

**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

**RE- DESIGN AND CONSTRUCTION OF A MANUALLY PEDAL
OPERATED COCOON DEFLOSSING MACHINE**

BY

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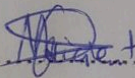
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ABSTRACT

Deflossing of cocoons means removing rough silk enveloping silkworm cocoons so as to make them clean. This increase their quality and prices in the market. Cocoons are used to produce silk yarns in textile industries. Sericulture is the activity of rearing silkworms and production of silk fibers from them. Removing floss by hands is time consuming and tiresome, automatically power operated cocoon deflossing machine can defloss high amounts of cocoons but are expensive to buy. A manually handle operated cocoon deflossing machine is cheap but some portion of reelable silk go as waste. Therefore the objective of this study was to design and construct a manually pedal operated cocoon deflossing machine aimed at addressing all the above problems. The design of the various machine parts was carried out by analyzing forces acting on them. Force analysis led to selection of proper materials to withstand the forces to avoid failure. Mild steel of various sizes and grades were used especially for the frame and low carbon steel used for the shaft. The engineering drawings of the various components were drawn before the various components were constructed. The different parts of the prototype were fabricated and the assembled. A fully functional prototype resulted after all the above operations. Testing of the prototype was carried out and the figures revealed that the machine had an efficiency of 79.6% and a deflossing capacity of 15kg/hour. The relevant literature to assist in the problem solving as well as the necessary design specifications, and equations plus the used references, and budget required for completion of the project are also inclusive in this report

DECLARATION

I MUWONGE VICIENT hereby declare to the best of my knowledge that this is my true and original piece of work and has never been submitted to any university or higher institution of learning by anybody for any academic award.

Signature 

Date 23/05/2016

APPROVAL

This project report is submitted to the Faculty of Engineering of Busitema University in partial fulfillment of the requirements for the award of a of Bachelors' degree in Textile Engineering with the approval of the following supervisors:

1. Mr. Mudanya Johnson

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DEDICATION

I dedicate this report to my mother; Ms. Nansiiti Sarah who have raised me up, educated me since nursery, given me financial assistance, parental guidance and counseling plus encouragement in all my academic endeavors.

I also dedicate it to my brothers; Ssekajjigo Paul, Lubega Dick john, Kizito Peter Clever, Kitonsa Isaac Joy and Uncle Kanonya Fred.

LIST OF ABBREVIATIONS

ADP- After Death

USA- For example

LIST OF ACRONYMS

NARO- National Agriculture Research Organization

UEPB-Uganda Export Promotion Board

FAO- Food and Agriculture Organization

CAD- Computer Aided Design

USIL-Uganda Silk Industries Limited

KASIKA-Kawanda Silk Craft Association

USPA- Uganda Silk Producers Association

LIST OF ABBREVIATIONS

AD- After Death

E.G- For example

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Development of cocoon rearing technology and silk rearing systems in the silk sector. This process is highly and is used to produce silk yarns in traditional by hand.

Silk rearing is a part of every day in Uganda due to the fact that people have a great interest in silk rearing. It was introduced by early 1900s when silk rearing was introduced through districts of Mukono, Masaka, Karamoja, Iganga, Jinja and others. This was under the support of IAEA, FAO and UNFA in collaboration with the Ministry of Agriculture. (DEPA, 2007) Rearing is a good source of income and needs a few facilities like a rearing house and the silkworm rearing guides to be provided. This has increased an export production which quality needs to be increased before they are taken to the market by removing their silkworms. (Appendix A, 200)

The silkworms are reared at the end of their fourth stage and start on to the fifth stage which is the final stage. After reaching a good size, they start to create cocooning shell and spinning 300 to 500 m of a single silk thread which is three days. (Karama, 2007) To make the silk filament suitable for rearing the silk rearing step the natural process is to take the cocoon from the spinning stage and drying them before the moth emerge. (Appendix A, 200)

Rearing is the activity of raising silkworms and production of silk from their cocoons. While rearing they eat a high silk rearing a silkworm's cocoon which has to be harvested from the cocoon after rearing process. This silk is then reeled and woven to form silk fabrics and textiles. (Appendix A, 200)

Rearing of silkworms is a very important activity. A new silkworm rearing process of 2000 per hectare (2000 silkworms) by using a cocoon by hand. This has produced silk which is used in various ways. (Appendix A, 200)

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Deflossing of cocoons means removing rough silk enveloping silkworm cocoons so as to make them clean. This increase their quality and prices in the market. Cocoons are used to produce silk yarns in textile industries by reeling process.

Sericulture industry is growing every day in Uganda due to the fact that people have a great interest in silk worm rearing. It was introduced by early 1990s where different farmers associations were formed in districts like kampala, Bushenyi, Mukono, Kanungu, Mbarara, Luweero and others. This was under the support of USIL, KASICA and USPA in collaboration with JICA to promote the sericulture activities. (UEPB, 2000) Sericulture is a good source of money and needs a few facilities like a rearing house and the mulberry leaves garden to be carried out. This has increased on cocoon production whose quality needs to be increased before they are taken to the market by removing floss from them. (Appendix A, 2003)

The silk worms stop eating at the end of their fourth stage and climb on to the heather spinning trays with holes. After securing a good grip, each worm spins its cocoon covering itself and producing 800 to 1500 m of a single silk thread in two or three days. (Kimura, S. et al., 1964) To make the silk filament suitable for trading the silk farmers stop the natural process by harvesting the cocoon from the spinning trays and sorting them before the moth comes out. (Pierrette Blin postcard, 2001)

Sericulture is the activity of rearing silkworms and production of silk fibers from them. While cocoon floss is the rough silk enveloping a silkworm's cocoon which has to be removed from the cocoons prior to reeling process. Floss silk is then carded and woven to sew rustic clothes and blankets. (S. P. Nandy, 2002)

Removing of cocoon floss is a very tiresome work. A man can defloss cocoons at an average of 2-3 kg per hour (10-12 kg per day) by using a stick or by hands. This low production rate wastes time and is tiresome. (Fatima S. Rodriguez, 2004)

The power operated cocoon deflossing machine can defloss 60-70 kg of cocoons per hour. However, the machine is expensive compared to a pedaling cocoon deflossing machine. It also needs power which some areas in Uganda carrying out silkworm rearing activity lack hence unsuitable for the local cocoon producers. (*Indian Silk, 2003*)

The automatically operated cocoon deflossing machine can defloss about 5kg per hour operating for 6 hours in a day making it about 30 kg per day. This production is lower than what pedal operated deflossing machine can produce. It uses power of about 19.2 watts per day. (*Madrid, A. E. 1996*) this is expensive to the local farmers in the villages where there is no power.

A manually handle operated cocoon deflossing machine can defloss 7-10 kg of cocoons per hour which is approximately. 60-80 kg of floss per day, but some portion of reelable silk goes as waste and it also needs two people to operate it. (*Commercial worm farming, 2003*)

To increase cocoon production output, a manually pedal operated cocoon deflossing machine is hereby proposed which will increase the comfort of the operator. It will have a larger working surface than a handle operated cocoon deflossing machine and a person can operate it by using both the hands by rotating the pedal manually or pedaling with legs. It also has a provision for the handle in case of disabled people and some women who cannot pedal. It is cheaper than the motorized and automatic machines due to few components. It does not require the use of power as compared to the automatic deflossers hence it will be adopted by local silkworm farmers most of whom lack electricity. The machine will also have familiar technology and hence easy to maintain. It will be estimated to deflose 50kg of cocoons and above per hour. The machine will be operated by two people to achieve this high output where one will be pedaling and the other one feeding, stirring and removing deflossed cocoons. One person will be able to operate it in case of low amount of cocoons to be deflossed where he/ she will be relaxing during loading and removing of cocoons from deflossing area.

The cocoons are deflossed for sorting, assessment of quality and easy emergence of the moths for egg production besides reeling purpose. Deflossed cocoons have good steaming effect in terms of reeling efficiency which helps in better cooking. (*Song, K.E., Lee, Y.W. and Choe, B.H. 1973*).

1.2 Problem statement

Cocoon floss removal is a tedious process and if not done correctly, it affects the quality and thus the price of cocoons in the market. (Fatima S. Rodriguez, 2013). In Uganda hand-sticks are used to defloss their cocoons. This has low output. They also use of fire flames to slightly burn off the floss from the cocoon. This can easily damage the yarns. Hand operated cocoon deflossers is of a low output capacity due to the small working area yet a lot of energy is needed to be operate. The automatic cocoon deflossing machines which are available on market are expensive and need electric power to be operated.

Therefore there is need for a simple and manually pedal operated cocoon deflossing machine that will be used by silk farmers in Uganda in order to meet industry demand on cocoon products.

1.3 Purpose of the study

The purpose of the study is to develop an effective and sustainable means of solving the problem of cocoon floss removal by designing a low cost, manually pedal operated cocoon deflossing machine. This study is geared to generating a sustainable solution to the fluctuating production of cocoons in Uganda which has been reported as being due to discouragement among the farmers because of little net income from flossed cocoons.

1.4 Objectives

1.4.1 Main objective

To design and construct a manually pedal operated cocoon deflossing machine.

1.4.2 Specific objectives.

1. To design the components of the cocoon deflossing machine.
2. To select suitable materials for the construction of the prototype of the machine.
3. To fabricate and assemble the machine.
4. To test the operation of the machine.
5. To carry out economic analysis.

1.5 Justification

The pedal operated cocoon deflossing machine has a higher output as compared to a hand operated and other local cocoon deflossing methods used in Uganda. It can defloss atleast 15kg/hour. The design of the intended machine also has an improved on the comfort-ability and safety of the operator. The technology used is familiar hence needs no skills and people will be able to operate it for long hours without getting tired as compared to a manually handle deflossing machine. It is also cheaper as compared to the motorized deflosser since it is made of slightly few components and cheaper raw materials hence it can be affordable to low income earners. It involve very low maintenance costs and maintenance expertise is readily available even among local communities. The person is able to defloss using hands in case he or she gets tired of using legs by removing the driven sprocket from the driver pulley and replaces it with the handle. The deflossing machine has increased the efficiency, effectiveness of cocoon deflossing and the quality of cocoons produced in Uganda.

1.6 Scope

The project coverage includes; the designing, constructing and testing a machine. It also covers Operating instructions, safety precautions, recommendations for possible improvements and future development is also provided.

REFERENCES

- A, A., 2003 . *Kahihi Silk Farmers Association Sericulture Project*. Uganda: s.n.
- AR, 1981. *Studies of steaming effect on deflossed and undeflossed cocoons*. 1st ed. s.l.:s.n.
- Auyzawa, C. e., 1972. *Handbook of silk worm processing*. 2nd ed. Japan: Fuji publishing Co. Ltd.
- Budynas–Nisbett, 2006. *Shigley's Mechanical Engineering Design*. Eighth ed. s.l.:McGraw- Hill.
- Choe, B. H., n.d. *The outline of natural silk processing*. third edition ed. Republic of Korea: Korea Silk Engineering Society.
- Choe, n., 1973. *The outline of natural silk processing*. Republic of Korea : Korea Silk Engineering Society.
- D, C. W., 1994. *Materials Science and Engineering: An introduction* Third Inc. ed. Newyork: John Wiley & sons.
- E., M. A., 1996. *Modification and Performance Evaluation of a cocoon deflossing machines*. Don Mariano Memorial State Univerity SRDI: s.n.
- FAO., 1972. *Manual on Sericulture*. vol 3 ed. s.l.:Silk Reeling Agricultural Services Bulletin No. 72/3.
- FAO, 2011. *silk reeling and testing manual*. REPUBLIC OF KOREA: Yong Woo Lee.
- J.K, K. R. a. G., 2005. *Text book on Machine Design*. 14th ed. s.l.:EURASIA publishing house (PVT) LTD.
- JAICAF, 2007. Summary Report to the Ministry of Agricul- ture, Land and Fisheries.. *Sericulture in East Africa*.
- Joubert, K. D. D. a. S., 2011. *Doubts on progress and technology. The short short history of early pedal powered machines*. First ed. s.l.:s.n.
- Lukose, L., December, 2013. *Digital Marketing Stragies for online sucess*. s.l.:s.n.
- Mahar, R. R., 2015. *chemistry of textile fibers*. 2nd ed. s.l.:s.n.
- Mysore, September 2003. *Indian Silk, Handout of CSR&TI*. s.l.:s.n.

- Nandy, S. P., 2002. *sericulture mannual, standards and procedures*. Guwahatti: directorate of sericulture.
- Nisbett, S. J. a. B.-., 1989. *Mechanical Engineering Design*. 8th ed. s.l.:McGraw Hill Publication.
- Rodriguez, F. S., 2004. Design, Fabrication and evaluation of cocoon Deflossing machine. *E International Scientific Research Journal*, i(1), p. 30.
- Tech, P., 1989. *Faculty of Mechanical Engineering*. 8 ISBN ed. Coimbatore, India: Poolamedu Sathankulam Govindsamy Naidu College of Technology [PSG Tech] DPV Printers.
- Tressler, D. a. J. M., 1961. *Fruit and Vegetable Juice Technology*.. Westport, Connecticut: AVI Publishing Company Inc., .
- V.B, B., 2007. *Introduction to machine design*. 8th ed. s.l.: Tata McGraw Hill publishing company limited.
- Khurmi R.S. and Gupta J.K., 2003 *Text book on Machine Design, 14th Edition*, EURASIA Publishing House (PVT) LTD
- Kris De Decker and Shameez Joubert, 2011. Doubts on progress and technology. The short history of early pedal powered machines.
- Shigley J.E and Budynas–Nisbett, *Mechanical Engineering Design*, McGraw Hill Publication, 8th Edition. 1989.
- William G. Sullivan, Elin M. Wicks and C. Patrick Koelling (2008): *Engineering Economy*, 14th Edition. Prentice Hall.