SERICULTURE IN EAST AFRICA

JAICAF

Japan Association for
International Collaboration of
Agriculture and Forestry

March 2007

Foreword

In accordance with the "Development Initiative" announced by the Japanese Government at the December 2005 WTO Hong Kong Ministerial Conference, the Ministry of Agriculture, Forestry and Fisheries of Japan has created the "Development Initiative by Ministry of Agriculture, Forestry and Fisheries." This initiative is to provide assistance to developing countries not only by production promotion, but also in the fields of processing, distribution and sales, and the training of human resources by south-south cooperation, and focuses on the creation of salable agricultural products. In order to contribute to the promotion of this development initiative, JAICAF, Japan Association for International Collaboration of Agriculture and Forestry has conducted a research and study project to collect, analyze and provide related information to Least Developed Countries (LDC). In 2006 Fiscal Year, sericulture in East Africa was raised as part of it.

This report summarizes current conditions of sericulture in East Africa, with the aim of providing basic data to be considered in the African development cooperation. We hope this information proves to be helpful to those concerned.

We wish to express our gratitude to Editor in chief of the report, Dr. Kiyoshi Kawakami, former team leader of The Project for Promotion of Popularizing Practical Bivoltine Sericulture Technology (1997-2002) of JICA, and authors, Mr. Akio Yamaguchi, former JICA long term expert of The Project for Strengthening Extension System for Bivoltine Sericulture in India (2002-2005), Dr. Kunikatsu Hamano, Professor, International Environmental and Agricultural Sciences, Graduate School of Agriculture, Tokyo University of Agriculture and Technology, with a doctorate in International Environment Agricultural Science, Dr. Kazuo Hanzawa, Professor, Department of International Development Studies, College of Bioresource Sciences, Nihon University, and Mr. Hiroshi Takasawa, Expert, Japan Association for International Collaboration of Agriculture and Forestry, for writing this report at our request. We also greatly appreciate the cooperation of all persons concerned the Embassy of Japan in Uganda, JICA (headquarters, Kenya Office and Uganda Office), JICA experts and Uganda Governments, and ICIPE related personnel during the on-site survey.

The view expressed in the report are those of the JAICAF and do not necessarily reflect those by the Japanese Government.

March 2007

Japan Association for International Collaboration of Agriculture and Forestry
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1. Agriculture in East Africa

East Africa faces the Indian Ocean and is mostly comprised of wet savanna. The cultivated area in East Africa is approximately 19% of all of the Sub-Sahara, which is approximately 0.4ha arable acreage per person. However, the average in East Africa is said to be much lower than the average in all Sub-Sahara. In recent years, Africa as a whole has been experiencing increased land pressure due to population growth, and unlike global trends, grain production per person has decreased. Also, human population pressure has led to agricultural land expansion through deforestation, hastening global warming.

Although cotton, coffee, and tea have been exported traditionally, agriculture in the countries of East Africa mainly consists of subsistence farming. However horticulture products, such as flowers and ornamental plants, and vegetables, have rapidly increased in recent years as non-traditional export products. Expectations are also high for sericulture as a new non-traditional export product which can contribute to the improvement in the income of farmers, including small-scale farmers and farmers in frontier areas.

2. What is sericulture industry?

The sericulture industry entails everything from cocoon and raw silk production and business transactions by various processes, such as breeding and maintenance of silkworm races, mulberry breeding and cultivation, silkworm egg production, silkworm rearing and mounting, cocoon drying, silk reeling, raw silk testing, to the production of silk products by manufacturing and weaving, as well as the silk thread and silk industry. The sericulture industry requires much technology and a certain level of investment, and the linkages of a large variety of related businesses.

As such, in order to work a sericulture production, organizations and traders who will purchase cocoons produced by sericulture farmers are needed. In other words, before silkworm rearing at sericulture farms can be established, silk reeling companies and brokers to purchase the cocoons are prerequisites. Silk reeling companies must manufacture raw silk of the quality and the price demanded by process manufacturers of the textile industry that use raw silk. In turn, in order to build a silk reeling business, these process manufacturers who will purchase the raw silk and produce silk products for domestic and international demands are needed.

A well-established relationship of supply and demand from downstream to upstream, from processed products and sales to sericulture farmers, based on both domestic and international consumption needs, and that can cooperate towards

operations growth, is major premise for the establishment of sericulture and silk reeling industry. Domestic demand is especially needed. Since cocoons and raw silk must face competition in the international free market, domestic demand is initially important in order to endure the competition. In particular, a unique domestic demand with historical and ethnic characteristics is an important factor for the sericulture industry and its development.

3. Current conditions of the sericulture industry in East Africa

As defined by the African Development Bank, 11 countries constitute East Africa-Comoros, Djibouti, Eritrea, Federal Democratic Republic of Ethiopia, Republic of Kenya, Republic of Madagascar, Mauritius, Republic of Seychelles, Somalia Democratic Republic, United Republic of Tanzania, and Republic of Uganda.

Among these countries, production of cocoons and silk thread from silkworms occurs in Ethiopia, Kenya, Madagascar, and Uganda, and production of cocoons and silk using wild silk insects (wild silkworms) is also performed. However, their operations are in the extremely immature phase and cocoons and silk as materials for traditional handcrafts are poorly supplied to the local market. Although a small amount of wild cocoons or silk thread was exported from Uganda to India and Japan in the past, exports to the overseas market have ceased. Sericulture in East Africa has a history of more than 30 years, but actual conditions in each country have not been successful because sericulture and silk reeling technologies are immature and the market cannot be secured.

Wild silkworms have been traditionally used for many years. However, productivity and product quality is low and the market is limited, so such production has not grown even as local industry. Ethiopia is the only country to export wild silk products to the overseas market.

Currently, International Centre of Insect Physiology and Ecology (ICIPE, Nairobi, Kenya) is playing a central role in sericulture development in Africa. ICIPE is conducting research and introduction of technologies to farmers in Africa and training for representatives of each government and farmers. ICIPE also have been provided technical support to farmers' groups in each country to reach sustainable sericulture development

4. Summary of the on-site survey of sericulture and raw silk production

Results of the survey carried out in August 2006 in Kenya, Uganda and Ethiopia are described here.

If the goal of sericulture is to eradicate poverty, low-cost sericulture by rearing methods adjusted to the economical and technical conditions of local farmers is desired, even though the quality of cocoon may be lower. However, if the goal is production (cocoon, raw silk) for export, quality at the international level and a volume of trade are required, so technologies and equipments close to the level of bivoltine sericulture of sericulture developed countries such as Japan and China are required. Also, the bivoltine silkworm race has been bred to achieve high quality and high-yield, and needs a large amount of high quality of mulberry leaves, and is prone to disease in comparison with other silkworm races such as the tropical silkworm (multivoltine). As such, high quality mulberry leaves produced from a mulberry field with good fertility management and a clean rearing environment is needed to rear bivoltine silkworms. Hence, a higher level of mulberry cultivation and silkworm rearing technologies are required than multivoltine sericulture, as well as a higher cost for mulberry field management, rearing equipment, and sterilization.

1) Silkworm egg production

For egg production of the bivoltine silkworm, a hybrid of the Japanese silkworm race and Chinese silkworm race is essential. Furthermore, not only the production of silkworm eggs, but since silkworms hatch only once or twice in a year, silkworm eggs with a good hatching rate (more than 95%) must be supplied year-round according to the start date of the silkworm rearing by farmers. To produce and distribute a large quantity of high quality silkworm eggs, advanced technology and a lengthy experience are especially required, as well as various equipment for cold storage of silkworm eggs (2.5°C, 5°C, 15°C, etc) according to distribution volume, and processing and preservation, such as acid-treatment and incubation (keeping silkworm eggs in a controlled environment adjusting temperature, humidity, and light ray, etc. to ensure uniform hatching).

In Uganda, hibernating egg production is carried out in the Bushenyi District and at the National Sericulture Center in Kampala, and while acid-treatment has been attempted a few times at the National Sericulture Center, silkworm eggs did not turn out as planned. The silkworm races mainly used were hybrids introduced from Japan and have been raised by the farmers. A portion of the produced cocoons are kept for propagation and are simply crossbred, so the quality of the silkworm eggs dropped due to repeated simple crossbreeding over the years.

Also, electricity is supplied every other day. Due to the poor electricity supply conditions, cold storage of the silkworm eggs and incubation equipment cannot be properly carried out, so appropriate hibernation storage and incubation of the silkworm eggs cannot be achieved, making planed distribution of silkworm eggs

difficult and negatively affecting silkworm egg hatching.

2) Mulberry cultivation

Since the quality of the mulberry fed to the silkworm greatly influences the rearing achievement of the silkworm (especially bivoltine), cultivating good quality mulberry is important. To do so, development of a mulberry field in a breezy and sunny location, and the use of high quality mulberry varieties which are adapted to the local weather, mulberry cordon and fertility management adjusted to the harvest are required.

Since most farmers in Uganda and Ethiopia do not apply fertilizers to mulberry fields, the nutritional quality and yield of the mulberry leaves is not suitable for bivoltine silkworm rearing. Due to the lack of appropriate guidance in mulberry cultivation technology and the fact that most farmers are poor, it is difficult to achieving favorable fertility management.

In the future, the selection and introduction of mulberry varieties and technical guidance of mulberry cultivation are needed for the thorough fertility management of a mulberry fields.

3) Rearing equipment, devices, and sterilization

The goal of bivoltine sericulture is the production of high quality cocoons by rearing silkworm breeds with high cocoon thread production potential. However, characteristics of the bivoltine silkworm include susceptibility to high-temperatures, humidity condition, and disease. As such, cleaning and sterilization of rearing equipment and devices are needed to maintain the appropriate rearing environment, and sanitary (not contaminated by disease-causing bacteria) condition. For example, the rearing room for young silkworm larvae, rearing room for grown silkworm larvae, room for mounting of silkworm larvae, and tools for silkworm rearing (papers for the rearing bed for silkworms, sheets for the shelves for silkworm rearing, cocooning frame, etc) must be sanitized and cleaned before, during and after rearing, hands must be washed and shoes changed when entering the rearing room to prevent the introduction of disease-causing bacteria. It also important to maintain a sanitized environment in the rearing room surroundings and the silkworm larvae and rearing beds must be disinfected to prevent an outbreak of diseases at the first feeding of newly hatched silkworm larvae, and at the initial mulberry feeding at each instars.

However, disinfection by farmers is merely spraying a bleach solution a few times, and no proper or sufficient disinfection is carried out. Disinfection on the rearing bed during rearing, washing hands before beginning rearing work or

changing shoes when entering the rearing room are not carried out.

The rearing room surroundings cannot be said to be a sanitary, and rearing rooms that have a dirt floor, clay walls, and a wooden cocooning frame are difficult to disinfect. Furthermore, the rearing bed in direct contact with the silkworms is covered with a plastic sheet, which is used repeatedly, and is such that disinfection and cleaning cannot be completely carried out. Thus, once there is an outbreak of disease, there is a higher possibility of the source of the disease becoming established, and there is the risk that subsequent outbreaks will lead to a constant decrease in income.

4) Silkworm eggs (incubation, first feeding of newly hatched silkworm larvae)

Newly hatched silkworm larvae (unit- 20,000 per box) are prepared by a silkworm egg producer according to the request of the farmers, and the newly hatched larvae are distributed to a joint rearing house for young silkworm larvae or to the farmer. Then, rearing of silkworms starts with the first feeding of newly hatched silkworm larvae. For incubation, the silkworm eggs must be kept for about 10 days at 25°C, 75% humidity, and specific lighting (16 hours light: 8 hours dark). Then 2-3 days before hatching, they must be kept in complete darkness to ensure uniform hatching. Uniform hatching of the silkworm eggs leads to uniform growth of the silkworms, which is extremely important for high quality cocoon production.

However at present in Uganda, the scale of the National Sericulture Center where the silkworm egg production is conducted at is small and the equipment and technology is insufficient. Thus, silkworm egg distribution cannot meet the requests from sericultural farmers. In particular, due to poor electric power conditions and constant electrical outage, silkworm egg preservation and incubation cannot be carried out stably, and in turn defective hatching of the silkworm eggs and interruption of silkworm egg production occurs. Improvements in silkworm egg production to meet the demands in volume, in silkworm egg preservation and handling, in incubation equipment and in the technical level are necessary for the stable supply of silkworm eggs.

5) Rearing

The larvae period for silkworms can largely be classified into three periods- the young silkworm period, from the first feeding of newly hatched silkworms to the 3rd instar after the second molting; the grown silkworm period from the 4th instar to the 5th instar, and the mounting period when cocoons are formed at the end of the 5th instar. It is desirable to carry out the rearing each period of young silkworms, grown silkworms, and mounting silkworms at different facilities, in order to prevent

disease outbreak and provide optimum conditions for rearing.

(1) Rearing of young silkworm larvae

Rearing of young silkworm larvae starts immediately after hatching until the 3rd instar. The rearing environment, quality of mulberry leaves and rearing technology greatly influence the growth of the silkworms, thus rearing in this period is very important for the production of high quality cocoons. This period requires a high level of skill and a good rearing environment (1st and 2nd instar: rearing temperature 28℃, rearing humidity 75-80%, 3rd instar: rearing temperature 26-27℃, rearing humidity 75%, clean condition: disinfection in the rearing room, washing hands and changing shoes, cleaning around the rearing room, etc). This can be done by establishing a joint rearing house for young silkworm larvae, rearing the newly hatched silkworm larvae of the first feeding until the 2nd instar on a conjoint basis and distributing them to farmers.

However at present, proper silkworm egg incubation is not carried out and hatching occurs at different times. The rearing house for young silkworm larvae cannot be maintained in the appropriate temperature and humidity and rearing skills are inadequate, as a result, simultaneously hatching can not be carried out. Such irregularities in the silkworm rearing process cause disparity of more than 1 day by the time of distribution to farmers.

Rearing during the 3rd instar, after distribution from a rearing house for young silkworm larvae to farmers, is still under the young silkworm period. The farmers must keep the rearing rooms under the clean condition and the appropriate temperature and humidity. However, the rearing of 3rd instar silkworms are currently carried out in the same rearing rooms as grown silkworms, and it is difficult to maintain the appropriate rearing environment.

(2) Rearing of grown silkworm larvae

During the rearing of grown silkworm larvae, the rearing temperature can be lowered and rearing is easier than the young silkworm period, but mulberry harvesting and feeding work intensifies as the volume of mulberry eaten increases. And, since the quality and feeding volume of mulberry leaves largely influence the growth of the silkworm larvae during this period, providing good quality mulberry in the appropriate rearing environment (4th instar: rearing temperature 26°C, rearing humidity 75%, 5th instar: rearing temperature 25°C, rearing humidity 70%, clean condition: disinfect the rearing room, wash hands and change shoes when entering the room, clean around the rearing room) is important to ensure good silkworm growth and development.

In the district we visited, though the temperature at night dropped below 20°C, even maintaining the appropriate temperature by simple heating such as

by charcoal fire was not carried out. Mulberry feeding was poorly timed and the sleeping period was poorly handled, leading to a disparity of 2-3 days in silkworm rearing. The volume of cocoon harvesting from mountages per single box of silkworm eggs was small and cocoon quality was even worse. Furthermore, as far as could be observed during the survey, the stored cocoons at the site were either smaller in size, and the volume of mulberry fed during the grown silkworm period was insufficient. Production of cocoons with the quality to compete in the international market is very difficult with current equipment, materials, and technology.

(3) Mounting

Since mounting largely influences to cocoon quality (reelability percentage of cocoon, contamination, etc), to maintain the appropriate temperature and humidity condition (temperature: 25°C, humidity: 65%, air circulation and ventilation: good), to gather silkworm larvae that have matured properly (silkworms at the most appropriate time to form cocoons), and to mount in mounting-specific facility using a mounting container to prevent deformity and contamination of the cocoons are important. Matured silkworms discharge a large quantity of urine before they start to form cocoons. So, if the growth of the silkworms is not uniform, earlier formed cocoons may be contaminated by the urine of slower growing silkworms, and an increase in room temperature may lead to a reduction of the reelability percentage of the cocoons. Hence, air circulation and ventilation in the room for mounting silkworm larvae must be fully carried out. Also, thorough cleaning and disinfection of the mounting container are important to prevent transmission of disease.

However, mounting is currently done over 1-2 days even if the silkworms have a growth disparity of 3-4 days, and the appropriate temperature control and air circulation and ventilation have not been carried out. Also, the size of rack in the mounting container is slightly too large, and cannot be rotated or maintain the appropriate distance, so there is bad air circulation and higher humidity, leading to reduced reelability percentage of the cocoons and increased number of contaminated cocoons. It is difficult to produce cocoons with uniform size and shapes under these conditions.

It is needed to achieve the uniform growth of the silkworm, and then to improve in the preservation methods and preservation location of the wooden cocooning frames.

6) Silkworm diseases

Silkworm diseases include viral disease, fungus disease, pebrine, and bacterial

disease, etc. Among these, pebrine is ovarially transmitted, and greatly affects the sericulture industry, and can even occur in a disinfected and clean room, with clean containers and eggs. For these reasons, elimination of pebrine by mother moth inspection during the silkworm egg production phase is essential. In other words, eggs produced by a mother moth in which microsporidia has been detected should be disposed of and not used.

At the silkworm room of the farm we visited, traces of possible nuclear polyhedrosis of a silkworm was observed, and it could be deduced that damage from the dangerous disease had already occurred. Also, there is the threat that pebrine may spread since mother moth inspection is almost never carried out. Furthermore, clean rearing environment is not maintained, such as disinfection of silkworm room and tools, so there is fear of reduced cocoon yield, and sometimes nothing is harvested due to silkworm disease contagions.

7) Cocoon harvesting from mountage and shipping to the buyer

Cocoon harvesting from the mountage is important work where the quality of cocoons is affected by the period and method. Harvesting when young silkworms in the cocoon have fully pupated is important, and if cocoons are harvested with incomplete pupation, the soft pupa may be damaged by impact during harvesting, floss removing from cocoon, or transportation. This contaminates the inside of the cocoon, resulting in reduction of quality. Cocoon sorting to remove defective cocoons during harvest is also important to produce high quality raw thread.

In the surveyed district, harvesting appears to be done 6-8 days after mounting, but all the cocoons are harvested on almost the same day, even though the disparity in the rearing process by the time of mounting is about 3 days, and temperature control during mounting is not appropriately carried out. This means that harvesting is carried out when some cocoons are not completely pupated. Cocoons which are not completely pupated are highly likely to cause inner contamination of the cocoon by damage to the soft pupa during harvesting, subsequent transportation and floss removal (the floss of the cocoon is the thread that silkworm first expels when making the cocoon, and is the cotton-like cocoon filament covering outside the cocoon), leading to a reduction in cocoon quality.

Cocoon sorting at the farm is just the removal of noticeably thin shell cocoons, and even at silk reeling process, only double cocoons, thin shell cocoons, pierced cocoons, and unshaped cocoons are removed. Thus, there is a problem with cocoon sorting as silk reeling material in order to meet international standards.

8) Grading cocoons (cocoon transactions)

In cocoon transactions, grading cocoons is very important for both the farmer side (seller) and the silk reeling side (buyer) and must be handled fairly and accurately. For the farmer, high quality cocoon production leads to higher income, and the right cocoon quality evaluation facilitates improvement in the quality of the cocoons produced by the farmers. Also for the silk reeling side, cocoon quality directly influences reeling efficiency and the quality of the raw silk, so it is also important from the view of securing profit.

However current evaluations in the surveyed area cannot be said to be appropriate because there are only a few items that are checked and also few samples are taken, and the grading range is narrow.

9) Cocoon drying

The purpose of cocoon drying is, first, to kill the pupa inside the cocoon to avoid piercing the cocoons by emergence of the adult moth and then to reduce the humidity the pupa and cocoon for long term storage to avoid damage by mold and discoloration, and most importantly, to equalize the loosening and tension of the thread from the cocoon when silk reeling, bringing out the characteristics of the bivoltine cocoon. To do so, the drying temperature, drying time, and degree of drying of the cocoon are important elements for raw silk production.

Since the drying condition of cocoon greatly influences reeling efficiency and the quality of the raw silk, the proper drying is required. Settings for drying condition differ slightly according to the drying cocoons, but by increasing the temperature to 110°C within about 30 minutes, then maintaining the temperature at 110°C for about 2-2 1/2 hours, and then subsequently decreasing the temperature to 60°C for about 3-3 1/2 hours, drying can be completed and weight of the cocoon can be reduced to about 45% of its original weight within 5-6 hours.

In reality in the surveyed area, however, it is structurally difficult for the drying cocoon equipment to increasing the room temperature to a high degree (110°C), and sometimes drying takes longer than one day, and confirmation of drying of the cocoon is done by touch of the hand only, and thus cannot be considered proper drying. Also, the current equipment cannot dry on schedule since drying requires a longer time. The structure of the drying facilities to be difficult to insert and remove the cocoons and height of the external chimney are also problems.

The current lengthy drying time and inadequate drying results in discoloration and mold on the cocoons, and deteriorates quality of raw silk. Long-term storage is also difficult.

10) Silk reeling

Silk reeling is to produce raw silk from cocoons by a manual, semi-automatic, or automatic reeling machine, and the method of reeling largely influences the quality of raw silk produced, so a high level of technology corresponding to the cocoon material is needed for all the process of reeling. Using a size detector for reeling to produce raw silk with a smaller size deviation is also needed in order to produce high quality raw silk. Raw silk is very delicate, so if it is exposed to strong string tension and then dried, it becomes extremely week in a short period of time and loses its commercial value.

However, in one of the silk reeling factories which we visited, raw silk reeled three months ago was not removed from the reeling machine, had discolored to yellow, and had no commercial value. Also essential conditions such as the supply of electricity and water for silk reeling were not considered.

Furthermore, because reeling technology was poor, it was difficult to ensure high quality cocoon material that meets the production capacity of the equipment, and the quality of produced raw silk was low. And storage conditions for the raw silk were bad, further lowering the quality of the raw silk.

11) Fabric

To sell fabric as commercial product, weaving based on the product plan to suit the needs of the customer is needed. Also, the fabric can have a different texture and quality depending on the thickness of the thread used (size), quality of the thread and method of weaving, so planning from cocoon material and reeling phase is required.

In Uganda, trial products were weaved, dyed, and made into finished products, but production of the products did not consider the needs of customer, and their qualities were insufficient. Although the production of finished products is also needed in consideration of the destination of the cocoons produced by the farmers, production of high quality cocoons and raw silk should be focused on first.

12) Domestic and international market and distribution

There are few consumers for cocoons, raw silk, or silk products in Uganda. This also means that the domestic market does not exist. Also, at present, the export of cocoons and raw silk has almost ceased. For Uganda, measures in either the domestic or international market are a major issue in proposals of plans for sericulture promotion and development.

5. Challenges in the promotion of sericulture in East Africa

Japan began its sericulture industry around 1900, and promoted and developed advanced sericulture technology and reeling technology for 50 years, surpassing Italy and France with its cocoon and raw silk production and established herself as world leader. There were many reasons for this. One was that sericulture required high level of agricultural technologies including the cultivation of mulberry and silkworm rearing and it was very labor-intensive. Because of these, hard working farmers with a high level of education and advanced knowledge were needed in the sericulture farming. Furthermore, factors that led to the development of sericulture include the facts that raw silk was an international product and must have been able to respond to the competition with foreign countries, silk needed to compete with the artificial fiber rayon invented at the end of 19th century, and to do so, research on sericulture was intensified and the government focused on dissemination of technology. Also sericulture farmers were eager to learn new techniques in sericulture as a cash crop over subsistence crops.

Here is an example of how the Japan Government policy encouraged the promotion of the sericulture industry. In particular, as an initial response for the production of high quality cocoons, free distribution of silkworm eggs to farmers throughout Japan was carried out from 1914 to disseminate the bivoltine hybrid. Furthermore, unlike today, there were about 11,000 villages in Japan at the time, and 11,000 sericulture extension workers were trained in the 1920's and were dispatched to each village to provide guidance to farmers for high quality cocoon production. Of course the sericulture extension workers were trained for 1 year at the government's expense. Also, it was necessary for training center for sericultural extension worker to be established in each prefecture. As this case shows, the Japanese Government historically promoted sericulture through institutional, financial, and technical measures.

In this report, challenges to sericulture development and promotion in East Africa are summarized in light of those experiences.

It became clear through the on-site survey in 3 countries, Kenya, Uganda, and Ethiopia, the sericulture industry is now completely inactive in East Africa. In other words, regarding the laboratory scale silkworm eggs production, the small-scale silkworm rearing at sericulture farms, low quality cocoons produced by sericulture farmers and the raw silk reeling from those cocoons as well as the various fabrics attempted to be produced with that raw silk, no clear goals in quality, price, volume, taste and design have been set. This is thought to be the result of the lack of domestic demand in any country in East Africa, and the lack of knowledge and information regarding the current sericulture industry. In other words, the current situation is just the dream of acquiring foreign currency and cash earnings through

the export to foreign countries, without any clear thought of consumption needs or target consumers, and without considering the quality, price and design of the cocoons, raw silk and fabric that should be produced.

In East Africa, the sericulture industry is in the infant phase, and preparation to start a new industry that has clear and practical goals in mind, such as what kind of demand, what kind of quality and price, and what volume of cocoons and raw silk are currently needed, requires strong national leadership through administrative, financial, and technical support. To do so, expert consideration of the kind of methods needed, long-term promotion planning, and the will to achieve these goals is required.

Another important factor for the establishment and promotion of a new sericulture industry is the consideration of conditions such as electricity, service water, management capital, and the sales market because the silk reeling industry which reels raw silk from cocoons is one of manufacturing industries. Added to these conditions, since cocoon production is an agricultural product, it is naturally affected by weather conditions, service water, and the eagerness of the farmers as well. The current conditions in East Africa are considered to be severed disadvantageous in view of each of these conditions. For example, we often heard that the weather in one area was suitable for sericulture, and even saw it in print. However, except for the reference on annual temperature and rainfall by Makerere University, in Kampala, the capital of Uganda, and that was displayed at the research center, there was nothing to show the temperature and rainfall in the sericulture area, even in the laboratory. Furthermore, no one locally knew the correct and appropriate rearing temperature for silkworms, or the temperature difference between morning and night in the district or the place which was said to be suitable for silkworm rearing, and even a thermometer, common to any farmer in Japan, could not be observed.

When considering sericulture industry in East Africa, issues arising from the lack of domestic demand must be understood, and a future response that reflects that understanding is required. To consider only the technical issues for the improvement of cocoon and raw silk production, without solving issues such as understanding the status of sericulture and silk on the international market, training of sericulture specialists, and consideration of an independent social, financial, and technical environment, further complicate the situation and increases our worries.

1) The role of ICIPE

When considering the development and promotion of sericulture in East Africa, the activity and role of the International Centre of Insect Physiology and Ecology

(ICIPE) in Kenya should be considered at first.

From our visit to Kenya, Uganda, and Ethiopia, and our meeting and talking with persons involved in sericulture in these countries, we could see that ICIPE is very influential and has strong leadership at the technical aspect consistently through its activity up to sericulture, reeling, and silk fabric. In other words, ICIPE's role is recognized as the stronghold of sericulture in East Africa. This recognition is considered to have been earned through its research and extension activities up to now.

ICIPE conducts research placing major emphasis on the combination environment conservation and sericulture, and the viewpoint of promoting the industry and earning foreign currency seem to be lacking.

One issue is the revision of ICIPE. In other words, ICIPE needs to realize its current leadership by strengthening sericulture research and training activities, and by establishing a system that can carry out a political and distributional study from the standpoint of management and marketing to build the sericulture industry.

2) Recognition of the sericulture industry and the international status of sericulture

Through this survey, it was evident that the viewpoint of East Africa regarding the meaning of promoting sericulture industry was not clear. For example, it was unclear who wanted to promote sericulture, who has responsibility for marketing, and who was in charge of supporting and teaching farmers, and there were no clear objectives in these countries.

Part of the reason is the lack of understanding of what the sericulture industry is and what the condition of competition in the international sericulture industry is. Looking at world raw silk production volume statistics, the situation is that China is the almost only country currently supplying raw silk. East Africa thinks that they have chance and potential to produce and export cocoons and raw silk. Of course, such there is potential. However, in order to withstand and succeed in international market competition, adequate consideration, strategy, and preparation for the requirements and how to respond to them are needed.

First, the status of international sericulture must be observed. Then, as an industry, renewed recognition of technical development, extension of technology, market-related measures, demand pioneering, quality control, etc., is needed, and how the sericulture administrative organization and political financial management operations should proceed must also be studied. Furthermore, in accordance with this recognition, a long-term sericulture promotion project based on East Africa's original strategy must be created, and international financial support must be

sought.

3) Human resource development such as specialists and advanced technical experts

Up to now, it is very regrettable that support by advanced countries has focused on hardware provision, such as machinery. The development of human resources should have been the prime task.

Executive experts who directly deal with or have a strong influence in the sericulture administration must be trained as human resources, at first. Next, as the high level sericulture engineers, the experts in each field of silkworm breeds maintenance, silkworm egg production, mulberry cultivation, silkworm rearing, and silk reeling must be trained, and experiment laboratories must be established by these experts and technology development, succession and extension of technology should be implemented in the laboratories. Without such experts, at the very least, a strategy for sericulture promotion and a long-term promotion plan that meets the condition of each country cannot be considered.

Furthermore, with regards to sericulture farmers, proper trainings are needed in order to introduce bivoltine sericulture.

4) Demand pioneering for the domestic and international market

The biggest challenge of sericulture development of East Africa is that it is not connected to market, in other words, to demand. The biggest reason why there is still confusion even with 30 years of history is that sericulture production is not linked to the market. So, they have not realized that thinking 'all you have to do is produce it and then you can sell it at a high price' is wrong. Since domestic demand for cocoons and raw silk is not reliable, the goal is to export. However quality and volume are insufficient and the products cannot be sold. So the silk reeling factory runs out of money and stops operation. In silkworm egg production, it is impossible to produce high quality silkworm eggs because of inappropriate maintenance of silkworm races as well as a lack of electricity and technology. Thus, the distribution cycle from production to sale does not circulate, and comes to a standstill.

This is closely related to the reasons previously described in item 3 above. Specifically, it is the result of production without the target or goal for production. In other words, production activity was carried out without the target, the quality and the price of cocoons or the amount of raw silk.

For example, according to the survey in Uganda, there are roughly 50,000 Indians back in Uganda carrying out economic activities. If that is so, a demand can be expected since the sari is an indispensable item for women from India. Also, a

local woman was seen wearing ethnic costume, Gomesh made from silk, so development of silk demand can be expected for the local dress. If you really want to promote sericulture, this kind of viewpoint is a very important.

The situation in Ethiopia with eri silkworm rearing was little different. There are two small scale companies that produce and sell manufactured goods made from eri silk to foreigners. It was a rare case in East Africa, which demand and production were linked together. However it was said that only about 800kg eri silkworm cocoons are produced annually and upgrading and expansion cannot be expected under the current situation.

From the above, development of new demand can be said to be the high-priority issue from now. Various measures can be considered. For example, support to start domestic eri sericulture companies such as the one described above, to attract foreign companies, especially inviting silk reeling and textile factories to produce saris for Indians, and the production of cocoons and raw silk for those factories with a clear goal of quality, quantity, and price in mind.

5) Long-term promotion project and framework of responsibility under the strong leadership of the central government

In order to entails creating a new industry, sericulture, a long-term promotion project of more than 20 years must be established under the strong leadership and responsibility of the central government. The current basic plan considered for each country does not show any strategies for export for countries which have no domestic demand for cocoons and raw silk. Also, the planned budget cannot be covered by a government funded budget, so it is doubtful that this plan has any operability. From now, the considerations on the plan from local sericulture experts who have completed trained, or from experts of sericulture from developed countries, and reconsideration after a full understanding of the status of sericulture of the world are needed. The plan needs consistency, promise of steady and sure effectiveness, even though this may take time and the government may change.

A detailed enforcement plan with economical technical proof must be prepared and carried out by trained local sericulture experts. Of course, domestic and foreign demand pioneering and specific goals for the targeted market must also be set. Then, according to the plan, in order, the establishment of administrative special sections to form the basic framework to start the sericulture industry, experiment laboratories, silkworm egg production centers, silk reeling factories, quality inspection stations for cocoons and raw silk, technical extension centers, and training centers for sericulture extension workers are needed.

Another task when starting a new sericulture industry is how the central government can bear their responsibility through the period until the industry can

respond to the new demand. In other words, it is doubtful that cocoons and raw silk of the desired quality and amount can be produced in the first several years, even if cocoon production begins with a feasible plan and technology with reasonable production goals. How much time is required before the goals can be met is unknown, but the government must create the system, such as purchasing cocoons from the sericulture farmers and raw silk from the silk reeling companies for certain period of time. New development is thought to be possible only through government commitment. The will and responsibility as a strong nation with political commitment is needed, even if support from other countries is sought.

6) Maintenance of the basic infrastructure

Depending on the country, with scheduled blackouts every other day, the lack of electricity can be considered fatal. As for water, some farms did not have a water supply. From the standpoint of the weather, the conditions of the highlands is that there is a large temperature difference between day and night, with low temperatures in the morning dropping under 20°C, which is not best suited for silkworm rearing. In other words, problems with water use for disinfection, washing by the farmer, and heating in low temperatures during silkworm rearing are major stumbling blocks in silkworm rearing.

In particular, the lack of electricity and water are mortal blows to the sericulture industry, and the performance of bivoltine sericulture silkworm egg production and preservation is doubtful without some kind of countermeasures.

Sericulture industry is not just the cultivation products in the field. It must be fully recognize that producing cocoons and raw silk as industry material, homogeneity of quality and a set volume are required. Furthermore, infrastructure maintenance is an essential basic condition for the promotion of sericulture in East Africa if export to a foreign country is the goal.

7) Interaction with sericulture developed countries and introduction of foreign technology

As already mentioned, East Africa has not actively pursued interaction with sericulture developed countries. Various projects have been carried out up to now, but the approach that eagerly seeks to know the status of world sericulture and the trends of the international market and efforts to introduce sericulture technology have not been observed. However, from now, interaction with sericulture developed countries such as China and India is needed to actively promote the search for suitable methods and promotion measures for the sericulture industry in East Africa. Also, if the goal of East Africa is to export, related executives and leaders

must have detailed understanding and recognition of the status and description of silk producing countries and silk consumption countries.

Many things can be learned from developed countries regarding administration, technical development, and technology extension. In particular, interaction with India which has a large sericulture industry, belongs to the same tropical zone, and is geographically close, is desired in future.

East Africa currently lacks interaction with developed countries of the sericulture industry, and has not sufficiently learned from other countries. From now, seriously seeking an expedient way to start an appropriate sericulture industry for each country is expected.

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