: Calculated by the outher for data in tables 6, 7, 8, 9, and 10

**Sensitivity Analysis:**

We need to consider, at least, other possible market scenarios which might determine variations in prices. In this context, at least, we shall abandon our previously established assumption of a context of certainty. The wisest course would be to perform sensitivity analysis. Doing so will enable us to determine clearly the effects that this might have in terms of variations in profitability, and variations in receipts and payments. Though, the project is low sensitive to changes in payments and receipts, as presented in tables numbers (13), (14) the average elasticity of IRR was -0.25 %, when we make variations in payments, that means a 5 % increase in payment will cause 25 % decrease in IRR of the project, and when we make a variations in receipts the average elasticity of IRR was 0.29 %, that means a 5 % increase in receipts will raise the IRR of the project by 25 %.

**Table (13): Sensitivity analysis for Natural Silk project when variations in payments.**

| payments | % change payments | IRR | % variation IRR | Elasticity |
|---|---|---|---|---|
| 80 | -20 | 59.30 | 26.27 | 1.31 |
| 85 | -15 | 56.08 | 19.42 | 1.29 |
| 90 | -10 | 52.96 | 12.77 | 1.28 |
| 95 | -5 | 49.92 | 6.30 | 1.26 |
| 100 | 0 | 46.96 | 0 | 0.00 |
| 105 | 5 | 42.08 | -10.39 | -2.07 |
| 110 | 10 | 38.30 | -16.31 | -1.84 |
| 115 | 15 | 34.58 | -26.36 | -1.75 |
| 120 | 20 | 30.96 | -34.07 | -1.70 |
| **Average elasticity** | | | | **-0.25** |

Source: Calculated by the outher for data in tables 6, 7, 8, 9, and 10

**Table (14): Sensitivity analysis for Natural Silk project when variations in receipts .**

| Receipts | % change receipts | IRR | % variation IRR | Elasticity |
|---|---|---|---|---|
| 80 | -20 | 24.47 | -47.89 | -2.39 |
| 85 | -15 | 29.45 | -37.28 | -2.49 |
| 90 | -10 | 34.80 | -25.89 | -2.59 |
| 95 | -5 | 40.61 | -13.52 | -2.70 |
| 100 | 0 | 46.96 | 0 | 0.00 |
| 105 | 5 | 53.92 | 14.82 | 2.96 |
| 110 | 10 | 61.58 | 31.13 | 3.11 |
| 115 | 15 | 70.05 | 49.16 | 3.28 |
| 120 | 20 | 79.45 | 69.18 | 3.46 |
| **Average elasticity** | | | | **0.29** |

Source: Calculated by the outher for data in tables 6, 7, 8, 9, and 10

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## الملخص العربى

## دراسة الجدوى الاقتصادية لإنتاج الحرير تحت الظروف المصرية

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يعتبر إنتاج الحرير الطبيعي من أهم الأنشطة الزراعية الصناعية التي تحقق للمنتج قيمة مضافة مرتفعة، هذا فضلاً عن أنها من الأنشطة كثيفة العمالة ، و على الرغم من تلك الأهمية،إلا ان إجمالي استهلاك الحرير الطبيعي فى مصر يفوق الإنتاج المحلى، لذا ينبغي إلقاء مزيد من الضوء والاهتمام على مشروعات إنتاج الحرير الطبيعي فى مصر.

وحيث إن إنتاج الحرير الطبيعي من المشروعات ذات التكلفة الاستثمارية العالية التي تحتاج الى دراسات جدوى اقتصادية قبل القيام بها ،هذا بالإضافة إلى قلة الأبحاث التي أجريت فى هذا المجال فان تلك الدراسة تهدف إلى :إلقاء الضوء على الجوانب الفنية الخاصة بتربية دودة القز وإنتاج الشرانق من ناحية، وتقدير مؤشرات الجدوى المالية لهذة المشروعات من ناحية أخرى،هذا بالإضافة إلى تحليل حساسية تلك المشروعات وتحديد قدرتها على الاستمرار فى ظل ظروف عدم التأكد أو اللايقين.

وقد اتضح من استعراض نتائج التقييم المالي لمشروع إنتاج شرانق الحرير الطبيعي ووفقا للمعايير المستخدمة فى الدراسة، إن المشروع فى حالة وجود قرض تمثل قيمته حوالي 50% من قيمة التكاليف الاستثمارية للمشروع يعتبر أفضل من الاستثمار فى حالة عدم وجود قرض.

كما تبين إنة وفقا للافتراضات التي تمت على أساسها الدراسة إن صافى القيمة الحالية للمشروع موجبة عند مختلف أسعار الخصم المستخدمة في التحليل، بالإضافة إلى أن نسبة العائد الى التكاليف اكبر من الواحد الصحيح فى جميع الحالات الأمر الذى يدل على الجدوى المالية من أقامة تلك المشروعات .

كما تبين أنة وفقاً لاختبار تحليل الحساسية للمشروع انخفاض حساسية المشروع للعوامل او الظروف التي يمكن أن تؤدى إلى انخفاض الإيرادات أو ارتفاع التكاليف.