ECONOMIC ANALYSIS OF BEEKEEPING IN THE JASIKAN DISTRICT OF THE VOLTA REGION

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF PHILOSOPHY DEGREE IN AGRICULTURAL ADMINISTRATION

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DEDICATION

I dedicate this work to my wonderful parents Mr. and Mrs. Padmore Dadzie, my dear friend Olive and my siblings for the timely input they made into my life to see this work become a reality.

DECLARATION

I, Yaw Antwi-Dadzie, author of this project report do hereby declare that the work presented in this thesis: "Economic Analysis of Beekeeping in the Jasikan District of the Volta Region" was done entirely by me in the Department of Agricultural Economics and Agribusiness, University of Ghana from 2001 to 2002. This work has never been presented in whole or part for any other degree of the University or elsewhere.

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This work has been submitted for examination with our approval as supervisors

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ABSTRACT

Agriculture in the Jasikan District in recent times is predominantly based on arable crop production, using traditional slash and burn techniques, which encourages extensification. There is the need for the development of sustainable agricultural practices that will not require new land but could still be incorporated into the farm business and be a source of income for farmers. Beekeeping has been identified as one such sustainable agricultural practice in the district. Unfortunately there is no study to substantiate the profitability of the venture, and the efficiency of resource use in the district. This therefore motivated the study into the economic analysis of beekeeping in the district.

Data was collected from 82 beekeepers using a random sampling method. The information collected span personal characteristics, production information, marketing functions and problems of beekeepers.

Profitability analysis showed that each cedi invested in beekeeping business in the district yields 3.5 cedis. Also B/C ratios computed from budget analysis for some food crops in the district revealed that on the basis of seasonal production, beekeeping is more profitable than cassava, maize and cassava intercrop, plantain, yam, minor season maize, groundnut and cowpeas, taking each as a unit.

Resource use efficiency analysis showed that apiary size and capital were underutilized in the district. Marketing functions for honey are generally not well developed in the district. The constraints to the beekeeping production in the district range from absconding of bees, faulty equipment, slow rate of colonization and marketing of honey to financial constraints that hinder them from expanding.

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LIST OF ABBREVIATIONS

B/C	Benefit-Cost Ratio
CIDA	Canadian International Development Agency
C_o	Original Value
DED	German Development Service
DFC	Depreciated Fixed Cost
DM	Deutsche Mark (German Mark)
FORUM	Forest Protection and Resource Use Management Project
FSD	Forestry Services Division
GTZ	German Agency for Technical Cooperation
IFAD	International Fund for Agricultural Development
IRR	Internal Rate of Return
Kg	Kilogram
KFW	German Bank for Reconstruction and Development
lb	Pound
LC	Labour Cost
MLF	Ministry of Lands and Forestry
MVP	Marginal Value Product
N	Expected Useful Life
N/K	Net Benefit-Investment Ratio
NPW	Net Present Worth
Rs	Rupees
S_v	Salvage Value

TC	Total Cost
TCC	Technology Consultancy Centre
TDFC	Total Depreciated Fixed Cost
TLC	Total Labour Cost
TR	Total Revenue
TVC	Total Variable Cost
U.S.A	United States of America
VC	Variable Cost
VORADEP	Volta Region Agricultural Development Project

CHAPTER ONE

INTRODUCTION

1.1 Background

Jasikan is one of the district capitals of the Volta Region. It can be found in the northern section of that region. It is located 7.5° north of the equator. To the west, it is bordered by the Volta Lake, to the east by mountains and hills stretching into Togo and to the south and north by the districts of Hohoe and Kadjebi respectively.

The district has varied landforms ranging from flat lands, rolling and steep hills. Much of the western area bordering the lake is gently rolling, with the dominant vegetation being grassland characteristic of the transitional zone. The rest of the district is hilly with the only flat land being found in the valley bottoms. Typically these used to be forested areas and the remnants outside the forest reserves are secondary forest with cocoa.

The population of the district is approximately 106000 people (2000 census) living in 10 administrative zones. It covers an area of 1,292 kilometre square with an average density of 82 people per square kilometre. The population is made up of many ethnic groups. In the north-western part of Jasikan the paramountcies of Abotoase, Worawora, and Apesokubi are Akan (However much of the population of Apesokubi and communities of Okrabe and Kaboso are Akposso, who dispute the Akan Paramountcy). Towards the southwest is the Nkonya paramountcy whiles the centre of Jasikan district contains Bowiri and Buem people, with the Buem Paramountcy extending to the eastern edge of the district.

Many different ethnic groups have settled within these paramountcies. These include the Ewes, Ada, Bassare, Kotokoli and Kabre people from Ghana and Togo.

Communities within these paramountcies, contain various ethnic mixtures ranging from the very diverse in trading towns to almost single ethnic groups of either settlers or indigenes in farming villages. The settlers arrived for share cropping with particular reference to cocoa in the past, but also for fishing and trading.

1.2 Traditional Agriculture in Jasikan District

In Jasikan cocoa was the major crop. Traditionally plantain, yam, cocoyam and water yam were the staple food crops of the area. These were grown in small clearings or merely gathered in the forest. Plantain that was once plentiful in the district has now become expensive. The production of cocoa has declined for a myriad of reasons, many of which are interrelated. Some of the reasons are due to increasing age of trees, with few new farms being established, the declining standards of maintenance of cocoa brought about by the return of the migrant farmers and splitting up of the farms to children who were well educated and had no desire to leave their jobs and return to full time farming, increased infertility of the soil due to constant cropping and lack of fertilizer inputs, and the increased importance of cocoa swollen shoot virus and black pod (GTZ, 1999).

The major down turn of the cocoa industry occurred during the drought of 1983, when uncontrolled forest fires spread throughout the region devastating the already weakened industry. Thirty years ago cocoa in the district was widespread, however in recent times, it is concentrated in the remaining forested areas outside the forest reserves, in particular the New Ayoma and Bodada administrative zones.

Agriculture is dominated by shifting cultivation carried out by small-scale producers using annual food cropping systems. Results from Melsbach (1995), showed that in Kudje (a town in Jasikan district), over 70% of both men and women have chosen cropping of annual food crops, in particular that of cassava and maize, in preference to perennial crops as a source of income. This preference will be found in much of Jasikan district, except possibly Bodada and New Ayoma administrative zones, where tree crops are important sources of income particularly for male farmers. Just over 40% of a sample of 30 male farmers interviewed by Melsbach indicated that their principal source of income came from cocoa.

In the forest areas the fallow vegetation is now predominantly the "Akyeampong" weed, (Chromolaena odorata). It spreads through producing seeds that are easily disseminated by the wind. The length of the fallow period varies considerably from one area to the other. For example in Kudje and Bodada, towns bordering the forest reserve, fields are left to fallow from 2 to over 20 years with over 60% of land being left for 4 to 6 years. A survey carried out in 1997, revealed that some fields were cropped for periods of up to 6 years, but the average cropping time for all the respondents was just over 2 years (GIDA, 2000).

From the same survey data of 29 farms in 1997, the average farm size for annual crops was 1.2 ha (2.7acres) with an average of 3 plots per farm. About 30% of all plots contained either pure cassava intercropped with cocoyam, which generates naturally. About 31% of the remaining land was solely cropped with maize in the major season, and 16% in the minor season. This shows the importance of the two staple crops (cassava and maize) as over 60% of all plots contained these two crops. The remaining crops were plantain, yams, vegetables, cocoyam and rice. Results from the survey showed that on none of the farms were there any notable innovations in the farming system. They followed the traditional slash and burn bush fallow practices.

Agricultural crop production is still based predominantly on shifting agriculture, using traditional slash and burn techniques. With the increase in rural population at the rate of 2% per anum (GTZ, 1999) and its reliance on annual cropping practices, the pressure on agricultural lands is mounting. There is a shortened fallow period, a decline in soil fertility, a high weed infestation and a disruption of the natural forest regeneration system.

1.3 Agricultural Diversification in the Jasikan District

With the prevalence of extensification and annual food crop farming system used as a source of income, it is important that farmers have the opportunity to diversify in order to reduce risk, increase income and promote a more sustainable form of agriculture. This is particularly relevant to forestry activities for without the introduction and later widespread acceptance of sustainable agricultural techniques farmers will require new land. It is highly likely that the forests will come under increasing pressure from the rural communities if no alternative to shifting agriculture is proposed and accepted by the majority of farmers living in the area (MOFA, Jasikan, 1999).

Most of the forests in the district have already been destroyed, and in a bid to safeguard what is left, the Government of Germany in collaboration with the Government of Ghana has initiated the "Forest Protection and Resource Use Management Project" (FORUM) aimed at forestalling the trend of forest depletion. The overall goal of the project is to enable local communities, other forest users and Forestry Services Division (FSD) to make use of the forest resources in the Volta Region in a more economically and ecologically sustainable and socially acceptable way. The total contribution of Germany to FORUM has been estimated at DM 39 million of which DM 12 million is provided through German Agency for Technical Cooperation (GTZ), DM 25 million from German Bank for Reconstruction and Development (KFW) and DM 2 million are contributed by the German Development Service (DED). Ghana's contribution has been estimated at DM 2.2 million (GTZ, 1999).

FORUM, which was started in March 1993, was originally designed for an overall promotion period of 10 years, but it has been found necessary to extend the project life to at least 15 years due to the nature of its goal. The implementing agency is the FSD on behalf of the Ministry of Lands and Forestry (MLF), the executing agency. The target population is the rural population living in the vicinity of the forest resources and the population in the south, which depend on wood supplied from the north.

Due to the extensification problem, the project has adopted an agricultural component to help stem deforestation. The agricultural component of the project, known as the Buffer Zone Development, has the major aim of helping rural communities develop alternatives to slash and burn agriculture and to promote more sedentary farming. Specifically, the agricultural component of the project promotes:

1. Agroforestry, especially the production and planting of fruit trees and oil palm.
2. Low external input farming, in particular, the establishment of cover crops and crop rotations.
3. Agro-based income generating activities, notably support to and training of beekeepers.

4. Improved storage, processing and marketing of agricultural goods, chiefly support to fish processors.

This study focuses primarily on the beekeeping aspect of the sustainable sedentary farming system, which was incorporated into the project in 1996. This is because of the following advantages of apiculture.

1. Tropical apiculture is cheap. It does not involve mass feeding of bees, because the insects can provide their own food all year round, and there is no over-wintering bee management as in the Temperate Zone.
2. All the necessary inputs required for beekeeping are available locally. Some may be wasted if bees are not kept, e.g. pollen and nectar from flowering plants.
3. Individuals and private organizations such as churches women's groups, youth associations and cooperative societies can initiate it with only limited funds.
4. Beekeeping is self-reliant. It does not depend on importation of foreign equipment or inputs.
5. In many rural localities the technology is available.
6. It improves the ecology. It helps plant reproduction. Bees do not over-graze as other animals do.
7. The honeybee produces honey, beeswax and propolis. These are non-perishable commodities that can be marketed locally or abroad.
8. The honeybee provides pollination service. This is an indispensable activity in the food production process.
9. The honeybee is the only insect that can be transported from crop to crop.

10. Honey and beeswax can be produced in semi-arid areas that are unsuitable for any other agricultural use.

Currently there are about 187 people, predominantly farmers, who have practical knowledge in beekeeping in the district and have access to supervision from extension officers working on the FORUM project. Out of the 187, 170 farmers have been trained by FORUM. Out of this number about 6 beekeepers have more than 5 beehives each. The statistics on FORUM trained beekeepers are as follows:

Table 1.1 Number of Trained Beekeepers

Year	Number trained	Male	Female	Hives
1996	10	10	-	20
1997	30	23	7	60
1998	50	25	25	100
1999	-	-	-	-
2000	30	30	-	60
2001	50	42	8	-
Total	170	130	40	240

Source: FORUM 2002

About 17 of the 187 beekeepers seemed to have started the business on their own and are practicing it. Also 50 out of the FORUM trained beekeepers have as yet not received equipment. These are made up of those trained in 2001. In 1997 the district recorded 450 kilograms of honey valued at ¢1.8 million, that is one kilogram sold at ¢4,000. In 1998 and 1999, 750 kilograms and 978 kilograms were realized yielding ¢3,750,000 and ¢5,868,000 selling at ¢5,000 and ¢6,000 per kilogram respectively.

1.4 Problem Statement

Presently, plans are underway to extend beekeeping as a sustainable sedentary farming system to other areas with similar ecological characteristics. From the table 1.1, it can be seen that more people are being trained to adopt this system, and harvested honey levels are increasing yearly with higher revenues being generated in the Jasikan district. With these positive trends, one may be easily beguiled into assuming that beekeeping is a possible panacea for solving the financial woes of farmers in the district. Unfortunately, nothing has been done in the area of establishing the financial profitability of this seemingly lucrative business. Until some study is done to ascertain the profitability and provide answers to other questions about the venture, the transfer of this technology to other areas might be difficult. These and other problems in the literature above underlie the following research questions.

1. What is the profitability of beekeeping in the district?

This question will help one compare the profitability of beekeeping with that of other farming activities especially some food crops grown in the district. It will also help to determine whether this new sustainable farming system could help lure the farmers from further extensification as they incorporate it into their farming business.

2. How efficiently are the resources being used in beekeeping in the district?

Resources are always scarce and thus the success of any venture depends on the effective and efficient allocation of resources. This question will help the researcher to suggest the best ways in which the scarce resources must be allocated.

3. How is honey marketed in the district?

Marketing has been one of the difficulties of rural agriculture. Sometimes production is in excess of demand in a particular area but because of poor market functions and other related problems, foodstuffs are wasted and prices are left to fall to the detriment of the producer. This question when answered will help expose any of such cases.

4. What are the problems that characterize beekeeping in the district?

Problems when identified will help find the requisite solutions and policies to be formulated.

1.5 Objectives

The primary objective is to analyse the economics of beekeeping in the Jasikan District of the Volta Region.

The specific objectives are as follows:

1. To estimate the profitability of beekeeping in the district.
2. To estimate the efficiency of resource use for beekeeping in the district.
3. To describe honey marketing in the district.
4. To identify the problems which characterize beekeepers in the district.

1.6 Relevance of Study

Studies in the area of beekeeping in the district are very scanty and this research seeks to add to existing literature. It will also throw more light on a sedentary sustainable farming system, which could provide farmers with an additional source of income and therefore prevent them from resorting solely to extensification.

From the stand point of the FORUM agricultural development programme and policies, the study could indicate the extent of the differentials in resource productivity in the district, as well as the constituent zones, and also suggest the causes of the differentials in resource productivity, in as much as these are explained by the kinds and quantities of resources used for production in these areas. The document will also allow implementers of the FORUM project to have a better basis for encouraging more farmers to go into the beekeeping venture.

It will also serve as a guide to future apiculturist in terms of resource use and to policy makers in the district. This study is important and timely since it seeks to assess what instruments are being put in place for the proper development of apiculture to salvage the plight of poor farmers in the district, whose incomes are fast eroding.

1.7 Scope and Limitation of the Study

The focus of the study was the Jasikan district of the Volta region (see figure 1, page 13). The district is divided into four agricultural zones namely; Ayoma, Jasikan, Kwamikrom and Worawora. The study covered 38 villages; eight (8) in Ayoma, nine (9) in Jasikan, thirteen (13) in Kwamikrom and eight (8) in Worawora.

The district was chosen primarily because it is one of the few areas in the country where beekeeping is being encouraged extensively and is also being monitored. Secondly bee forage abounds in the district due to the presence of the forest reserve that has a rich diversity of flowering plants, rich in nectar which if not tapped could go waste.

The study covers various aspects of beekeeping. These are the economics of beekeeping (including profitability and efficiency of resource use), characteristics of the beekeepers, the problems they face and the honey marketing functions in the district. The study spans a production season. The production season starts from the brood cycle stage from July/August through the harvesting season, which spans from November to June.

The first limitation is the availability and quality of data. This arises because most beekeepers in the district and farmers for that matter have not yet developed the culture of keeping farm records. The period of cross-sectional data collection generally extends over one production year. The underlying assumption is that the survey year is normal and or typical. Under this circumstance the reliability of the estimated productivity parameters depends upon how the production survey year is. When the year is typical, the results are valid only for the period covered by the data. In such a situation, expensive year-to-year estimates may be needed to keep the estimates current and to build up a body of data, which could reflect the changing structure of agricultural production in the area.

Secondly the specification of a production function, which includes all the relevant explanatory variables, is extremely difficult, if not impossible. There are many unquantifiable factors affecting the production process in traditional agriculture.

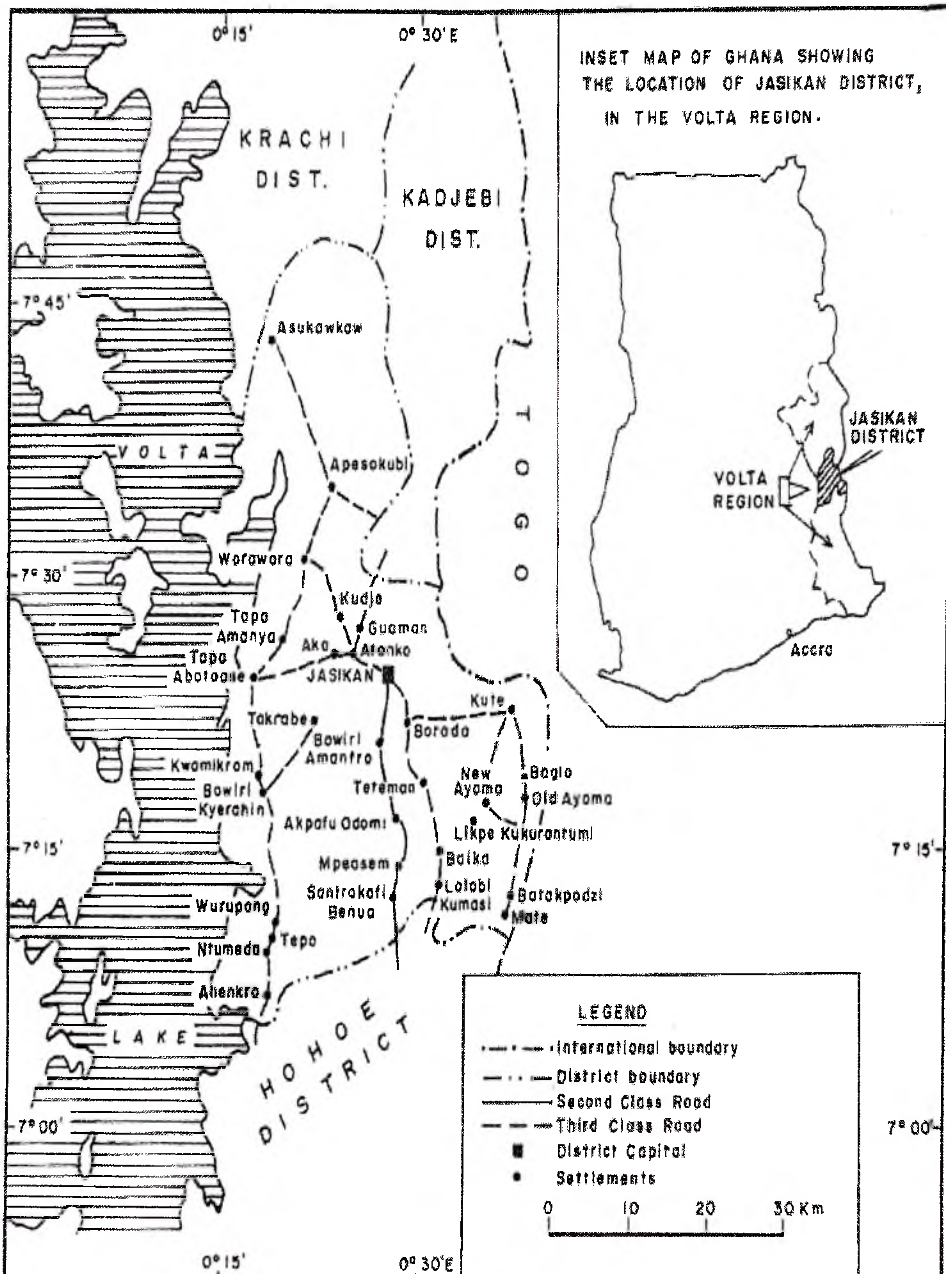
Managerial ability and other socio-economic factors affect the production function, but are usually not accounted for. One cannot help but agree with Heady (1954) that it is difficult for a single algebraic model to adequately describe the complex agricultural production with its ranges of complementarity and the competition between resources and products.

In view of all the problems discussed above, researchers in the developing countries have always warned that productivity parameters and the implications drawn from them should be regarded as indicative rather than firm or definite policy prescriptions. However, when survey is carefully planned and executed, and the most appropriate analytical tools used, the results could give fairly reliable direction of policy prescriptions for agricultural development strategies (Ogunforawora et al, 1974).

1.8 Organisation of the study

The study is organized into five main chapters. Chapter One introduces the research topic. Chapter Two which is the literature review, puts the study in the body of existing knowledge. Chapter Three entails a detailed description of the methodology used in addressing the set objectives. Chapter Four presents the analysis and discussion of results while the summary, conclusion and recommendations are presented in Chapter Five.

FIG. I A MAP SHOWING JASIKAN DISTRICT



SOURCE: Jasikan District Assembly Office, JASIKAN.

CHAPTER TWO

LITERATURE REVIEW

This chapter presents literature that puts the research work into its right perspective. It takes a look at some critical issues in beekeeping as a whole. The literature covers what beekeeping actually is, importance of the venture and some methodological issues.

2.1 Beekeeping

Beekeeping: or bee-having involves bees being housed in hollowed sections of tree trunks, clay pots, gourds, straw, and mud containers and managing or manipulating them for their products such as honey and beeswax and propolis. Combs containing honey are removed periodically and those containing brood (larvae) are left. This can take place near one's residence or on plantation farms. According to Gentry (1984), beekeeping is the most developed stage in the historical development of the bee-human relationship. The first stage is bee killing. The second stage is bee-having or beekeeping.

With the passage of time, modern equipment like the Langstroth hive, Tanzania transitional hive, Kenyan top-bar and movable comb frameless hives, are gradually replacing the traditional bee hives listed above.

An apiary: (or bee yard or bee farm) is a place where beehives are kept. In the United States, Canada and Australia, an apiary can contain a hundred or more bee colonies. Where there are plenty of nectariferous trees for bees to enjoy, 100 colonies crowded in a small area can obtain their food supply without any trouble. According to Adjare (1990) an apiary in Africa, should contain only about 10 hives per km^2 due to the low number of flowering plants in tropical vegetation zones compared to temperate climate and the high incidence of bushfires.

Hive colonization: is not automatic, but most beehives installed and baited will be colonized. The time required for colonization varies from place to place depending on the environmental characteristics. The earliest time known is within 20 minutes after installation (Adjare, 1990). Hives sited very close to residential areas may take a long time to attract bees and hives sited near large quantities of flowering plants will generally be colonized rapidly.

2.2 Seasonal and Brood-rearing Cycles[1]

Seasonal cycle: Tropical bees work all year round. There is no need to over-winter them or keep them indoors as in temperate regions. In contrast to temperate-zone bees that swarm once a year, the tropical bee has two main swarming seasons: one in December/February and the other in June/ November. It is during these two swarming seasons that the beekeeper should get bees in his hives.

An energetic queen always heads a good swarm. An average swarm weighs between two and three kilograms and contains between 7000 and 9000 bees. Absconding colonies are however larger than this. They sometimes number over 50, 000 bees. The day they arrive at a hive, most of them hang themselves in festoons and build combs to enable the queen to start laying.

Brood-rearing cycle: It takes place after the main rainfall season, when flowers begin to bloom. In forest and high savannah areas, brood-rearing occurs between August and early October and from March to April. This stage is characterized by

[1] See Adjare S. O. (1990), "Beekeeping in Africa". *FAO Agricultural Service Bulletin,* 68/6, 130

intense activity in the colony. Food is usually abundant. Comb builders need to work fast to enable the queen to lay; nursing bees must feed the young brood; pollen, nectar and propolis must be collected; water must be carried to dilute brood food; and all repair work at the security gate must also be performed.

At the peak of the brood-rearing stage, a good queen may lay over 2000 eggs a day, a load heavier than her own weight. The population of the hive increases rapidly, and sometimes the workers cannot supply enough empty cells to enable the queen to lay more eggs. When this situation occurs, the colony may prepare to swarm. Queen and drone cells will be constructed, the queen will lay drone eggs, and queens will be raised in preparation for the swarms.

2.3 Pests and Diseases

Adjare (1988) noted that several diseases affect bees. Some are known to man and others are still unknown. He mentioned some of the diseases as the American Fowl Brood and the European Fowl Brood. Investigations are still continuing in other parts of the globe to identify bee diseases. He also stated that in our tropical region, where beekeeping is an infant industry, not very much is known, but it is believed that more diseases identified in the temperate regions and elsewhere also prevail in the tropical climate. Therefore a judicious study must be undertaken in the tropics to identify and combat such diseases if we want to get the maximum benefit from our efforts.

The bees have a number of pests due to the substance they produce (Awuku et. al., 1991). According to them ants are the most important pests. They steal honey. Wax moth is another destructive pest, which lays its eggs in the comb cells, and when the larvae hatch they eat the wax and destroy the comb cells.

Gentry has stressed that, diseases are of more a problem where intensive beekeeping is carried out because of the large number of colonies concentrated in small areas. He continued that the economic impact of diseases is also greatest where the financial investment in beekeeping equipment is the greatest (Gentry, 1984).

2.4 Importance of Beekeeping

Honeybees are kept by man because of the valuable products they produce and also the role they play in pollination. According to Radionov and Sharbarshov (1986), when a bee is collecting nectar or pollen, hundreds of thousands of pollen grains that are male gametes of plants, stick to the bees hairy body. Upon landing on a new flower of the same species or even of another one, the bee not only gathers pollen from the flower but it simultaneously deposits on it some pollen from another blossom. In this way flying from flower to flower, bees pollinate them, promoting the richest setting and high quality of fruits.

Bees are effective pollinators and may be a contributory factor to crop yield. Hambleton (1954) noted, "The most important service that the bee renders to mankind is pollination of fruit crops". The fact that bees are important in pollination is not new, but the fact that honeybees are becoming indispensable in our agricultural economy may be considered as relatively new. It has been estimated that the value of bees in pollination exceeds ten (10) to twenty (20) times their value in production of honey and bees wax," Adjare (1990). He also stated that the value of pollination of fruits, vegetables and seeds in the United States of America, totalled very close to $8 billion in the 1960's, and 20 years later the figure is probably close to $20 billion. He went on to calculate that foods derived from insect pollinated plants represented about one-third of the total food consumed in the U.S.A. In 1970, this amounted to $40 million. (http://www.fao.org/docrep/t0104e/T0104E0b.htm). He concludes:

"Many parts of the world are blessed with similar variety and nutritive quality in their available food supply. If less fortunate parts of the world are to improve their diets to include more meat, dairy products, fruits and vegetables, there will be the need for great world-wide increases not only in bee pollinated crops but also in bees and bee-keepers to carry on the pollination and particularly an increase in knowledge and understanding of what a potent force in food production and human nutrition and honey bee activity is".

There is the need for such an activity (pollination by insects) in the African agricultural economy, where hunger, malnutrition and desertification are enormous problems. In Africa many crops depend on the wind for pollination, including cereals: millet, guinea corn, maize and rice. Plantain, cocoyam and yam also do not need insects to pollinate them. Most leguminous vegetables, cash crops such as coffee, cola nut, cocoa, coconut, palm, cashew and shea butter, fruits such as mango citrus and many other plants cannot be pollinated without insects (Adjare, 1990). Root (1962) also stated that the pollination activity of bees help growers keep their strains pure.

Hertz (1993) also pointed out that honeybees have always been connected with honey production but in reality the value of pollination job done is of much importance. He continued that pollination in many crops is as important as water and fertilizer for a good harvest. That is the reason why honeybees are a matter of concern for not only beekeepers but also for farmers and vegetable growers and agronomist as well.

According to Khalise (1991), the nutritional value of bee products (honey, pollen, beeswax, and propolis) is very high and can be used to supplement the diets of the people in the rural areas. In her contribution, Crane (1990) pointed out that honey is produced in every country and 90% of the world's production is eaten directly as honey. The remaining 10% is used in baking, confectionery, fermentation to alcoholic drinks, tobacco curing and the manufacture of pharmaceuticals and cosmetics.

Radionov and Sharbarshov (1986) believed that a secondary valuable and essential product derived form honeybees is wax. Adjare pointed out that the tropical bee produce less honey than the Apis Mellifera in the temperate zone, but the tropical bee is a superior producer of wax. The substance possesses unique properties found in no other element in nature, and it can preserve its qualities for hundreds of years. In the distant past, beeswax functioned as currency, serving as the reference standard in commodity exchange on the international market (Adjare, 1984).

There is great scope for broadening the base of beekeeping in developing countries. However poor a man may be in terms of land or money, it is quite likely that he can increase his income by keeping bees at a level suited to its locality and his individual capability. It can be integrated conveniently into the normal farming system because it does not have any negative effect on the normal activities of the farmer but brings him additional income at the end of the year. This additional income will assist in bettering the living standard of the farm family (Ababio-Danso, 1996).

In Egypt, the Coptic Organization for Social Services has distributed thousands of modern hives in El-Minia and Assiut Governorates to help increase the income of the farmers through beekeeping (Newsletter for Beekeepers, No. 8, 1986)[1]. Honeybees have also been utilized for the pollination of certain crops in newly reclaimed lands (Rashad, 1976). At the moment expansion of modern beekeeping in new reclaimed lands, isolated stations for queen rearing and planting of more honey plants have been identified as urgent needs in Egypt's beekeeping industry (Hussein, 2000).

Morocco, Tunisia and Algeria have formed a regional grouping aimed at improving the production and living standards of rural people through beekeeping. They have initiated a program called "Improvement of Technical Capabilities in Apiculture Production". Women are being encouraged to go into beekeeping in Morocco and in line with that, a project for "Development of Women's Apicultural Cooperatives" (TCP/Morocco/6653), has been established. Four demonstration apiaries have been built to provide training for women and development of Women's Apiculture Co-operatives.

Observations recorded in the "Apicultural Section" of the "National Agricultural Laboratories" in 1971, indicated that beekeeping project could be expanded rapidly into a major source of income for farmers in Kenya (Kigatiira, and Wamura, 1980). "Kenya National Beekeeping Station", has been established in the Mount Elgon District of Kenya, for training 15 women's groups (Bjorklund, 1987). Kenya has also advanced efforts to complement traditional hives, by propagation of Kenya top-bar hives, but irregularity of extension visits, costs of wood, and equipment, have been the limiting factors (Clauss, 1989).

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[1] See Hussein, M. H., 2000 "Beekeeping in Africa". North, East, Northeast and West African Countries. Plant Protection Department, Faculty of Agriculture, Assiut University, Egypt.

Tanzania has been one of the largest exporters of wax in the world. In 1973, 275 tons were exported. In Handern District, mean yield/traditional hive, is 15 kilograms of honey. Assuming that 1/2 to 2/3 of harvested wax is obtained for export, the number of colonies must be between 800 thousands to a million (Hussein, 2000). In 1991, 86.4 tonnes of "organic" honey were exported to United Kingdom and Netherlands. Arusha branch of "Wildlife Conservation Society of Tanzania", is funding "Hadza Beekeeping Scheme", to assist traditional hunters to sustainably use their environment through production of honey and wax.

In Uganda, "Tropical Projects Ltd", is a company that specialises in beekeeping extension. They have 150 beekeepers and over 2500 colonies. Seventy women in this group have specialized in collecting honey and wax in large quantities for sale. They have formed an important link in the marketing chain, which is enhancing the industry. Orders for honey are received from Arabia, France and Germany (Hussein, 2000).

In Bas Congo, placing of hives in the forest areas has encouraged villagers not to disturb the forest for as long as possible, particularly where there are a significant number of beekeepers in the village. Beekeeping has provided additional income to farmers and the return from several hives provides useful income to cover the cost of school fees, clothing and medical expenses. This gives the forest fallow added value. It is not uncommon to find up to ten hives in a hectare of forest yielding from 50 - 100 litres of honey per annum which currently sells at $2 per litre (Latham, 2000).

In Sarangarajan's article "Apiculture, A Major Foreign Exchange Earner", he noted that beekeepers co-operative society in India claim that a beekeeper who invests Rs 1 lakh (100,000 Rupees) for raising colonies and towards the cost of providing artificial feeding, can realise the entire amount, in addition to profit, within a year. The society has registered moderate sales ranging from Rs 60 lakh to Rs 65 lakh in the past three years. The society finds marketing a Herculean task. Apart from beekeeping and marketing, honey could be promoted under a self-employment scheme among rural youth in a big way to improve the rural economy, especially when national resources are available in Kanyakumari district (Sarangarajan, 2000).

2.5 Beekeeping in Ghana

Ghana is a typical tropical country. Evergreen rainforest occupies the central part of Ghana. A narrow strip of the southern coastal lands as well as the northern areas, are covered with the savannah vegetation that is rich in bee forage (Hussein, 2000). In Ghana and other parts of West Africa, the honeybee-man interactions, are the same as other tropical regions, where numerous species of bees occur. Honey hunters exploit feral nests of Apis Mellifera. Adansonii, as well as stingless bees. In West African sub-region, honey season occurs from September to April and a minor peak in November-December.

Beekeeping in Ghana started in the early 1960's but was not successful (Adjare 1990). The failure was due to the fact that, the Caucasian bees, which were imported into the country, could not stand the harsh environmental conditions. This caused active beekeeping in the country to be shelved for almost a decade.

"Technology Consultancy Centre" (TCC) started its beekeeping programme in 1978, yet no government or aid agency has made any attempt to develop traditional beekeeping. From 1981 to 1989, more than 20 "Beekeeping Workshops" and short "Beekeeping Courses" were organised when several Caucasian bee colonies were imported. Since then a lot of work has been done in the area of developing beekeeping in various locations in the country. At present beekeeping clubs and societies can be found all over the country.

Honey production for both the local and external markets, have been identified as important steps toward income generation. In view of this chemical analysis of honeys from different regions in the country have been determined, with the view of their use in food industry (Doddo and Aidoo, 1999). Production of wax is urgently needed by many manufactures and beekeepers are being encouraged to try commercial production.

2.6 Studies in Profitability

There is no one best technique for estimating project worth. The techniques available are all financial and economic measures of investment worth and are only tools for decision-making. However some are especially deficient. There are two broad methods that are usually used. They are the discounted and undiscounted measures.

The undiscounted measures include: ranking by inspection, payback period, proceeds per unit outlay, average annual proceeds per unit outlay and average income on book investment. There are two main problems that have been identified with these measures. They fail to cater for projects that last several years and have different shaped future costs and benefit streams and also those with varying sizes. In short they do not take care of the time value of money. These problems make them inefficient measures for project worth.

The usual method of addressing these is through discounting. There are four main discounted measures[2] suitable for application to agricultural projects. These are: net present worth (NPW), internal rate of return (IRR), benefit-cost (B/C) ratio and net benefit-investment (N/K) ratio. The arithmetic of these discounted measures, and the way we interpret the measures and their limitations are exactly the same whether we are using financial or economic analysis. The difference is only whether we apply the techniques to financial or economic values (Gittenger, 1996).

2.6.1 **Managing Profitability in Beekeeping**:

Over the years, several studies have concluded that beekeeping is not profitable. However, it is necessary to define what that means based on an individual operator's experience. As with management goals, components of profitability must also be defined. This is encompassed in the term "enterprise analysis" (Sanford, 1984). The profitability components are size of operation and cost classes.

Size of operation: Economies of scale figure prominently in determining profitability. Studies in Canada have shown that operations with 500 to 700 colonies appear to be most efficient. This appears to correlate with the highest number of hives a single person might effectively manage. As employees are added, this takes a toll on profitability potential. That does not mean that large operations are inherently inefficient or not profitable, only that there are many more variables to consider as size increases.

Cost Classes: Cost considered in beekeeping profitability include those associated with capital and operations. Labour is considered a special cost because of

[2] See Prest and Turvey (1966), Merrett and Sykes (1973), Bierman and Smidt (1980) and Irvin (1978).

its importance in managing bees. The relatively high labour costs in comparison to capital investment makes beekeeping a good development tool in developing economies (http://www.ifas.ufl.edu/~mts/apishtm/apis84/apsep84.htm#1). Many beekeepers decide not to pay themselves as labourers and consequently these figures do not make it into calculations and analysis of an operation.

Two other cost classes are fixed and variable. The former is independent of production activity. Fixed costs are incurred whether or not bee management yields marketable results. Variable costs are dependent on the amount of capacity produced by an operation. Both should be analysed individually, as well as their relationship to one another. Traditionally, fixed to variable cost ratio analysis have been used in many enterprises. Unfortunately, it is also variable and can only be adequately analysed with reference to the standard or average ratios found in the enterprise as a whole. Those for beekeeping and for many agricultural operations are not known. (http://www.ifas.ufl.edu/~mts/apishtm/apis84/apfeb84.html#2).

Cash is the most important thing to be remembered in any business operation. Cash flow analysis, therefore, becomes the yardstick by which any beekeeper can determine whether or not an operation is profitable. An annual financial analysis or check-up is in order for operations, and this can prevent unseen or unexpected costs from damaging the enterprise (Sanford, 1984).

2.6.2 Case Studies of Profitability in Beekeeping

Unfortunately, case studies of individual beekeeping operations are extremely rare. In addition, surveys of costs and returns are also generally not available. Hoopingarner and Sanford published the most recent in the American Bee Journal.

Another is currently taking place under the auspices of the American Beekeeping Federation.

Tom Sanford's 1996 report on "Case Studies of Profitability in Beekeeping" in Minneapolis highlighted the major cost centres in the beekeeping business in some parts of Canada and America. Cost centres differed from beekeeper to beekeeper. Those that cut across were hired labour, feed costs and utilities. Per colony costs ranged between $62 and $100. The high per colony cost of $100 was attributed to labour cost of the owner /entrepreneur. That of the entrepreneur was $50/hr while that for hired labour was just $8/hr (Sanford 1996).

Hoopingarner and Sanford (1990), also studied Costs of Beekeeping. Data was collected through the mailing system of survey research. The average colony yield was 90 lb, cost of honey was $0.75/lb and average cost per vehicle was $12,519. The number of apiary visits per year was between 9-11 trips per year.

Ayers (1992) in his document on "Exploring the Economics of Planting for Bees", argued on how inappropriate Hoopingarner and Sanford's methodology for collecting data was for his kind of work. He argued that "while this technique worked well for them and provided many interesting insights into the economics of beekeeping, it isn't possible in this instance because few beekeepers plant for bees and those who do rarely keep records. Even if records were kept, it is hard to imagine in most cases that adequate means of evaluating results would be available" (Ayers, 1992). While the former authors used quantitative statements, Ayers resorted to the use of qualitative statements due to the numerous factors that affect profitability. He concluded that, if a beekeeper were surrounded by (1) large amounts of (2) high quality bee forage for (2) the entire summer, it would not be profitable to plant for bees. However, if the first two factors are absent then profitability of planting for bees depends on (a) size of the beekeeping operation, (b) availability of land for planting, (c) maintenance needs of the plant and (d) other uses the plant can be put to apart from bee forage (single versus multiple use plantings)

2.7 Studies in Resource Productivity

Studies in resource productivity can be divided into two broad categories. The first category is micro-oriented, focusing on resource use efficiency in the individual enterprises such as maize, cotton and other crops produced in a sample of farms. The underlying assumption of this category of studies is that the main objective of any producing unit is to coordinate and utilize resources or factors of production in such a manner that together they yield the highest net returns (Saini, 1969). This category of studies thus provides quantitative estimates, which could be used as a basis for efficient allocation of resources at the farm level. They could also suggest necessary modifications in the production practices and the pricing policies, which could improve the profitability of the enterprises concerned.

The second category of resource productivity studies involves the comparison of resource productivity between enterprise groups such as crops versus livestock enterprises, or export versus food crops enterprises. The category of studies provides quantitative estimates, which could guide macro-level allocation decisions on these groups of enterprises. They do not however indicate the magnitude and the direction of needed adjustment within a particular enterprise group. Budget analyses are often used to supplement production function analyses in overcoming this shortcoming (Heady, 1954). When done on a national or regional basis, the results could provide policy makers with relevant information on how to achieve an optimal allocation of the limited development resources among regions or provinces producing these groups of enterprises.

2.7.1 **Measurement of Resource Productivity**

The simplest method of measuring resource productivity is in terms of individual input-output ratios. For example, labour productivity can be measured in terms of ratio of total output to the total inputs of labour. In terms of aggregate output-input framework, resource productivity in crop production, for example, can be measured as an index of total output of crops to the index of total inputs used in crop production (Olayide, 1972).

These indices enable the farmer to determine whether to modify the intensity of resource use or whether attention should be directed towards improving production efficiency of the existing enterprises so as to obtain higher yields. Resource productivity indices for the component farm enterprises could be calculated and used to obtain a pattern and direction of resource adjustment on the farm.

The other two analytical tools commonly used for studying resource productivity are the Linear Programming and the Production Function analyses.

Linear Programming

In a typical linear programming analysis, the magnitudes of the marginal value productivities of fixed resources are obtained as by-products of the conventional linear programming solution. The elements in the Z-C row of the disposal activity columns represent the marginal value product (MVP) of these resources and are regarded as the measure of the ceiling that should be set in acquiring extra resources. By conducting linear programming exercises for different regions, the MVPs of resources can be compared and used as the basis for resource adjustment and pricing policies.

The linear programming approach has two shortcomings. First, only resources that are exhausted in the production process have marginal value productivities in the final solution, resources that are in surplus supply have zero marginal value products. Second, the marginal value productivities of resources relate only to their use in the given enterprise system considered in the programming exercise; their marginal value productivities may differ significantly when used for the production of the individual enterprises that comprise the system (Ogunfowora et al., 1974).

Production Function

The production function is a mathematical relationship between the production of a given output and the factors affecting the production process. The production function has been the traditional tool for analysing problems of resource productivity and returns to scale. It does not only provide a direct measurement of the parameters of resource productivity but it also overcomes the shortcomings of the linear programming approach. A number of functional forms – quadratic, linear, Spillman, square root, power functions and variants of these – are possible in the production function studies, but functions estimated from farm samples ordinarily have been power or linear forms because of the relative ease of computation and the smaller degrees of freedom involved in estimating the parameters (Heady and Dillon, 1996).

Quadratic and other functional forms fitted to farm samples generally lead to a loss of many degrees of freedom and often results in too many regression coefficients which are not often significant in the a probability sense. The linear and power functions are particularly useful where interest revolves around the quantitative estimation of resource productivities at the means of input (Ogunfowora et al., 1974).

2.7.2 **Factors Affecting Honey Production**

From the classical theory of production, capital and labour have a positive relationship with output (Koutsoyiannis, 1982). In a study on "Methodologies, Organization and Management of Global Partnership Programmes" in apiculture and sericulture, Herren (2001) stated that "Productivity escalates with increasing number of improvements and with time as natural, social and human capital are accumulated. Each type of improvement can make positive contribution to rising production, however the real dividend comes with combinations". Improvements, natural, social and human capital are accumulated with the passage of time. The accumulation of these could be collectively referred to as management skill. Management skill is hence expected to have a positive relationship with output. According to Sanford (1998), size of operation also has a positive relationship with the efficiency of honey production.

In answering the question of the various factors that influence the size of the United States of America honey production, it was realised that weather, agricultural practices and the economics of the honey industry played a major role (http://www.suebeehoney.com/honeyfacts.html#12). In an article by the Ministry of Agriculture, Fisheries and Food in Vernon 1996, "Planning for Profit", the weather, available forage and hive populations were found to be the key factors affecting honey production (http://fbminet.ca/bc/pfp/Ent.pdf/HONYSI96.PDF). However when dealing with a relatively smaller area where environmental conditions are constant, weather condition becomes a less important variable in factors that affect beekeeping in that area.

2.7.3 Resource Use Efficiency Applications

In analysing the resource productivity in traditional agriculture in the Kwara State of Nigeria, Ogunfowora et al. (1974), used the Cobb Douglas production function. They run both the power and linear functions and used marginal value product as a yardstick of resource productivity. Land was found to be very important to agriculture in that region, and its MVP showed the potential acquisition value of land. The study as a whole showed clearly the unproductive nature of Kwara State Agriculture.

Phiri (1991), examined the resource efficiency of maize, cotton and groundnut farmers using gross margin analysis. Assuming that efficiency is a relative measurement rather than the neoclassical economic definition where marginal factor costs are equated to marginal revenue products, the study uses output values as opposed to mere total volumes produced. In another study by Olagoke (1991), a production function using the ordinary least squares method was used to derive the marginal products of rice production inputs. The marginal physical product and marginal value product estimates were estimated to judge the efficient use of resources. Both authors differed on the measurement of labour input. Olagoke includes family labour while Phiri excludes it based on the assumption that family labour was similar across all the respondents.

Dittoh (1991) examined the relative economic efficiencies of different irrigation systems in Nigeria using a profit-function approach. Factor demand functions were used to test for relative price efficiencies. The analysis showed that labour was used inefficiently on large farms, while fertilizers were used inefficiently on small farms.

In examining returns to scale and optimal output in beekeeping in Malaysia, Habibullah and Ismail (1992), found out that 90% of the beekeepers in the sample experienced increasing returns to scale. The objective of the research was to determine the returns to scale and the optimal output of a sample of Malaysian beekeeping data, employing the ray-homothetic production function.

Conclusion

Beekeeping offers a unique opportunity for increasing incomes of large numbers of smallholders and landless farmers. Local and international non-governmental agencies have played a significant role in its development in many developing countries. The efforts by these agencies have contributed to the springing up of bee clubs and cooperatives, which are harnessing the potential of this business.

In managing profitability of beekeeping, the most important areas of concern are the size of operation and the two main cost classes, fixed and variable costs. Labour cost is considered as a special cost and although it is very high in the European countries, it will be interesting to find its significance in a developing country like Ghana and Jasikan district to be specific.

In looking at the best method to use to measure resource productivity, the literature has revealed that the production function approach is a better option than linear programming, since it overcomes the marginal productivity for surplus supply and enterprises that comprise a system problems. Also some of the important variables that affect honey production include: size of operation, management skill, labour and capital.

However, empirical literature on the economics of beekeeping is generally dominated by works on large-scale beekeeping enterprises in developed countries. Very little of such literature can be found in developing countries. This study will contribute toward filling this gap.

CHAPTER THREE

METHODOLOGY

Introduction

This chapter presents the study's methodology, which includes the theoretical framework and analytical tools adopted to address the study objectives. This section presents the description of the data requirements, data collection and data sources, and sampling techniques.

A theoretical framework was developed for estimating profitability and efficiency of resource-use as well their method of analyses. However in describing the socio-economic characteristics, marketing and problems facing apiculturist in the district qualitative analysis was used.

3.1 Estimating Profitability

3.1.1 Theoretical Framework

This research adopts the benefit-cost measure of project worth. The benefit-cost ratio is defined as the present worth of the benefit stream divided by the present worth of cost stream. This provides a set of rules to determine whether any element of expenditure should be undertaken. If the Benefit-Cost Ratio (BCR) is greater than one (1), the venture could be considered profitable. If BCR is less than one (1), the venture is considered as non-profitable. If it is equal to one (1), the venture is said to break-even.

The information for the calculation of the benefit-cost ratio for this study is obtained from a farm income analysis. Farm income analysis is generally used to evaluate the performance of a farm in a particular year. Its objective is to help improve the management of the farm. Current prices are used and a depreciation allowance is included to account for the portion of longer-term capital investment used up in the year being considered. Noncash items such as home-consumed production and payments in kind are included. Off-farm income and expenditure are excluded because the analysis is intended to evaluate the performance only of the farm itself. The analysis provides return to capital as one of its estimates (Schaefer-Kehnert, 1980).

3.1.2 **Method of Analysis**

In estimating the fixed cost, we use its amortized value. This is obtained by using the straight-line method of depreciation.

Depreciation:

$$DFC = \frac{Co - S_v}{N} \quad \text{................}(1)$$

DFC = Depreciated fixed cost
C_O = Original value
S_V = Salvage value
N = Expected useful life

Total Depreciated Fixed Cost:

$$TDFC_i = \sum_{j=1}^{j=k} DFC_{ij} \text{.......} (2) \qquad \text{Where } i = 1,2,3\text{........}n$$

$TDFC_i$ = Total depreciated fixed cost for the i^{th} beekeeper.
DFC_{ij} = Depreciated cost of the j^{th} fixed input component of the i^{th} beekeeper.
k = Number of fixed inputs

Variable cost arises from employing variable inputs. Summation of the cost of all the individual variable input components gives the total variable cost (TVC).

Total Variable Cost:

$$TVC_i = \sum_{j=1}^{j=m} VC_{ij} \ldots\ldots\ldots\ldots(3) \qquad i = 1,2,3\ldots\ldots n$$

TVC_{ij} = Total variable cost of the i^{th} beekeeper
VC_{ij} = The cost of the j^{th} variable input of the i^{th} beekeeper
m = Number of variable inputs

Labour cost arises from employing labour to do the various time-consuming activities. Summation of the cost of all the labour components gives the total labour cost.

Total Labour Cost:

$$TLC_i = \sum_{j=1}^{j=l} LC_{ij} \ldots\ldots\ldots\ldots(4) \qquad i = 1,2,3\ldots\ldots n$$

TLC_i = Total labour cost for the i^{th} beekeeper
LC_{ij} = The cost of the j^{th} labour input of the i^{th} beekeeper
l = Units of labour input

Total cost which is the sum of all the costs incurred in the beekeeping production is given as the sum of all the cost items calculated above.

Total Cost:

$$TC_i = TDFC_i + TVC_i + TLC_i \ldots\ldots\ldots\ldots\ldots(5)$$

TC_i = Total cost of the i^{th} beekeeper

Revenue from each enterprise is obtained by multiplying the average of the 2000/2001 prevailing market prices by the quantity of honey harvested.

Total Revenue:

$$TR_i = P \times Q_i \text{...........}(6) \qquad i = 1,2,3\text{.........}n$$

TR_i = Total revenue of the i^{th} beekeeper
P = Average market prices of the year 2000/2001 in cedis
Q_i = Honey output harvested over the season in kg by the i^{th} beekeeper

The difference between the cost of production and revenue from the business is given as the net revenue.

Net Revenue:

$$NR_i = TR_i - TC_i \text{............}(7) \qquad i = 1,2,3\text{........}n$$

NR_i = Net revenue for the i^{th} beekeeper
TR_i = Total revenue for the i^{th} beekeeper
TC_i = Total cost for the i^{th} beekeeper

Benefit Cost Ratio:

From the above computations profitability is captured through the use of the Benefit-Cost Ratio defined as:

$$B/C.Ratio = \frac{\sum_{t=0}^{t=T} (TR_{ti})/(1+R)^t}{\sum_{t=0}^{t=T} (TC_{ti})/(1+R)^t} \text{.......... ....}(8)$$

TR_{ti} = Total Revenue for i^{th} input in time t.
TC_{ti} = Total Cost for i^{th} input in time t.
t = Time Period, for $t = 1,2,3......n$
R = Discount Rate
$1/(1+R)^t$ = Discount factor

This formula is usually suitable when considering a project over a period of time "t.", but in this study benefits and costs cover just the 2000/2001-production year, thus the formula becomes a simple ratio of the benefits to costs or total revenue to total cost.

$$TR_i / TC_i \quad \text{.................(9)}$$

Interpretation of this result could be taken as return to capital invested. This gives value of returns per cedi of investment. Results for this computation will be compared with that of other foodstuffs cultivated in the area to determine their relative profitabilities.

3.2 Estimating Efficiency of Resource Use

3.2.1 Theoretical Framework

Efficiency is a relative term and it is never absolute; it is always relative to some criterion. The criterion for economic efficiency is value. A change that increases value is an efficient change and any change that decreases value is an inefficient change. Economists are interested in economic efficiency for two reasons, one positive and the other normative. The positive reason is based on the observation that people search for value.

Economic growth, particularly, in the agricultural sector depends ultimately on the impact of productive resources and the efficiency with which they are used (Norton and Alwang, 1993). In simple terms, improved efficiency means getting more output for the same input used by allocating them in a better way.

3.2.2 Method of Analysis

The production function approach is used in this study. The power and linear forms are fitted to the data. The postulated relationship between the dependent and explanatory variables is expressed as follows.

$$Q = f(V, L, K, M) \qquad (10)$$

Linear: $Q = a + a_1V + a_2L + a_3K + a_4M + U_i$ ....(11)

Non-Linear (Power function): $Q = \alpha V^{\beta_1} L^{\beta_2} K^{\beta_3} M^{\beta_4} e^{u}$ ....(12)

$$LogQ = Log\alpha + \beta_1 LogV + \beta_2 LogL + \beta_3 LogK + \beta_4 LogM + .\varepsilon \qquad (13)$$

Q = honey output (Cedis)
V = size of apiary (No. of hives)
L = labour (Cedis)
K = capital (Cedis)
M = management skill (No. of years)

The $a's$ and the α and $\beta's$ are the regression coefficients and the U_i and ε are the error terms for the equations. In equation (13), the coefficients are the elasticities of production in respect to the corresponding inputs. Diminishing returns holds true if the exponent for any one resource is less than unity, implying that the productivity of that resource declines as more of it is used while holding the others constant at some specified level.

With reference to the information on factors affecting honey production in the literature review, it is assumed that the aproiri expectations for all the explanatory variables (labour, capital, management skill and apiary size) are positive, implying that an increase or decrease in any of the variables will lead to a corresponding increase or decrease in the output respectively.

A farm business is said to be price efficient or allocative efficient if it maximizes profit by equating the value of the marginal product of each variable input to its price (Olagoke, 1991). Thus the allocative efficiency index for each farm business in a given location is calculated as follows:

$$MVP_{ij} = P_j \; MPP_{ij} = r_{ij} \; k_{ij} \ldots\ldots\ldots\ldots(14)$$

MVP_{ij} is the marginal value product of the i^{th} input for the j^{th} beekeeping location, MPP_{ij} is the marginal physical product of the i^{th} input for the j^{th} beekeeping location, P_j, the price of output, r_{ij} is the average price of the i^{th} input of the j^{th} beekeeping location and k_{ij} is the allocative efficiency parameter of the i^{th} input for the j^{th} beekeeping location.

However, in this study, the dependent variable, Q (the gross value of honey output) is measured in cedi values. Thus marginal value products and marginal revenue products (partial derivatives of output or revenue terms of the variable inputs) will be equal in this analysis. Thus P_j, the price of output, is no longer relevant and the allocative efficiency index may be calculated as,

$$k_{ij} = MVP_{ij} / r_{ij} \ldots\ldots\ldots\ldots\ldots(15)$$

Size of apiary is measured by number of hives and management skill in number of years spent in the beekeeping business. The allocative efficiency indices for these inputs measured in physical units are calculated using equation (15). The price of the beehive was assumed to be equal to the cost of depreciation for the period of study, however no value in monetary terms was assigned to management skill.

For the remaining inputs such as labour and operating expenses, which are measured in value (cedi) terms rather than physical units, their allocative efficiency parameters are calculated as

$$k_{ij} = MVP_{ij} \ldots\ldots\ldots\ldots\ldots(16)$$

The allocative efficiency index is a measure of efficiency in resource use.

If $k_{ij} < 1$, resource is over-utilized

If $k_{ij} > 1$, resource is under-utilized

If $k_{ij} = 1$, resource is efficiently utilized

3.3 Qualitative Analysis

The qualitative analysis covered, a description of marketing of honey and the problems that characterise beekeeping in the district. These addressed objectives three and four respectively. The information for these objectives was captured through the use of questionnaire. With the help of the Statistical Package for Social Scientist

(SPSS), the answers from the questionnaire were cross-tabulated and frequencies and percentages were used to analyse and discuss the results.

The aspects of marketing of honey discussed included the various specialized activities performed in accomplishing the marketing process. It covered exchange functions (Buying and selling), physical functions (Storage, transportation and processing) and facilitating functions. (Standardization, Financing).

3.4 Measurement of Variables

Fixed cost – The fixed items in apiculture are yearly depreciation cost on bee-shade or house, beehive, platform for the hive, veil, smoker, gloves, knife, hive tool, bee suit, rubber boots, bowl/collector, extractor, flashlight and storage facility.

However equipment such as cutlasses, flashlights, boots and knives are multipurpose in the sense that they are used for other activities apart from the beekeeping business. This gives rise to the problem of trying to allocate cost to these multipurpose implements. In this case implements that are used specifically and exclusively for beekeeping, i.e. beehive, bee suit, smoker, veil, extractor and well-constructed shed, are the items to which depreciation is applied.

Variable costs – In this study variable cost include cost of broom, grease for protecting hives from ant attack and nylon net used in straining the honey from the combs.

Labour costs – they are the cost imputed to the use of labour. They are calculated by determining how much time will be needed by an individual in all the activities that are involved in the beekeeping business for a specific year or period of interest. The labour unit is in man-days but it could also be calculated in monetary terms. A man-day in this study is assumed to be six (6) hours. This assumption was made because from most of the farmers interviewed they go to their farms by 6 am and return by 12 noon. Total labour cost is therefore obtained from aggregating that for every activity.

In this study, it was difficult quantifying the time spent for some labour activities like inspection of hives, weeding around the stands and greasing of bee stands. These in practice take very little time hence in this study; time used for these activities for the whole production period is estimated as one man-day. The labour variable was largely contributed by time taken to harvest honey combs and straining honey from it.

Variables used in the production function are also measured as follows. Output was obtained from the sale of honey. It is measured in revenue terms (cedis). Capital is taken as the costs of depreciation, repairs and maintenance. This includes; depreciated fixed cost of hives, hive-stands, gloves, veil and smoker, and materials used in general maintenance. It is also measured by the cedi value of the materials. Number of years in beekeeping business is used as a proxy for management skill. Labour is also measured in mandays and the cedi value is calculated in line with cost of labour per manday.

3.5 Data Sources

The data for this study was derived from a cross-sectional survey of 82 randomly selected beekeepers using the snowballing[1] method. The 82 beekeepers were from the four agricultural zones in the Jasikan district. The questionnaire was

[1] A first contact is selected and interviewed and then asked to suggest other interviewees and so on.

pre-tested in some parts of the Ayoma and Jasikan zones with 20 randomly selected beekeepers in the month of March. The actual interview with the beekeepers started in April and ended in May 2002.

The questionnaire was designed to gather information on general characteristics of beekeepers, marketing of honey, the problems they face and production costs and returns. A detailed form of the questions from which results were used to discuss and address objective three and four can be found in Appendix 1.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

This chapter presents the results and discussions of the data analyses. A brief background is given on the socio-economic characteristics of the beekeepers interviewed. This is followed by estimates of the costs, returns and benefit-cost ratios of the whole district and its constituent zones, as well as the efficiency of resource use in the district. The data used for these two analyses, were extracted from the questionnaire and can be found in Appendices 5 and 6 respectively). The existing marketing functions and various problems characterizing beekeeping in the district are outlined and discussed as well.

4.1 Socio-economic Characteristics

Beekeepers are distributed in all the four agricultural zones of the district. The highest number of beekeepers is from Kwamikrom making up 29% of the sample. This is followed by Worawora 27%, Ayoma 26%, and Jasikan 18% as shown in Table 4.1.

Table 4.1 Zonal Distribution of Sample Beekeepers

Zone	Respondents	Percentage of Sample
Kwamikrom	24	29.3
Worawora	22	26.8
Ayoma	21	25.6
Jasikan	15	18.3
Total	82	100.0

Source: Field survey 2002

4.1.1 Gender

The sample consisted of 72% males and 28% females (Table 4.2). Although this percentage was obtained from the sample drawn, it shows that there is gender imbalance and that more must be done to encourage females to go into beekeeping.

Table 4.2 Gender of Sample Beekeepers

Sex	Respondents	Percentage of sample
Male	59	72
Female	23	28
Total	82	100

Source: Field Survey 2002

4.1.2 Age Distribution

Majority of the sample (41%) are aged between 31 and 40 years. Only 18% of the sample fall in the above 51 age group (Table 4.3). The predominant age group constitute the middle age bracket, where people generally have certain social responsibilities and as such look for extra income from other sources to supplement that from their main occupation. Also the low percentage respondents for the young (below 21), could be attributed to the fact that they are still in school.

Table 4.3 Age Groups of Sample Beekeepers

Age groups	Respondents	Percentage of Sample
Below 21	1	1.2
21-30	10	12.2
31-40	34	41.5
41-50	22	26.8
Above 51	15	18.3
Total	82	100

Source: Field Survey 2002

4.1.3 **Occupation**

The major occupation in the district is farming as reported by 85% of the sample. Other occupations are fishing, driving, electrical works, tailoring and carpentry (Table 4.4). About 59% of the respondents are exclusively farmers while the other 41% have other minor occupations.

Table 4.4 Occupations of Sample Beekeepers

Occupation	Respondents	Percentage of sample
Farmer	70	85.4
Fisherman	2	2.4
Driver	1	1.2
Electrician	1	1.2
Tailor/Seamstress	3	3.7
Carpenter	5	6.1
Total	82	100.0

Source: Field Survey 2002

4.1.4 **Marital Status**

About 87% of respondents are married, 5% are single and the status of the rest is as reported in Table 4.5. Some of the respondents have family and dependants. About 94% of those married have family and dependants, and the remaining 6% do not. The 6% is made up of young married couples. The highest number of dependants from the survey is 10, and three respondents indicated this figure.

Table 4.5 Marital Status of Sample Beekeepers

Status	Respondents	Percentage of Sample
Single	4	4.9
Married	71	86.6
Divorced	5	6.1
Widow	1	1.2
Widower	1	1.2
Total	82	100.0

Source: Field Survey 2002

4.1.5 **Education**

Most of the respondents have had some form of formal education as can be seen in the Table 4.6. Fifty-five percent of the respondents have had education to the middle school level, while only 4% of respondents have attained tertiary level education. The illiterates accounted for about 5%. This implies that most of the beekeepers can either read or write and as such should, to an extent, be amenable to any new technological change that may arise in their vocation.

Table 4.6 Level of Education of Sample Beekeepers

Level	Respondents	Percentage of Sample
Primary	13	15.9
Middle School	45	54.9
Secondary	12	14.5
Vocational	5	6.1
Tertiary	2	3.7
Illiterate	4	4.9
Total	82	100

Source: Field Survey 2002

4.1.6 **Religion**

Eighty-nine percent of the respondents are Christians. About 2% is made up of Moslems and about 9% are traditionalist (Table 4.7). This pattern of distribution of the sample for religion represents a true picture of what actually exists in the district (http://www.africaonline.com.gh/Voltahealth/volta_region.html).

Table 4.7 Religion of Sample Beekeepers

Religion	Respondents	Percentage of Sample
Christian	73	89.1
Moslem	2	2.4
Traditional	7	8.5
Total	82	100

Source: Field Survey 2002

4.2 Characteristics of Resources

4.2.1 **Hives**

All respondents use the Kenyan Top-bar hives. About ninety-two percent of respondents have hives made from only Chorophora excelsa /"Odum" wood. About 2% also have theirs made from Mahogany wood, whiles the remaining 6% have hives constructed with both "Odum" and Mahogany wood (Table 4.8). The "odum" is a relatively more expensive wood and can last over 40 years (Adjare 1990).

Table 4.8 Hive Wood-type of Sample Beekeepers

Wood Type	Respondents	Percentage of Sample
Odum	75	91.5
Mahogany	2	2.4
Odum+ Mahogany	5	6.1
Total	82	100.0

Source: Field Survey 2002

The colony with the greatest number of colonized hives can be found in Worawora. The colony has 30 colonized hives followed by 29 in Ayoma. The number of colonized hives with the highest relative frequency of about 48% is 2, followed by 1 colonized hive, which accounts for 29% of the respondents (Table 4.9).

Table 4.9 Colonized Hives of Sample Beekeepers

Number	Respondents	Percentage of Sample
0	7	8.5
1	24	29.3
2	39	47.6
3	5	6.1
4	1	1.2
5	3	3.7
11	1	1.2
29	1	1.2
30	1	1.2
Total	82	100.0

About thirty-six percent of the respondents with colonized hives harvested from 2 hives while those who harvested from 5, 11, 25 and 29 accounted for just about 1 % of the respondents each respectively. For the study period, about 27% had no harvest. The results are presented in Table 4.10.

Table 4.10 Distribution of Number of Harvested Hives

Number of Hives	Respondents	Percentage of Sample
0.0	22	26.8
1.0	20	24.4
2.0	29	35.5
3.0	4	4.9
4.0	3	3.7
5.0	1	1.2
11.0	1	1.2
25.0	1	1.2
29.0	1	1.2
Total	82	100

Source: Field Survey 2002

4.2.2 **Labour**

Although large family sizes with dependants exist in the district, farm hands are not easy to come by. About 59% of the potential farm hands are schooling hence they only offer help as and when they are on vacation. The highest percentage of family farm hands is about 12%.

Those who use paid family farm hands account for just about 5% of the sample. Thirty-eight percent of the sample do not pay their family labour, the reason being that they eat from the farm produce. Fifty-seven percent prefer using either hired labour or relatives for their farm labour. However for the beekeeping business it is usually centred on family labour.

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4.2.3 Sources of Finance

Many of the beekeepers finance the beekeeping business with their own resources as can be seen in Table 4.11. About 97% of the respondents finance the business from their own resources. About 3% of the respondents receive financial support from their relatives, while none borrow from the bank.

Table 4.11 Source of Finance of Sample Beekeepers

Source	Respondents	Percentage of Sample
Own resources	69	97.2
Relatives	2	2.8
Bank	0	0.0
Total	71	100.0

Source: Field Survey 2002

4.3 Profitability: Production Cost and Returns and B/C Ratios

The production costs and returns and B/ C ratio (main measure of profitability) for the district is presented and discussed in this section. The results from Table 4.12 show that, the gross revenue for honey production in the whole district is ¢11,702,300.00 or ¢142,711.00 per beekeeper or ¢41,793.00 per hive. The total cost of honey production is ¢3,355,315.00 for the whole district or ¢40,919.00 per beekeeper or ¢11,983.00 per hive (made up of 9% variable cost, 38% labour cost and 53% depreciated fixed cost). This leads to net revenue of ¢8,346,985.00 or ¢101,792.00 per beekeeper or ¢29,810.00 per hive. The B/C ratio is 3.49, which is greater than unity implying that the venture in the district is highly profitable. This suggests that each cedi invested, yields benefits of 3.5 cedis. The results above were obtained from a collation of data from the four zones.

Table 4.12 Cost and Returns of Beekeeping in Cedis, Jasikan District

Item	Value per Beekeeper	Value per Hive	Total Value for District
Gross Revenue	142,711.00	41,793.00	11,702,300.00
Labour Cost	15,733.00	4,607.00	1,290,075.00
Variable Cost	3,456.00	1,012.00	283,400.00
Dep. Fixed Cost	21,730.00	6,364.00	1,781,840.00
Total Cost	40,919.00	11,983.00	3,355,315.00
Net Returns	101,792.00	29,810.00	8,346,985.00

Dep. Fixed Cost = Depreciated Fixed Cost
B-C ratio = 3.49
Source: Appendix 5

Although the district as a whole presents a B/C ratio of 3.5, this ratio varies from one zone to the other. The zone with the most profitable beekeeping enterprise is Worawora with a B/C ratio of 4.51 followed by Kwamikrom (3.32), Ayoma (2.80), and the least profitable area is Jasikan with a ratio of 2.58 (Table 4.13).

Based on the average total cost per beekeeper, Jasikan had the least of ¢24,400.00 followed by Ayoma zone ¢37,950.00, Kwamikrom ¢37,990.00 and then ¢52,880.00 for Worawora (Table 4.13). It would have been expected that the zone with the least cost would be the most profitable, ceteris paribus, because from economic theory one way to increase profits is to reduce cost of production. This contrary situation could be attributed to the level of productivity of the hives in a particular zone.

Table 4.13 Costs and Returns of Beekeeping in the Various Zones, (000) Cedis

Item	Value per Beekeeper				Value per Hive				Total Value			
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Gross Revenue	106.1	88.83	126.1	238.5	26.83	41.64	44.05	51.28	2,227	1,332	2,775	4,769
Labour Costs	15.5	16.31	15.80	15.05	3.92	7.65	5.52	3.24	325.2	244.7	347.7	301.0
Variable Costs	1.66	1.20	1.68	9.30	0.42	0.57	0.59	2.00	34.90	18.10	37.00	186.0
Dep. costs	20.79	6.88	20.51	28.53	5.26	7.91	7.16	6.13	436.5	253.2	451.1	570.6
Total Costs	37.95	24.40	37.99	52.88	9.60	16.13	13.27	11.37	796.6	516.0	835.8	1,057
Net Returns	68.15	64.44	88.11	185.6	17.23	25.51	30.78	39.91	1,430	816.0	1,939	3,712

Zone 1 = Ayoma, BCR = 2.80
Zone 2 = Jasikan, BCR = 2.58
Zone 3 = Kwamikrom, BCR = 3.32
Zone 4 = Worawora, BCR = 4.51
Source : Appendix 5

Yield per hive is highest in Worawora, 8.1 kg, followed by 6.9 kg in Kwamikrom, then 6.6 kg in Jasikan and 4.25 kg in Ayoma. Also the number of hives per beekeeper is highest in Worawora with approximately 5 hives followed by 4 hives in Ayoma, 3 hives in Kwamikrom and 2 hives in Jasikan. Although the yield per hive in Jasikan was higher than in Ayoma, that zone turned out to be the least profitable due to the low number of hives per beekeeper.

The high average number of productive hives per beekeeper in Worawora and Ayoma is due to the presence of three professional beekeepers that have more than 10 hives. In Worawora one of them harvested from 11 hives while the other harvested from 25 hives. The beekeeper from Ayoma harvested form 29 hives. The Worawora zone produced 757kg of honey followed by Kwamikrom 440.5kg, Ayoma 353.5kg, and then 211.5kg in Jasikan in the 2000/2001-production year.

Farm budgets calculated for various crops in the district reveals that beekeeping is a relatively more profitable business at the district level. However when the various zonal benefit-cost ratio's of beekeeping are compared with that of plantain and yam for the district, beekeeping in Jasikan and Ayoma are less profitable (Table 4.14).

Table 4.14 Benefit Cost Ratio of Other Crops in the District

Item	Benefit Cost Ratio
Cassava	1.26
Cocoyam	1.26
Cowpea	1.51
Okro and Pepper inter-crop	1.53
Maize (minor season)	1.55
Groundnut	1.64
Cassava intercropped with Maize	2.32
Yam	2.73
Plantain	2.92

Source: GIDA, 2000.

4.4 Efficiency of Resource-use

Different production functions were selected as the lead equations, based on the magnitude of the coefficient of multiple determination, R^2, the signs and statistical significance of the estimated regression parameters as well as the overall production function as judged by the F-value, for the whole district and its constituent zones. The results are presented in the Table 4.15 and appendix 3. Descriptive statistics including mean, median, maximum, minimum, standard deviation, skewness and kurtosis of variables are reported in Appendix 4.

The F-value of the regression shows that the overall regression equation is significant at 1% level; hence the non-significance of some of the individual regression coefficients could be accommodated within limits (Heady, 1953). Heteroscedasticity poses potentially severe problems for inferences based on least squares, but one can rarely be certain that the data are heteroscedastic (Greene 1990). Ohtani and Toyoda (1980) suggest that it is best to test first for heteroscedasticity rather than merely assume that it is present.

White test for heteroscedasticity for cross and non-cross terms show that both F-statistic and nR^2 values are insignificant at all levels of significance. The results are presented in appendix 2. This implies that predictions based on ordinary least square estimates are efficient and can be relied upon.

Table 4.15 Results of Regression Coefficients for Beekeeping in Jasikan district

Variables	Coefficients	Std. Errors	T. Statistics	Probabilities	Elasticities
A	0.592741	1.193056	0.496826	0.6213	0.59
Log V	0.364155*	0.199945	1.821281	0.0740	0.36
Log L	0.313533	0.229112	1.368469	0.1767	0.31
Log K	0.709570***	0.191452	3.706254	0.0005	0.71
Log M	-0.214813	0.184077	-1.166977	0.2483	-0.21

R-squared	0.617952	F-Statistic (†)	22.24022
Adjusted R-squared	0.590166	Probability (F-Statistic)	0.0000
Standard error of Regression	0.248631	* T-values significant at 10%	
Sum Squared Residue	3.399957	*** T-values significant at 1%	
Mean Dependent Variable	0.388375	† F-value significant at 1%	
Standard Deviation of Dependent Variable	0.388375		

Source: Appendix 2

The estimates show that the explanatory variables jointly accounted for 62% of the total variation in honey output. The size of apiary in the district is significant at 10%, has elasticity of 0.36 and also meets the positive a priori expectation sign. This means that a 1% increase in apiary size will correspondingly increase the output of honey produced by 0.36%. This is in conformity with the theory of production theory, which states that as capital increases, ceteris paribus, output increases.

Labour has a-priori positive expectation sign, but is insignificant at all levels of significance (1%, 5%, 10%).

The non-significance of the labour variable could be attributed to the low labour requirement for beekeeping in the district. This could further suggest that beekeeping is an income generating activity that farmers in Jasikan District could conveniently incorporate into their farm business without worrying about its labour demands. It is in line with what Ababio-Danso (1996) who wrote: “It can be integrated conveniently into the normal farming system because it does not have any negative effect on the normal activities of the farmer but brings him additional income at the end of the year. This additional income will assist in bettering the living standard of the farm family”.

The study also revealed that capital “K” (cost of depreciation, repairs and maintenance) is significant at 1% level, with an elasticity of 0.71, and conforms to the positive a-priori expectation sign. This means that a 1% increase in capital will correspondingly increase the output of honey by 0.71%. This high percentage increase relative to other inputs suggests that it is the most important factor of beekeeping production in the district ceteris paribus.

Management skill on the other hand is not significant at all levels of significance and does not conform to the positive a priori expectation sign. The marginal value productivity for management skill is -5671.72 (Table 4.16) and could be approximated to zero.

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Based on the average total cost per beekeeper, Jasikan had the least of ¢24,400.00 followed by Ayoma zone ¢37,950.00, Kwamikrom ¢37,990.00 and then ¢52,880.00 for Worawora (Table 4.13). It would have been expected that the zone with the least cost would be the most profitable, ceteris paribus, because from economic theory one way to increase profits is to reduce cost of production. This contrary situation could be attributed to the level of productivity of the hives in a particular zone.

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Yam	2.73
Plantain	2.92

Source: GIDA, 2000.

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Adjusted R-squared	0.590166	Probability (F-Statistic)	0.0000
Standard error of Regression	0.248631	* T-values significant at 10%	
Sum Squared Residue	3.399957	*** T-values significant at 1%	
Mean Dependent Variable	0.388375	† F-value significant at 1%	
Standard Deviation of Dependent Variable	0.388375		

Source: Appendix 2

The estimates show that the explanatory variables jointly accounted for 62% of the total variation in honey output. The size of apiary in the district is significant at 10%, has elasticity of 0.36 and also meets the positive a priori expectation sign. This means that a 1% increase in apiary size will correspondingly increase the output of honey produced by 0.36%. This is in conformity with the theory of production theory, which states that as capital increases, ceteris paribus, output increases.

Labour has a-priori positive expectation sign, but is insignificant at all levels of significance (1%, 5%, 10%).

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The study also revealed that capital "K" (cost of depreciation, repairs and maintenance) is significant at 1% level, with an elasticity of 0.71, and conforms to the positive a-priori expectation sign. This means that a 1% increase in capital will correspondingly increase the output of honey by 0.71%. This high percentage increase relative to other inputs suggests that it is the most important factor of beekeeping production in the district ceteris paribus.

Management skill on the other hand is not significant at all levels of significance and does not conform to the positive a priori expectation sign. The marginal value productivity for management skill is -5671.72 (Table 4.16) and could be approximated to zero.

The scale of production, which is obtained through the sum of the elasticities, revealed that the estimated scale elasticity is 1.16 units. This implies that beekeeping business in the district exhibits increasing returns to scale (a unit increase in all inputs leads to an output of 1.16 units in the district).

4.4.1 Allocative Efficiency

This section tests the hypothesis that, beekeepers efficiently allocate resources. The allocative efficiency parameters for size of apiary, labour, capital and management skill are derived from the marginal product values of these independent variables. These are presented in Table 4.16.

Table 4.16 Marginal Values and Allocative Efficiency Indices

Variable	Marginal Values	Efficiency Indices
V	6443.34	2.58
L	4.81	Φ
K	8.07	8.07
M	-5671.72	Φ

Φ Estimate/index was not derived because estimated regression coefficient was not statistically significant.
Source: Appendix 2

The results show that for the district as a whole, size of apiary "V" and capital "K" are underutilized. The underutilization of apiary capacity could be attributed to the total number of hives from which honey was obtained during harvest. Out of a total of 280 hives only 61% of them were able to produce honey. This percentage of harvested hives was obtained from a total of 206 colonized hives representing 72% colonization. Out of this number of colonized hives, 12% of them were weakly colonized, hence yielded little or no honey. This percentage of colonization according to Technology Consultancy Centre, Kumasi is considered to be low[1]. This feature has been attributed to the high incidence of bushfires in the Jasikan district, which destroy the habitat of the bees in the forest and reduce their populations (GTZ, 1999).

The underutilization of capital could also be attributed to the low productivity of hives in the district. This is because although the capital used cover the 280 hives, only 172, representing 61% of the hives were productive. Also the small apiary sizes could be a reason.

The resulting allocative efficiencies in the whole district could be accounted for by the relative allocative efficiencies in the four agricultural zones. Although this could be true, due to the low numbers of respondents in the various zones, they can just be used as indicators. The regression analysis, from which these allocative estimates were computed, can be found in Appendix 3. The estimates show that the explanatory variables jointly accounted for over 82% of the total variation in the honey output in Ayoma, Kwamikrom and Worawora zones. Their respective regression equations were also significant at 1% level. However for the Jasikan zone, the explanatory variables accounted for only 36% of the total variation, and the regression equation was insignificant at all levels of significance (1%, 5%, 10%). The estimates of allocative efficiencies for these zones are presented in Table 4.17.

Table 4.17 Allocative Efficiency Estimates for the Various Zones

Item	Ayoma	Jasikan	Kwamikrom	Worawora
V	5.43*	Φ	Φ	33.72***
L	0.0006*	Φ	Φ	0.0002***
K	3.47*	Φ	8.77***	Φ
M	Φ	Φ	Φ	-47003.02**

[1] Obtained from personal interview with a Beekeeping consultant, Mr. Adjare, from Technology Consultancy Centre, Kumasi.

Φ Estimate/index was not derived because estimated regression coefficient was not statistically significant.
* T-values significant at 10%
** T-values significant at 5%
*** T-values significant at 1%
Source: Appendix 3

Apiary size is underutilized in Ayoma and Worawora while labour is also overutilized in these 2 zones. Capital is underutilized in Ayoma and Kwamikrom while management skill is overutilized in Worawora. Apiary size is relatively more underutilized in Worawora than Ayoma, while labour is relatively more overutilized in Ayoma than Worawora. Also capital is relatively more underutilized in Kwamikrom than Ayoma.

4.5 Marketing of Honey

After harvesting the honey, none of the apiculturists sell it out-right. They keep some for their own consumption and also as gifts to relatives and friends. This accounts for about 5% of the harvested honey. About 80% of honey is sold in the district and the remaining 15% is sent to areas like Togo, Accra and other nearby towns.

About 67% of the respondents do not do any active marketing. The consumers come to their homes or "the apiary gate" to purchase the honey with their own containers. About 11% sell their honey to middlemen who come to the area during the peak of the harvesting season. About 2% combine selling at home and taking some to Accra, other surrounding towns and Togo to sell. About 6% combine selling at home and taking it to relatives in big towns to sell it for them. The remaining 2% practice all three forms of marketing. These results are presented in Table 4.18. Prices in the district fetch between 6,000 and 7,000 cedis per kilogram of honey while those sold in the bigger towns fetch about 10,000 cedis for the same quantity and quality..

Table 4.18 Marketing of Honey in Jasikan District

Item	Respondents	Percentage of sample
Farm gate	55	67.1
Middlemen	9	11.0
Markets+Farm gate	5	6.1
Farm gate + Middlemen	2	2.4
All the above	2	2.4
Total	73	100

Source: Field Survey 2002

Standardization of measures of honey is poor in the district. Most of the beekeepers use different bottles in measuring the honey they sell. Also some of the bottles are not neatly covered making it unattractive to consumers.

The market determines pricing of honey in the district. All the beekeepers sell at the going price and no one beekeeper can influence the price. The price however varies with the seasons, according to supply levels.

The beekeepers store their honey in different containers. Out of the 73 respondents who had harvested before, 90% store what they are not able to sell in 5 litre gallons. About 3% store in big rubber bowls with covers and about 5% use both container types. The remaining 3% store in drums and barrels.

4.6 Problems Faced by Beekeepers

There is a myriad of problems that plague the beekeepers in the district. However for the sake of the research work, the results have been narrowed down to the most relevant for this study. The problems that plague them include: marketing of honey, absconding of bees from their hives, financial constraints, faulty equipment and slow rate of colonization. These problems and their percentage of the sample drawn are outlined in Table 4.19.

Table 4.19 Constraints Facing Respondents

Issue	Respondents	Percentage of Sample
Marketing	73	89.0
Absconding of Bees	49	60.0
Faulty Equipment	10	12.2
Financial Constraint	82	100.0
Rate of Colonization	51	50.0

Source: Field Survey 2002

About 89% of the respondents who had harvested and sold before, singled out marketing of honey as one of their most common problems. The problem stem from a number of factors.

1. Competition from wild honey hunters, who sell low quality honey to consumers at a relatively cheaper price. Sometimes beekeepers have to keep their honey till the wild honey hunters have run out of their store, else they also have to reduce their price.
2. Beekeepers do not get buyers who buy in bulk; hence they always have to depend on local demand, which is not frequent. This makes them keep their honey stores for very long periods, thereby denying them ready income.

All respondents indicated that due to financial constraints expansion of their business is a major problem. The "Odum" boards used in preparing the hives are very expensive. Also due to the ban on chainsaw operators the wood is very scarce.

About 12% of the respondents mentioned faulty equipment as being a major problem. Some of them complained of unworkable smokers, warped top bars of hives, torn gloves and punctured netting of the veils. It was noted that the beekeepers were waiting for the project handlers to replace their faulty equipment, instead of making the effort to purchase them for their own use.

Sixty percent (60%) of the respondents had absconding of bees as a perennial problem. The root causes for absconding of bees are: bush fire incidences, heavy rains and thefts. In the case of thefts, respondents reported that the thieves destroy the hives with live fire in order to get the bees out before harvesting honey, and in the process the bees abscond. The heavy rains causing absconding was a problem faced by beekeepers that did not have sheds/bee-houses for their hives. As a result the exposure to the direct effect of the rains and sometimes storms, the stands supporting the hives break, causing the hive to topple over leading to the bees absconding. For others it was due to poor management practices, which make the hives prone to attack by termites, spiders and lizards. Some do not weed around the hives and others also fail to grease the stands of the hives making it susceptible to these pests.

Slow rate of colonization was a major concern for 50% of the respondents. The slow rate of colonization can be attributed to the dwindling bee population in the district. This is as a result of the prevalent bush fire incidence in the district (GTZ, 1999).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

With the demise of the cocoa industry in Jasikan district, agriculture has in recent times been predominantly based on arable crop production, using traditional slash and burn techniques. This method of shifting agriculture has put the already fast depleting forest under threat. Income levels of farmers in the district are also dwindling because farmers are constrained by land size for annual crop production. The need has therefore arisen for the development of sustainable agricultural practices that will not require new land but could still be a source of income for farmers and they can also conveniently incorporate it into their farming business.

Beekeeping has been identified as a sustainable agricultural practice that could provide some answers to extensification and income generation for farmers in the district. Currently, income generated from beekeeping is increasing and more farmers are being encouraged to go into the venture. There are plans to extend this sustainable agricultural technology to other districts of similar ecological characteristics..

Data was collected from 82 beekeepers using a random sampling method (Snow-balling method) from the four agricultural zones in the district. The information collected span personal characteristics, production information, marketing functions and problems facing the beekeepers.

With the help of cross tabulations and percentages, socio-economic characteristics, marketing functions and problems were described. Profitability was captured through the use of Benefit Cost Ratios. Benefit-Cost ratios were computed for the district as a whole and also the constituent zones (Jasikan, Ayoma, Kwamikrom and Worawora). The efficiency of resource use was estimated using the Cobb-Douglas Production Function. Ordinary least squares method was used to run the regression analysis. The power and linear forms were fitted to the data. The power form was selected as the equation for the analysis of the whole district data, based on the R^2-value, F-value, statistical significance of t-values and the sign of parameter coefficients. For the constituent zones due to limited data set, the linear model was used.

Profitability analysis showed that each cedi invested in beekeeping business in the district yields 3.5 cedis. The most profitable zone was Worawora with B/C ratio of 4.5, and the least profitable was Jasikan zone, with B/C ratio of 2.58. Also B/C ratios computed from budget analysis for some food crops in the district revealed that on the basis of seasonal production, beekeeping is more profitable than cassava, maize and cassava intercrop, plantain, yam, minor season maize, groundnut and cowpeas.

From budgetary analysis of the various zones, which contributed to that of the district, average total cost per beekeeper was least in Jasikan but it was the third most profitable zone out of the four. This was attributed to the low productivity of hives in that zone.

Production function analysis showed that apiary size and capital invested were underutilized in the district. This implies that allocative efficiency cannot be obtained through the substitution of one resource for the other. Rather the needed reorganization is that of scale, involving increasing the use of capital and apiary size. In tackling this feature from the zonal level, the most crucial zones to consider are Ayoma and Kwamikrom for capital and Ayoma and Worawora for apiary size.

Most of the honey output is sold at the farm gate. Prices fluctuate with the lean and harvest seasons. Consumers bring their own containers to buy honey at the farm gate, and unsold honey is mostly stored in 5 litre gallon containers.The constraints to the beekeeping production in the district range from absconding of bees, faulty equipment, slow rate of colonization, marketing of honey to financial constraints that hinder expansion.

5.2 Conclusion

In conclusion, this study has shown that although beekeeping is a profitable venture in the district, some work needs to be done in the area of attaining allocative efficiency of resource use in apiary size and capital, in order to increase output. The low labour and management skill requirement makes beekeeping a convenient business which farmers can incorporate into their farming activities. Efforts must also be made to find market for honey in the district.

On the whole however, this research has revealed that beekeeping has an important role to play in diversification of agriculture in Jasikan district and some opportunities for improving farm incomes and living standards as well as for contributing toward self-sufficiency in food production.

5.3 Recommendations

Beekeeping has been shown to be profitable and also a possible source of extra income for people in the district. In order to develop beekeeping into one of the major sources of income for beekeepers in the Jasikan district of the Volta region, some issues need to be addressed.

Increasing the size of apiaries (number of hives) will enable beekeepers to increase their earnings (profits) and help them also achieve allocative efficiency in this input as indicated by the study. However this opportunity is constrained by high cost of hives, low hive colonization and the absence of a very ready market in the district.

It is recommended that research be conducted into developing cheaper sources of wood for the construction of the beehive instead of the traditional "Odum" wood, which is very expensive. Although the durability of the "Odum" wood cannot be denied, it is assumed that when beekeepers are able to generate income from the use of the relatively less expensive hives, with time they will be able to afford the durable "Odum" hives. This, when done, will reduce the financial barrier they face in trying to expand their business.

Further research must be conducted into the population distribution of bees in the district. This will ensure that the beehive capacity for a given area in the district is not exceeded in an attempt to expand. In Africa, it is estimated that generally an apiary should contain only about 10 hives per square kilometre (Adjare, 1990). However this will differ from region to region depending on the prevailing ecological characteristics. One of the root causes for the low hive colonization has been attributed to bushfires, which destroy the habitat of bees. The FORUM project could try and check this hazard by stimulating and motivating the formation of local beekeeping societies. They could print identity cards for beekeepers, on a zonal basis. These societies could be charged with the responsibility of checking runaway fires, so that rather than being a source of forest fires, beekeeping societies will bring strong social pressure to bear against arson or the careless use of fires. This will go a long way to complement the work of volunteer fire squads in the district.

Added to the protection of the forest against bushfires, intense reforestation practices (especially with bee forage plants; see Appendix 7) should be encouraged to ensure that bees have adequate forage in the near future. Ayers (1992), in his work on "Exploring the Economics of Planting for Bees", came to a conclusion that it was indeed time for some beekeepers to at least consider the possibility of planting for bees.

It is also recommended that more farmers be encouraged to add beekeeping to their farming activities due to its low labour and management skill requirements in the district. On the marketing side, "Honey Bank" or honey collection points could be created where harvested honey of beekeepers could be stored and sold in bulk. This will help them control prices and also compete effectively with the wild honey hunters. For this to work, a strong cooperative must be in place to facilitate this activity. The formation of a strong and working cooperative will enable the beekeepers to also solicit funds from financial institutions in their locality, since their voice will become stronger where their demands are concerned.

Some non-governmental agencies could also help in the marketing of honey by acting as middlemen who buy in bulk from the beekeepers and look for outlets for the honey produced in the district. FORUM project coordinators could also facilitate development of markets (including export markets) for honey in the district. They could look for outlets (pharmacies, restaurants, food processors) for the sale of honey for the beekeepers. Finding markets for the honey will go a long way to make the beekeeping business in the district sustainable, since it will eliminate the problem of keeping stored honey for long periods, which locks their capital. This will encourage them to expand their business.

On the situation of faulty equipment, it is recommended that the project coordinators earmark some selected shops for the beekeepers from which they can buy their equipment. This will ensure that the problem of unworkable equipment is not transferred to the beekeepers.

Training courses for the beekeepers must be encouraged and efforts must also be made to integrate modern and traditional beekeeping methods. Research should also be conducted into commercial bee production, so that bees could be supplied to beekeepers.

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APPENDIX 1

ECONOMIC ANALYSIS OF BEEKEPING IN THE JASIKAN DISTRICT OF THE VOLTA REGION.

QUESTIONNAIRE

Area .... Date .... Serial number...........

Personal Information

1. Name..

2. Sex: male ( ) female ( )

3. Age: Below 21 ( ) 21-30 ( ) 31-40 ( ) 41-50 ( ) Above 51 ( )

4. Occupation: Major .... Minor ....

5. Marital status: Single ( ) Married ( ) Divorced ( ) Widow ( ) Widower ( )

6. Education: Primary ( ) Middle school ( )Secondary ( ) Vocational ( )Tertiary ( )

7. Religion; Christian ( ) Moslem ( ) Traditional religion ( ) Others........................

8. Do you have a family? Yes ( ) No ( ).

9. Family size..

10. Number dependent on you................................

11. Number that help you in your business..................

12. Do you pay them?..

Beekeepers Information

13. Have you ever hunted for honey in the wild? Yes ( ) No ( )

14a. Do you still hunt for honey in the wild? Yes ( ) No ( )

14b. Give reasons..
....
......

15. For how long have you been keeping bees?..................

16a. Who trained you in beekeeping? Relative ( ) Friend ( ) FORUM ( ) others...................

16b. Which year did you receive training?..........................

17. Where do you keep your beehives? Own land ( ) Somebody's land ( ) Others.................

18. How many beehives do you have?...

19. What type of wood is it made off?...

20. How many beehives have you received from FORUM.........................

21. How many of the hives have been colonized?...

22. Have you trained some beekeepers yourself? Yes ( ) N0 ( )

23. If yes, give number..................

24. How many of them are still in business?................................

Production Information

25. **Fixed Cost 2000/2001**

Item	Year acquired	Number	Cost/unit	Total in cedis
Bee house/shade				
Hive				
Veil				
Smoker				
Gloves				
Knife/Hivetool				
Bee suit				
Boots				
Bowl/collector				
Extractor				
Storage facility				
Flash light				
Cutlass				

26. **Labour Cost for 2000/2001**

Activity	Tools used	No. of people	Time for activity	No. of times	
Hive(dist)					
Weeding					
Greasing					
Harvesting					
Straining					

27. **Variable Cost for 2000/2001**

Item	Quantity used	Price per unit	
Broom			
Paint			
Grease			
Maintenance			
Nylon net			

28. Output and Returns 2000/2001

Item	a. Hives harvested		b. Qty harvested		c. Qty sold		d. Unit price	
Honey								

Marketing Information

29. After harvesting do you sell all honey? Yes ( ) No ( )

30. How do you sell your products? Middlemen ( ) Market ( ) Others specify…………

31. If you take it to the market, what is the transportation cost? …………………………

32. How do you store what you are not able to sell?………………………………

Finance

33. How do you finance your business? Own resources ( ) Relatives ( ) Professional money lenders ( ) Commercial Banks ( ) friends ( ) Others specify………………

34. How much do you pay on borrowed funds?……………………………………

35. If borrowed funds are from bank, state which bank?………………………………

Problems

35. What are some of the problems you face in your business?………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

36. What do you think can be done to solve this problem?……………………………..

……………………………………………………………………………………………

……………………………………………………………………………………………

Benefits

37. Has the beekeeping business been beneficial to you? Yes ( ) No ( )

38. Give reasons…………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

39. Will you encourage your children and others to go into it? Yes ( ) No ( )

40. Give reasons..

....

....

....

41. What conditions will make you increase your number of hives?.....................

APPENDIX 2
REGRESSION STATISTICS

JASIKAN DISTRICT (Linear Model)

Dependent Variable: REVENUE
Method: Least Squares
Sample (adjusted): 1 82
Included observations: 82 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YRS_N_BK01	-5671.715	8706.018	-0.651471	0.5167
OP_COST01	8.074092	0.814173	9.916922	0.0000
NUM_BH01	6443.338	6447.080	0.999420	0.3207
LC_CEDIS01	4.811296	2.111951	2.278129	0.0255
C	-137933.5	33795.73	-4.081389	0.0001

R-squared	0.923397	Mean dependent var	142711.0
Adjusted R-squared	0.919418	S.D. dependent var	387171.2
S.E. of regression	109906.2	Akaike info criterion	26.11168
Sum squared resid	9.30E+11	Schwarz criterion	26.25843
Log likelihood	-1065.579	F-statistic	232.0467
Durbin-Watson stat	2.161341	Prob(F-statistic)	0.000000

JASIKAN DISTRICT (Power Model)

Dependent Variable: LGREV
Method: Least Squares
Date: 08/27/02 Time: 13:56
Sample (adjusted): 2 81
Included observations: 60
Excluded observations: 20 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGYRS	-0.214813	0.184077	-1.166977	0.2483
LGOPCOST	0.709570	0.191452	3.706254	0.0005
LGLCC	0.313533	0.229112	1.368469	0.1767
LGBH	0.364155	0.199945	1.821281	0.0740
C	0.592741	1.193056	0.496826	0.6213

R-squared	0.617952	Mean dependent var	5.023145
Adjusted R-squared	0.590166	S.D. dependent var	0.388375
S.E. of regression	0.248631	Akaike info criterion	0.133962
Sum squared resid	3.399957	Schwarz criterion	0.308491
Log likelihood	0.981140	F-statistic	22.24022
Durbin-Watson stat	2.414725	Prob(F-statistic)	0.000000

JASIKAN DISTRICT CROSS TERMS HETEROSCEDASTICITY TEST

White Heteroskedasticity Test:

F-statistic	0.450722	Probability	0.946916
Obs*R-squared	7.378794	Probability	0.919122

Dependent Variable: RESID^2
Method: Least Squares
Sample: 2 81
Included observations: 60
Excluded observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	261.0114	205.4662	1.270338	0.2105
LGV	26.34160	20.00943	1.316459	0.1947
LGV^2	0.367919	0.752434	0.488972	0.6272
LGV*LGL	-1.646460	1.264757	-1.301800	0.1996
LGV*LGK	-1.171975	1.117750	-1.048513	0.3000
LGV*LGM	1.07E-05	6.43E-05	0.166681	0.8684
LGL	-31.97140	23.73027	-1.347283	0.1846
LGL^2	0.438552	0.696705	0.629466	0.5322
LGL*LGK	2.580108	1.761128	1.465032	0.1499
LGL*LGM	-2.32E-05	5.67E-05	-0.408562	0.6848
LGK	-25.63150	22.43871	-1.142289	0.2594
LGK^2	0.147317	0.471280	0.312589	0.7560
LGK*LGM	-4.09E-05	8.39E-05	-0.488156	0.6278
LGM	0.000678	0.000787	0.862185	0.3932
LGM^2	-1.40E-09	1.50E-09	-0.932025	0.3563

R-squared	0.122980	Mean dependent var	0.296757
Adjusted R-squared	-0.149871	S.D. dependent var	0.610602
S.E. of regression	0.654761	Akaike info criterion	2.203226
Sum squared resid	19.29206	Schwarz criterion	2.726812
Log likelihood	-51.09678	F-statistic	0.450722
Durbin-Watson stat	2.762075	Prob(F-statistic)	0.946916

JASIKAN DISTRICT NON-CROSS TERMS HETEROSCEDASTICITY TEST

White Heteroskedasticity Test:

F-statistic	0.456591	Probability	0.880544
Obs*R-squared	4.010115	Probability	0.856210

Dependent Variable: RESID^2
Method: Least Squares
Sample: 2 81
Included observations: 60
Excluded observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.492672	60.53988	-0.008138	0.9935
LGV	-0.077671	0.688072	-0.112882	0.9106
LGV^2	-0.076836	0.290761	-0.264257	0.7926
LGL	-0.627719	10.80300	-0.058106	0.9539
LGL^2	0.047058	0.558747	0.084220	0.9332
LGK	0.294439	3.706038	0.079448	0.9370
LGK^2	-0.005773	0.185663	-0.031092	0.9753
LGM	2.43E-05	2.90E-05	0.840506	0.4045
LGM^2	-3.97E-10	5.63E-10	-0.705488	0.4837

R-squared	0.066835	Mean dependent var	0.296757
Adjusted R-squared	-0.079544	S.D. dependent var	0.610602
S.E. of regression	0.634422	Akaike info criterion	2.065278
Sum squared resid	20.52709	Schwarz criterion	2.379429
Log likelihood	-52.95833	F-statistic	0.456591
Durbin-Watson stat	2.744102	Prob(F-statistic)	0.880544

APPENDIX 3

ZONAL MODELS

AYOMA ZONE (Linear Model)

Dependent Variable: REVENUE
Method: Least Squares
Sample: 1 21
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YRS_N_BK01	-3762.753	6602.558	-0.569893	0.5767
OP_COST01	3.477820	1.522027	2.284993	0.0363
LC_CEDIS01	4.665537	1.924945	2.423725	0.0276
NUM_BH01	13589.80	6540.865	2.077677	0.0542
C	-82930.83	31835.44	-2.604985	0.0191

R-squared	0.974291	Mean dependent var	106050.0
Adjusted R-squared	0.967864	S.D. dependent var	224717.4
S.E. of regression	40284.00	Akaike info criterion	24.24955
Sum squared resid	2.60E+10	Schwarz criterion	24.49825
Log likelihood	-249.6203	F-statistic	151.5888
Durbin-Watson stat	2.639929	Prob(F-statistic)	0.000000

JASIKAN ZONE (Linear Model)

Dependent Variable: REVENUE
Method: Least Squares
Sample (adjusted): 1 15
Included observations: 15 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YRS_N_BK01	12760.28	17102.51	0.746106	0.4728
OP_COST01	2.677693	6.845867	0.391140	0.7039
NUM_BH01	10718.95	43965.48	0.243804	0.8123
LC_CEDIS01	5.027021	2.897146	1.735163	0.1134
C	-113800.5	116219.7	-0.979184	0.3506

R-squared	0.363317	Mean dependent var	88830.00
Adjusted R-squared	0.108643	S.D. dependent var	82091.89
S.E. of regression	77504.34	Akaike info criterion	25.61526
Sum squared resid	6.01E+10	Schwarz criterion	25.85127
Log likelihood	-187.1144	F-statistic	1.426599
Durbin-Watson stat	2.726307	Prob (F-statistic)	0.294673

KWAMIKROM ZONE (Linear Model)

Dependent Variable: REVENUE
Method: Least Squares
Sample (adjusted): 1 22
Included observations: 22 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YRS_N_BK01	22947.09	13915.13	1.649075	0.1175
OP_COST01	8.774656	1.562624	5.615335	0.0000
NUM_BH01	17833.71	13119.34	1.359345	0.1918
LC_CEDIS01	1.503472	2.532150	0.593753	0.5605
C	-226825.7	55561.16	-4.082452	0.0008

R-squared	0.821887	Mean dependent var	126143.2
Adjusted R-squared	0.779979	S.D. dependent var	149238.8
S.E. of regression	70002.60	Akaike info criterion	25.34717
Sum squared resid	8.33E+10	Schwarz criterion	25.59513
Log likelihood	-273.8189	F-statistic	19.61131
Durbin-Watson stat	1.756736	Prob(F-statistic)	0.000003

WORAWORA ZONE (Linear Model)

Dependent Variable: REVENUE
Method: Least Squares
Sample (adjusted): 1 20
Included observations: 20 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YRS_N_BK01	-47003.02	11865.69	-3.961256	0.0013
NUM_BH01	84317.59	10040.74	8.397551	0.0000
OP_COST01	-1.663001	1.120327	-1.484389	0.1584
LC_CEDIS01	14.33749	3.181899	4.505953	0.0004
C	-174904.4	33643.83	-5.198707	0.0001

R-squared	0.993827	Mean dependent var	238455.0
Adjusted R-squared	0.992181	S.D. dependent var	736339.5
S.E. of regression	65112.21	Akaike info criterion	25.21793
Sum squared resid	6.36E+10	Schwarz criterion	25.46686
Log likelihood	-247.1793	F-statistic	603.7201
Durbin-Watson stat	1.241656	Prob(F-statistic)	0.000000

APPENDIX 4

DESCRIPTIVE STATISTICS OF VARIABLES

	V	L	K	M	Q (Dependent)
Mean	3.44	15732.62	25185.85	3.59	142711.0
Median	2.00	14300.00	18057.50	4.00	66150.00
Maximum	40.00	58344.00	314800.0	10.00	3307500.
Minimum	1.00	7150.00	5225.00	1.00	0.00
Std. Dev.	5.44	9327.94	38383.40	1.56	387171.2
Skewness	5.63	2.31	6.043	0.65	6.99
Kurtosis	35.28	10.96	42.72	4.99	56.26

V = Size of apiary, L = Labor, K = Capital, M = Management skill, Q = Output

APPENDIX 5

DATA EXTRACTED FROM QUESTIONNAIRE TO COMPUTE B/C RATIOS

NUMBER OF RESPONDENTS	DEPRECIATED FIXED COST	LABOUR COST	VARIABLE COST	REVENUE GENERATED	ZONAL RESPONDENTS
1	5675.00	7150.00	500.00	.00	JASIKAN
2	21205.00	16659.50	2000.00	126000.00	"
3	16980.00	26169.00	500.00	88200.00	"
4	16980.00	26169.00	1500.00	252000.00	"
5	15530.00	26169.00	1200.00	88200.00	"
6	16205.00	7150.00	200.00	.00	"
7	16530.00	7150.00	200.00	.00	"
8	16205.00	26169.00	1500.00	66150.00	"
9	23730.00	14300.00	1000.00	88200.00	"
10	18555.00	11440.00	500.00	88200.00	"
11	16980.00	7150.00	1500.00	.00	"
12	17430.00	14300.00	1500.00	264600.00	"
13	16755.00	19019.00	1500.00	50400.00	"
14	17430.00	19019.00	2500.00	132300.00	"
15	16980.00	16659.50	2000.00	88200.00	"
16	17205.00	17875.00	2500.00	113400.00	KWAMIKROM
17	17880.00	21450.00	2000.00	132300.00	"
18	17430.00	23595.00	2500.00	12600.00	"
19	22430.00	16659.50	2000.00	88200.00	"
20	12430.00	14300.00	2000.00	50400.00	"
21	11980.00	18590.00	1500.00	113400.00	"
22	16980.00	16659.50	2000.00	113400.00	"
23	19930.00	16659.50	2000.00	63000.00	"
24	16980.00	16659.50	2000.00	50400.00	"
25	16980.00	16659.50	500.00	50400.00	"
26	16980.00	14300.00	500.00	75600.00	"
27	68910.00	16088.00	2500.00	661500.00	"
28	28355.00	11440.00	4000.00	88200.00	"
29	17705.00	14300.00	2000.00	308700.00	"
30	23780.00	19019.00	1500.00	176400.00	"
31	9980.00	7150.00	500.00	.00	"
32	26880.00	30959.50	1500.00	308700.00	"
33	16430.00	11869.00	1500.00	44100.00	"
34	16755.00	7150.00	500.00	.00	"
35	16530.00	7150.00	2000.00	63000.00	"
36	26880.00	14300.00	2500.00	264600.00	"
37	15530.00	33962.50	1000.00	132300.00	"
38	15530.00	9509.50	500.00	66150.00	"
39	15755.00	10725.00	2000.00	44100.00	"
40	18705.00	21450.00	1500.00	220550.00	WORAWORA
41	16655.00	10725.00	1500.00	132300.00	"
42	5000.00	7150.00	2000.00	.00	"
43	17205.00	19019.00	2500.00	176400.00	"

44	17655.00	21450.00	500.00	220500.00	"
45	15755.00	19019.00	2000.00	50400.00	"
46	15530.00	7150.00	500.00	.00	"
47	15530.00	7150.00	500.00	.00	"
48	5000.00	7150.00	500.00	.00	"
49	5000.00	7150.00	500.00	.00	"
50	142230.00	23023.00	8000.00	617400.00	"
51	15530.00	7150.00	200.00	.00	"
52	16430.00	7150.00	2000.00	.00	"
53	15960.00	19019.00	2000.00	126000.00	"
54	15755.00	7150.00	2000.00	.00	"
55	16770.00	7150.00	500.00	.00	"
56	23930.00	22022.00	2200.00	88200.00	"
57	16530.00	7150.00	500.00	.00	"
58	159800.00	58344.00	155000.00	3307500.00	"
59	16980.00	16659.50	500.00	50400.00	"
60	16980.00	14300.00	2500.00	88200.00	"
61	16980.00	16659.50	1500.00	44100.00	"
62	22205.00	14300.00	1500.00	88200.00	AYOMA
63	14500.00	14300.00	2000.00	44100.00	"
64	21655.00	28600.00	1500.00	176400.00	"
65	20530.00	17875.00	1500.00	44100.00	"
66	15530.00	7150.00	500.00	.00	"
67	15530.00	17875.00	200.00	.00	"
68	16205.00	16659.50	1500.00	110250.00	"
69	6550.00	21450.00	500.00	66150.00	"
70	17205.00	17875.00	1500.00	110250.00	"
71	15530.00	7150.00	500.00	.00	"
72	16725.00	14300.00	500.00	44100.00	"
73	5450.00	14300.00	500.00	44100.00	"
74	22880.00	16659.50	1500.00	176400.00	"
75	17205.00	11869.00	2500.00	44100.00	"
76	3725.00	11869.00	1500.00	44100.00	"
77	117710.00	57200.00	15000.00	1058400.00	"
78	16980.00	7150.00	500.00	.00	"
79	16980.00	7150.00	500.00	88200.00	"
80	16980.00	7150.00	500.00	.00	"
81	19705.00	7150.00	200.00	88200.00	"
82	16755.00	7150.00	500.00	.00	"
TOTAL	1781840.00	1290075.00	283400.00	11702300.00	
AVERAGE	21729.7561	15732.62195	3456.09756	142710.9756	

APPENDIX 6

REGRESSION ANALYSIS DATA FROM QUESTIONNAIRE

NUMBER OF RESPONDENTS	APIARY SIZE (V)	LABOUR (L)	CAPITAL (K)	MANAGEMENT SKILL (M)	OUTPUT (Q)	ZONAL RESPONDENTS
1	2.00	7150.00	6175.00	1.00	.00	JASIKAN
2	4.00	16659.50	23205.00	4.00	126000.00	"
3	2.00	26169.00	17480.00	1.00	88200.00	"
4	2.00	26169.00	18480.00	6.00	252000.00	"
5	2.00	26169.00	16730.00	3.00	88200.00	"
6	2.00	7150.00	16405.00	4.00	.00	"
7	2.00	7150.00	16730.00	4.00	.00	"
8	2.00	26169.00	17705.00	4.00	66150.00	"
9	2.00	14300.00	24730.00	4.00	88200.00	"
10	2.00	11440.00	19055.00	3.00	88200.00	"
11	2.00	7150.00	18480.00	5.00	.00	"
12	2.00	14300.00	18930.00	4.00	264600.00	"
13	2.00	19019.00	18255.00	5.00	50400.00	"
14	2.00	19019.00	19930.00	6.00	132300.00	"
15	2.00	16659.50	18980.00	4.00	88200.00	"
16	2.00	17875.00	19705.00	5.00	113400.00	KWAMIKROM
17	2.00	21450.00	19880.00	5.00	132300.00	"
18	2.00	23595.00	19930.00	4.00	12600.00	"
19	4.00	16659.50	24430.00	4.00	88200.00	"
20	4.00	14300.00	14430.00	3.00	50400.00	"
21	2.00	18590.00	13480.00	4.00	113400.00	"
22	4.00	16659.50	18980.00	2.00	113400.00	"
23	3.00	16659.50	21930.00	2.00	63000.00	"
24	2.00	16659.50	18980.00	5.00	50400.00	"
25	2.00	16659.50	17480.00	4.00	50400.00	"
26	2.00	14300.00	17480.00	4.00	75600.00	"
27	6.00	16088.00	71410.00	4.00	661500.00	"
28	2.00	11440.00	32355.00	4.00	88200.00	"
29	2.00	14300.00	19705.00	6.00	308700.00	"
30	2.00	19019.00	25280.00	2.00	176400.00	"
31	3.00	7150.00	10480.00	2.00	.00	"
32	6.00	30959.50	28380.00	6.00	308700.00	"
33	2.00	11869.00	17930.00	4.00	44100.00	"
34	2.00	7150.00	17255.00	2.00	.00	"
35	1.00	7150.00	18530.00	2.00	63000.00	"
36	6.00	14300.00	29380.00	4.00	264600.00	"
37	2.00	33962.50	16530.00	4.00	132300.00	"
38	2.00	9509.50	16030.00	4.00	66150.00	"
39	2.00	10725.00	17755.00	4.00	44100.00	"
40	3.00	21450.00	20205.00	3.00	220550.00	WORAWORA
41	2.00	10725.00	18155.00	4.00	132300.00	"
42	2.00	7150.00	7000.00	1.00	.00	"
43	2.00	19019.00	19705.00	1.00	176400.00	"

44	2.00	21450.00	18155.00	1.00	220500.00	"
45	2.00	19019.00	17755.00	4.00	50400.00	"
46	2.00	7150.00	16030.00	1.00	.00	"
47	2.00	7150.00	16030.00	2.00	.00	"
48	2.00	7150.00	5500.00	2.00	.00	"
49	2.00	7150.00	5500.00	2.00	.00	"
50	12.00	23023.00	150230.00	5.00	617400.00	"
51	2.00	7150.00	15730.00	2.00	.00	"
52	2.00	7150.00	18430.00	2.00	.00	"
53	3.00	19019.00	17960.00	4.00	126000.00	"
54	2.00	7150.00	17755.00	2.00	.00	"
55	3.00	7150.00	17270.00	1.00	.00	"
56	5.00	22022.00	26130.00	6.00	88200.00	"
57	2.00	7150.00	17030.00	2.00	.00	"
58	40.00	58344.00	314800.00	5.00	3307500.00	"
59	2.00	16659.50	17480.00	5.00	50400.00	"
60	2.00	14300.00	19480.00	4.00	88200.00	"
61	2.00	16659.50	18480.00	4.00	44100.00	"
62	2.00	14300.00	23705.00	5.00	88200.00	AYOMA
63	4.00	14300.00	16500.00	4.00	44100.00	"
64	4.00	28600.00	23155.00	4.00	176400.00	"
65	2.00	17875.00	22030.00	6.00	44100.00	"
66	2.00	7150.00	16030.00	2.00	.00	"
67	2.00	17875.00	15730.00	2.00	.00	"
68	2.00	16659.50	17705.00	5.00	110250.00	"
69	6.00	21450.00	7050.00	10.00	66150.00	"
70	2.00	17875.00	18705.00	4.00	110250.00	"
71	2.00	7150.00	16030.00	2.00	.00	"
72	2.00	14300.00	17225.00	4.00	44100.00	"
73	2.00	14300.00	5950.00	3.00	44100.00	"
74	5.00	16659.50	24380.00	4.00	176400.00	"
75	2.00	11869.00	19705.00	4.00	44100.00	"
76	1.00	11869.00	5225.00	3.00	44100.00	"
77	32.00	57200.00	132710.00	6.00	1058400.00	"
78	2.00	7150.00	17480.00	4.00	.00	"
79	2.00	7150.00	17480.00	3.00	88200.00	"
80	2.00	7150.00	17480.00	3.00	.00	"
81	3.00	7150.00	19905.00	3.00	88200.00	"
82	2.00	7150.00	17255.00	3.00	.00	"
TOTAL	280.00	1290075.00	2065240.00	295.00	11702300.0 0	
AVERAGE	3.4146341	15732.6219 5	25185.85366	3.597561	142710.975 6	

APPENDIX 7

SOME HONEYBEE FORAGE PLANTS IN THE TROPICS AND SUB-TROPICS

Acacia albida
Acacia dudgeoni
Acacia gourmaensis
Acacia nilotica
Acacia polyacantha
Acacia senegal
Acacia tortilis
Adansonia digitata (baobab)
Albizzia lebeck
Allium L.spp. (onion, leek, garlic, etc.)
Anacardium excelsum
Anacardium occidentale (cashew)
Annona senegalensis
Anogeissus leiocarpus
Asparagus officinalis (asparagus)
Avicennia marina (mangrove)
Azadirachta indica (neem)
Brachystegia bentham spp.
Brachystegia spiciformis
Carica papaya (papaya)
Cassia siamea
Ceiba pentandra (silk-cotton tree)
Citrus aurantium (orange)
Citrus bergamia (bergamot)
Citrus deliciosa
Citrus grandis (grapefruit)
Citrus limon (lemon)
Citrus medica (lime, citron)
Citrus paradici
Citrus reticulata (mandarine)
Citrus sinensis
Cocos nucifera (coconut palm)
Coffea arabica (coffee)
Cola nitida (cola)
Combretum L. spp.
Combretum paniculatum
Croton L. spp. (croton)
Dalbergia sissoo (sissoo)
Dialium elgleranum
Diospyros batocana
Diospyros mespiliformis (Zanzibar ebony)
Diospyros virginiana (persimmon)
Durio zibethinus (durian)

Dyschoriste Nees spp.
Ehretia acuminate
Elaeis guineensis (African oil palm)
Eriobotrya japonica (loquat)
Eucalyptus alba
Eucalyptus albens (white box)
Eucalyptus cadambae
Eucalyptus camaldulensis (red gum)
Eucalyptus citriodora (lemon gum)
Eucalyptus cladocalyx (sugar gum)
Eucalyptus maculata (spotted gum)
Eucalyptus melliodora (yellow box)
Eucalyptus paniculata (grey ironbark)
Eucalyptus robusta (swamp mahogany)
Eucalyptus saligna
Eucalyptus torrelliana
Euphoria longana (longan)
Eutyrospermum parkii
Gleditsia triacanthos (honey locust)
Gliricidia sepium
Gmelina arvorea
Gossypium hirsutum (cotton)
Grevillea robusta (grevillea)
Grewia mollis
Haematoxylon campechianum L. (campeche, logwood)
Helianthus annuus L. (sunflower)
Hibiscus spp.
Hymenaea stilbocarpa
Hypoestes Solant spp.
Impatiens Riv. ex L. spp. (balsam)
Impatiens glandulifera Royle (Himalayan balsam)
Inga vera
Julbernardis globiflora
Khaya senegalensis (African mahogany)
Malhuca longifolia
Mangifera indica (mango)
Melicocca bijuga (honeyberry, genip)
Melicocca lepidopetala
Mimusops elengi
Moringa oleifera (teen nut tree)
Musa L. spp. (banana, plantain)
Nepeta L. spp.
Nephelium lappaceum (rambutan)
Nephelium litchi (litchi)
Nyssa ogeche (Ogeechee lime)
Ocimum L. spp. (basil)
Parkia bicolor

Parkia biglobosa
Parkia clappertoniana
Parkinsonia aculeata (Jerusalem thorn)
Persea americana (avocado)
Phaseolus L. spp. (bean)
Pithecolobium ducle
Pistacia vera L. (pistachio)
Polygonum L. spp. (bistort)
Pongamia pinnata
Prosopis cineraria
Prosopis glandulosa (mesquite, honey mesquite)
Prosopis juliflora
Prosopis pallida
Prosopis pubescens (screw bean)
Protea L. spp. (honey flower, etc.)
Psidium guajava (guava)
Pterocarya erinacea
Rhamnidium glabrum
Ricinus communis L. (castor)
Robinia pseudacacia (black locust)
Roystonea regia (royal palm)
Salix L. spp. (willow)
Schinus terebinthifolius
Sclerocarya caffra
Sesamum indicum (sesame)
Spathodia campanulata
Spondias mombin
Syzygium aromaticum (clove)
Syzygium cordatum
Syzygium cuminti
Syzygium jambos (rose apple)
Tamarindus indica (tamarind)
Terminalia ivorensis (framiré)
Terminalia superba (limba)
Toona ciliata (toon, Indian mahogany)
Trifolium spp. (clover)
Vaccinium L. spp. (bilberry, blueberry, etc.)
Vitex agnus-castus (chaste tree)
Vitex doniana
Zizyphus maritania
Zizyphus mucronata
Zizyphus spina-christi (Christ's thorn)

Source: (Adjare, 1990).