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Determinants of Box Hive Promotion and Financial Benefits in Selected District Of Ethiopia

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Though beekeeping is a common farming enterprise and income generating activity in Atsbi Wemberta district, and promotional efforts have been made to improve it, no systematic study has been undertaken to evaluate the promotional efforts and people's response to it. The objectives of this study were to identify determinants of improved box hive adoption by the beekeepers; and to analyze financial benefits from adopting improved box hive technology. It was found that credit, knowledge, education level of household head, perception and visits to demonstrations positively and significantly influenced adoption of box hive. Hence, Linking honey producers to stable and reliable markets and following a participatory value chain based approach; promoting private entrepreneurs to provide additional services for value addition; promoting farmer-to-farmer knowledge sharing; and encouraging farmer groups create a learning environment are some initiatives that could go a long way in the sustainable development of this important economic sub-sector. **[Workneh Abebe et al. Determinants of Box Hive Promotion and Financial Benefits in Selected District Of Ethiopia. International Journal of Agricultural Science, Research and Technology, 2011; 1(3):137-144].**

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1. Introduction

Livestock is an important economic sector in Ethiopia, which contributes to economic development. Ethiopia is generally considered to have the largest population of livestock of any country in Africa (Halderman, 2004). Livestock contribute to 20% to Ethiopia's GDP and livelihoods of 60-70% of the population (Aklilu, 2002). The author further stated that apiculture, which is one of the important livestock sub-sectors, contributes significantly to improvement of the livelihoods of the nation's population.

There is no well-documented evidence that indicates when and where beekeeping practice started in Ethiopia. According to Ayalew (1978), it had started in the country between 3500-3000 B.C. The country has a high potential for beekeeping, as the climate is favorable for growing different vegetation and crops, which are a good source of nectar and pollen for honeybees. Due to suitable natural environment of the country a large number of honeybee colonies, estimated at about 10 million, exist in the country (Ayalew, 1978).

Ethiopia produces around 23.6% and 2.1% of the total African and world's honey, respectively. It is the leading honey producer in Africa and one of the ten largest honey-producing countries in the world (Ayalew, 1990). It is also one of the four largest bees-wax producing countries in the world. In Ethiopia, beeswax is one of the 12 major exportable agricultural products and an estimated one million farmers are engaged in beekeeping (Mammo, 1976). The country produces about 28,500 tons of honey and 5,000 tons of beeswax annually (HBRC, 2004).

Beekeeping in Ethiopia plays an important role in income generation for beekeeper farmers. An average of 420 million Eth. Birr is obtained annually from the sale of honey, both in local and world markets. Honey production of the country meets beverage requirements of the urban and rural population. It is also demanded for its nutritional and medicinal values. The other hive products such as beeswax, royal jelly, propolis, and bee venom have high demand globally.

In addition, honeybees play a great role in pollinating plants and contribute to increased crop yield. Self-sterile plants (cross pollinated) require pollinating agents to maintain viable seed. According to Crane (1990) honeybees can increase the yield of Citrus sinensis by 30%, water melon by 100% and tomatoes by 25%. Adimasu et al. (2004) also reported

that onion yields increased by 94% due to honeybee pollination.

The Ethiopian government, realizing the potential of beekeeping sub sector of the country, established demonstration stations at Holeta, Nekempt and Jima in 1965. The main objectives of the demonstration stations were to introduce imported improved beekeeping technologies (box hives, casting mold, honey extractor, honey presser, smoker, water sprayer, veil, glove, etc) to the beekeepers and to offer beekeeping training for farmers and experts. According to EBA (2005), formally organized beekeeping extension started in 1978. While the demonstration stations mainly targeted beekeepers located in the vicinity of the station and their coverage was small, formally organized extension has been aiming for a wider coverage. Currently, different private organizations are also engaged in the production of beekeeping equipment.

This study looked at adoption of improved box hives at the individual farm household level. Individual adoption refers to the farmer's decisions to incorporate a new technology into the production process (Feder et al., 1985). According to Dasgupta (1989), the term adoption implies the continued use of a recommended idea or practice by individuals or groups over a reasonably long period. Adoption is a complex process, which is governed by many socio-economic factors including; farmers' socio-psychological system; their degree of readiness and exposure to improved practices and ideas i.e. changes like the awareness and attitude of farmers towards improved agricultural technologies; institutional factors which act as incentives/disincentives to agricultural practices and; farmers' resource endowment like land holding size and labor are some of the factors of considerable importance in bringing about the technological change in agriculture (Salim, 1986). The decision of whether or not to adopt a new technology hinges upon a careful evaluation of a large number of technical, economical and social factors. Adoption or rejection of an innovation is a decision to be made by an individual.

Adoption is viewed as a variable representing behavioral changes that farmers undergo in accepting new ideas and innovations in agriculture. The term behavioral change refers to desirable change in knowledge, understanding and ability to apply technological information, changes in feeling behavior such as changes in interest, attitudes, aspirations, values and the like; and changes in overt abilities and skills (Ray, 2001).

Identification of the factors that influence the adoption of a technology, positively or negatively, are important for policy makers, researchers and organizations involved in beekeeping development programs to get insights into the adoption of improved box hive, which in turn would help them to suitably modify the strategies for improved uptake.

Kerealem (2005) showed that adoption rate of improved box hives is low in the country and highlighted the importance of investigating factors influencing the adoption of improved box hives. There is no information currently available on the determinants of the technology adoption, and the financial benefit of adopting the box hive technology. To fill this knowledge gap, this study was designed with the specific objectives of:

- Identifying the determinants of improved box hive adoption by the beekeepers and,
- Analyzing the financial benefits from adopting improved box hive technology.

2. Materials and methods

2.1. The Study Area

Atsbi Wemberta district is located in Eastern zone of Tigray Region at about 65km north east of Mekele, the regional capital city. It has an altitude at Dega (highland), which ranges from 2400 m to 3000 masl and at weinadega (midland) ranging from 1800 m to 2400 masl. The District has a total area of about 1223 sq. km, with 70% and 30% Dega and Weina dega, respectively. The average temperature of the area is 18^{o}C. Rainfall is usually intense and short in duration, with an annual average of about 667.8 mm.

Atsbi Wemberta has a total human population of 112,639, of which 55,359 (49.15%) and 57,280 (50.85%) are male and female, respectively. The urban and rural population is 9609 and 103,030, respectively (District Agricultural and Rural Development Office, 2006).

2.2. Sampling Techniques

Purposive sampling was employed to identify Peasant Associations in which improved box hive was promoted. Based upon the number of beekeepers and honeybee colony population, four Peasant Associations (Hayelom, Dibab-Akorein, Barka-Adisabiha and Michael–Emba) with high beehives population were selected purposively (Fig 1). In the selected Peasant Associations, the beekeepers were stratified into adopters and non-adopters[1] of improved box hives. The total sample size for the study was 130 beekeepers among which 8

1- Adopters are those beekeepers who used improved box hive for at least two years and non-adopters are beekeepers who did not use improved box hives during the study period.

are women and 122 are men. There were no women that adopted box hives in the sample respondents. Based on the probability proportional to size principle, 45 adopters and 85 non-adopters were selected for the study through systematic sampling method.

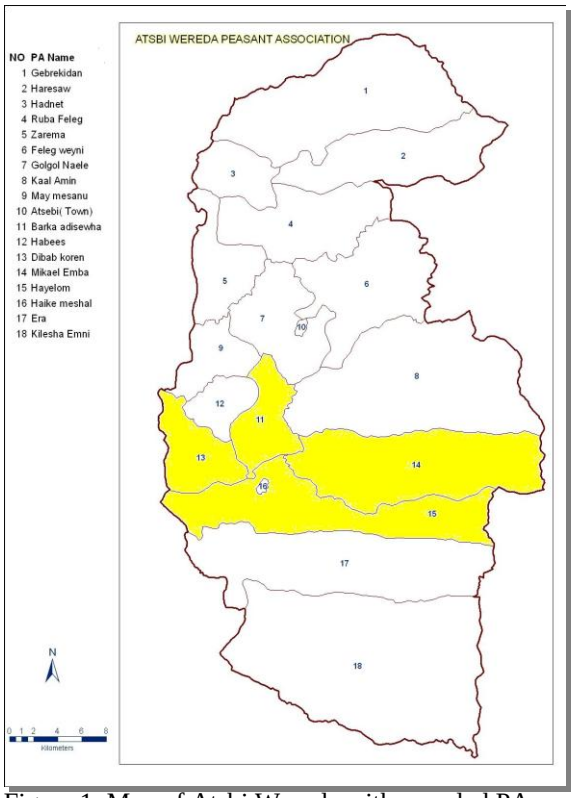

Figure 1. Map of Atsbi Woreda with sampled PAs

2.3. Data collection and analysis

A full understanding of the complexities involved in the adoption of technologies and the impacts they have can only be achieved by mixing methods, such as quantitative surveys, qualitative interviews, focus group discussions, etc (Dick et al., 2004). The required data were collected from beekeepers and extension workers of the district. Structured interview schedule was prepared and pre-tested to include all quantitative data pertaining to the proposed study. For obtaining the relevant information, personal observations, focus group discussions and personal interviews were conducted with beekeepers, extension workers and bee experts.

Enumerators who have know-how on beekeeping were recruited and trained to collect data using the interview schedule, under the supervision of the researcher. The researcher monitored the enumerators during data collection. Secondary data were collected from different sources such as books, research publications, journals, office reports, Internet etc.

The required data for partial budgeting, such as prices of improved box hive, pure bees–wax and accessories were collected from the District ARD office. Honey yield, price, feed cost, labor cost and traditional hive cost were collected from respondents.

2.4. Data analysis

The tools used for data analysis and presentation were descriptive statistics such as percentages, frequencies, mean and standard deviations; t-test and χ^2 were employed to test the significance of continuous and discrete variables, respectively. SPSS version 12 was used to analyze the quantitative data. Any data/information that could not be captured through quantitative analysis were analyzed qualitatively based upon interview and group discussion with extension workers and beekeepers. For assessing financial benefit of improved box hive, partial budgeting[2] was employed.

Many models used in adoption studies fail to meet the statistical assumption necessary to validate the conclusions based on the hypothesis tested and they recommend the use of qualitative response models (Feder et al., 1985). Logit and probit models are mainly used in adoption studies. However, the output of Probit and logit models is usually similar (Aldrich and Nelson 1984). Even though their outputs are similar, the logit model is easier to estimate. A binary logit model was used to identify the determinants of improved box hive adoption in this study. Following Gujarati (1988) the model is specified as:

$$\text{Ln } (Pi/(1-Pi)= b_0 + b_1x_1 + \text{ --- } + b_{16}x_{16} + e$$

The dependent variable is the natural log of the probability of adopting improved box hive (P), divided by the probability of adopting (1-P). The model was estimated using the maximum likelihood method. The variables presented below were used in the model hypothesized to influence the adoption of improved box hive positively are denoted by (+), and negatively by (-).

X_1=AGE (age of household head in years (-)
X_2 =AMLSIZ (number of family members (+)
X_3= EDUCATI (years of formal schooling of household head (+)
X_4= CREDIT (borrowing habit of household head, dummy variable (+)
X_5=EXTCONTA (extension contact, dummy variable (+)

2 - A partial budget is a technique for assessing the benefits and costs of a practice relative to not using the practices. It takes into account only those changes in costs and returns that result directly from using a new practice.

X_6= VISTDEM (Visiting demonstrations, dummy variable (+)
X_7= MKTAVIL (availability of market, dummy variable (+)
X_8= BKTRAIN (attending beekeeping training, dummy variable (+)
X_9=PERCEPTION (perception of household head, in five point scale (+)
X_{10}=KNOWLGE (knowledge of household head that helps in addressing practical questions (+)
e= error term

3. Results and discussion

Adoption of Improved Box hives for Beekeeping in Atsbi-Wemberta District

A. Demographic and socioeconomic characteristics of sample respondents

Table 1 summarizes demographic and socioeconomic characteristics of sample respondents. The mean age of household head for adopters and non-adopters is 42.2 and 47.2 years, respectively, with a significant mean difference at P<0.01. It implies that beekeepers are generally reluctant to experiment with new technology, as they get older. Yohannis (1992) and Shiferaw and Holden (1998) in their study of adoption of soil and water conservation in Ethiopia also indicated that age of the household head negatively influenced adoption. The mean family size is 6.6 and 5.9 for adopters and non-adopters, respectively again significantly different at P<0.05. This indicates that beekeepers with large family size opt for improved technologies to improve productivity and incomes. Adopting improved box hives also demands additional labor and therefore, households with larger family size are more able to meet these demands. IPMS (2005) documented that highest labor is involved in watching and during swarming times, beehive construction, honey extraction and colony multiplication.

In relation to beekeeping experience, there is no statistically significant difference between adopters and non-adopters. The average years of beekeeping experience of both categories is nearly equal. The education level of adopters of improved box hive is significantly higher than non-adopters of the technology, implying the influence of the variable in making adoption decisions. The average farm size of adopters and non-adopters is 0.55 ha and 0.59 ha, respectively (both below the national average land holding of 1.5 ha). This difference was not statistically significant, implying that farm size does not affect adoption of improved boxhive in the study area.

Table 1. Demographic and Socio-economic characteristic of sample respondents (n=130)

Variable	Sta.	Adopters	Non-adopters	T-test
Age	Mean	42.2	47.2	2.621***
Family size	Mean	6.6	5.9	2.043**
BK experience	Mean	10.7	9.5	0.941Ns
Farm size	Mean	0.55	0.59	0.465Ns
Education	Mean	2.7	1.1	4.239***
Apiary size	Mean	26.8	19.01	1.388Ns
Livestock	Mean	4.4	3.9	0.615Ns
Bee colony	Mean	3.2	2.4	1.590Ns
Perception	Mean	16.4	13.8	4.008***
Knowledge	Mean	4.7	3.3	6.054***
BK training	Yes	(75.6)	(5.9)	$\chi 2$
	No	(24.4)	(94.1)	68.014***
Extension	Yes	(84.4)	(42.4)	
	No	(15.6)	(57.6)	21.259***
Credit	Yes	(88.9)	(27.1)	
	No	(11.1)	(72.9)	45.036***
Apiary Visit	Yes	(71.1)	(29.4)	
	No	(28.9)	(70.6)	20.780***
Market	Yes	(75.6)	(21.2)	
	No	(24.4)	(78.8)	36.253***

*** Significant at P<0.01, ** Significant at P<0.05, NS- Non- significant

Figures in parentheses indicate percentages

Apiary is the place where honeybee colonies are kept on the farm/homestead. The apiary size ranges from 6 m^2 to 100 m^2 with the mean of 26.8 m^2 and 19.01 m^2 for adopters and non-adopters, respectively. The difference, which is not significant, indicates that beekeeping activity does not require large or fertile pieces of land. Uncultivated land can also be used. Even landless farmers with small plots of land around homesteads can engage in this activity.

The mean livestock holding, taken as a proxy for wealth status, is 4.4 and 3.9 for adopters and non-adopters, respectively. There is no significant difference in the wealth status of both categories measured by livestock holding, implying that the improved box hive technology is not necessarily suitable only for resource rich households. The average honeybee colony holding was 3.2 and 2.4 honeybee colonies for adopters and non-adopters, respectively. Having more or less number of colonies did not affect the use of improved box hive, as farming households that decided to use the technology could start by purchasing the colonies. Among the respondents, 29.4% and 71.1 % of non-adopters and adopters respectively, had got an opportunity to visit an apiary, through extension activities. It is significantly different at P<0.01, showing that farmer-to-farmer exchange of experience and knowledge sharing influences

adoption positively. The difference in positive perception about the technology was also significantly different among adopters and non-adopters. Higher yields and better quality, ease of inspection and, ease of product harvesting are the major relative advantages of improved box hive identified by the majority of beekeepers. On the other hand, high cost, high skill requirement need of accessories, and unavailability of the box hives are the main relative disadvantages of improved box hive as noted by the respondents.

B. Factors influencing the adoption of improved box hive

As indicated in Table 2, 90 % of the total variation for the adoption of improved box hive is explained by binary logit model. The χ^2 result shows that the parameters are significantly different from zero at P<0.01 for the adoption of improved box hive. The model correctly predicted sample size of 84.4 % and 92.9% for adopters and non-adopters, respectively. Among, the explanatory variables, credit, knowledge, education level of household head, perception and visiting demonstration were found to be significant as hypothesized. Age, family size, extension contact, market availability and beekeeping training were insignificant compared to other explanatory variables in the regression. Probably, the lower influence of variables such as beekeeping training, extension contact and availability of market is due to the fact that the high cost of the improved box hive and honeybee colony dominates all other factors. In the other way, though there is extension service and training in the area, it cannot enhance adoption of the technology if the user cannot afford the technology. In relation to marketing, both adopters and non-adopters may have market for their products. This argument was confirmed by group discussion with the farmers.

The explanatory variables that were significantly influencing adoption of improved box hive are discussed here:

Credit – In the study area, improved box hive was perceived as being costly by the beekeepers. Under such circumstances, credit plays a significant role in enhancing the technology promotion. As anticipated, credit affects adoption positively and significantly at P<0.01, the odds in favor of adopting improved box hive increased by a factor of 13.6 for beekeepers who had received credit. Similarly, Lelisa (1998) study on determinants of fertilizer adoption, intensity and probability of its use and found that access to credit is one determinant of fertilizer adoption and intensity of its use. Doss et al. (2003), Feder et al. (1985), and Cramb (2003) also concluded that credit is correlated with the use of improved inputs.

Table 2. Logistic regression for factors influencing improved box hive adoption

Variables	B	S.E.	Wald	Sig.	Exp(B)
AGE	-.017	.045	.150	.699	.983
FAMLSIZ	.382	.257	2.211	.137	1.466
EDUCATI	.446	.172	6.729	.009***	1.562
PERCEPTION	.252	.134	3.523	.061*	1.287
CREDIT	2.607	.968	7.251	.007***	13.555
EXTCONTA	.805	.628	1.643	.200	2.237
VISTDEM	2.262	.905	6.247	.012**	9.598
KNOWLED	1.656	.603	7.549	.006***	5.239
MKTAVAIL	1.257	.789	2.538	.111	3.515
BKTRAIN	.144	.413	.122	.727	1.155
Constant	-15.465	4.362	12.570	000	000

-2 log likelihood 59.852
χ^2 07.857***
Predicted adopter 84.4 %
Non-adopter 92.9%
Over all 90% *, **, *** significant at p<0.1, p<0.05, and p<0.01

Knowledge – Improved beekeeping technology requires knowledge on the practical aspects. The odds in favor of adopting improved box hive increased by a factor of 5.24 for beekeepers who acquired better skills on improved beekeeping practices. The result is in line with Yadav (1992) who finds that adoption of improved paddy cultivation practices has a highly significant and positive correlation with knowledge of farmers. Degnet and Belay (2001) also showed that farmers' knowledge of fertilizer use and its application rate positively influenced adoption of high yielding maize varieties.

Education – Education increases the access to information and thereby possible knowledge of beekeepers regarding improved box hive. It also increases the understanding of the technology and facilitates its application. As hypothesized, education influences adoption of improved box hive positively and significantly at P<0.01 %. The odds in favor of adopting improved box hive increased by a factor of 1.56 for beekeepers who had higher education level. The result is also supported by earlier studies of Voh (1982) that dealt with factors associated with the adoption of recommended farm practices in a Nigerian village; Feder et al. (1985) which focuses on adoption of agricultural innovation in developing countries; and Cramb (2003) that identified factors affecting the successful adoption of new technologies by Smallholders.

Apiary visit- Apiary is the place where the honeybee colonies are kept, in the farms of model farmers. Visiting the apiary helps the beekeeper to learn more about the technology. It also motivates the

beekeepers towards adopting the technology. The odds in favor of adopting improved box hive increased by a factor of 9.6 for beekeepers who had an opportunity of visiting apiary. Beekeepers, who get an opportunity of visiting the apiary and exchanging knowledge and experience with fellow farmers, seem to become more favorable to adopting the technology. Beekeepers trust information from each other more than they do with the outsiders. Hence, apiary visit is an important mechanism to introduce beekeeping technology and induce adoption. The result coincides with Melaku (2005), who explains that there is significant association between adoption and apiary visit by farmers.

Perception – Positive perception of beekeepers about the technology favorably influences adoption decision. The odds in favor of adopting improved box hive increased by a factor of 1.28 for beekeepers who perceived the technology positively. Shiferaw and Holden (1998) also found that perception influences adoption positively. The result is also in agreement with study of Million and Belay (2004) on factors influencing adoption of soil conservation measures in Gununo area of south Ethiopia, which found that the perception about soil conservation problem influenced adoption of soil conservation technology positively. Farmer to farmer experience sharing visits also contributes towards developing positive perception towards an innovation or a new technology.

C. Financial benefits of adopting improved box hive

Yield is an important determinant factor in adopting the technology. The higher the yield obtained from the introduced technology, the easier it is to convince the farmers to adopt the technology. In the study area the minimum and maximum honey yield per annum for improved box hive is 8 kg and 64 kg, respectively. The mean annual honey yield is 27 kg. It is above the national honey yield average, which is about 20-25 kg/hive/annum. The price of one kg pure honey was 35 Birr at farm gate and 50 Birr at nearby regional town. Hence, a beekeeper could get 945 - 1350 Birr gross benefit per hive/annum.

The partial budgeting reveals that adoption of improved box hive does result in additional income to the extent of 489.11 Birr in the study area (Table 3), the income being almost three times what one would get from the traditional hive. Melaku (2005) using partial budgeting analysis in his study also concluded that both the homemade and institutionally made Kenya Top Bar Hive (KTBH) were beneficial and remunerative. As noted by the author, movable top bar hives result in higher net return per colony compared with traditional hives. The national average of KTBH is 10-15 kg crude honey/hive/annum, which is below the national average of improved box hive (20-25 kg pure honey/annum). Comparison of KTBH with improved box hive was not included in this analysis, as the KTBH were not used in the study area.

Observation and discussions with beekeeper farmers revealed that they were using only one super, while they received two supers. Hence, there is an opportunity to reduce the price of the hive if the beekeepers are provided with one super instead of two supers. Currently, the hive stand of box hive is made up of metal, which also increases the cost of the hive. This can also be made from locally available materials. With the reduction in cost of these two items, the price of the hive can be reduced.

4. Conclusion and Recommendations

Both economic and non-economic factors affect the adoption of improved box hive. Hence, for effective utilization of the technology, both factors need equal consideration by policy makers and organizations involved in beekeeping development. In other words, providing the necessary exposure and skills and; institutional support in the form of credit, technology and, market linkages need to be addressed simultaneously.

Participatory value chain based approach: All the problems faced by beekeepers cannot be addressed by a single organization. Various actors (including research, extension, decision makers, input suppliers, credit agencies and those along the value chain) need to collaborate in search of appropriate solutions and implement them. Following a participatory value chain based approach would go a long way in the efficient development of the sub-sector. Formation of formal or informal actor-alliances with a specific objective will be a useful mechanism to do this. The extension service should take the lead in creating necessary linkages and forming such alliances.

Availability of institutional credit strongly influences the adoption of improved box hives, due to the high cost of the box hive and the colony. Even though credit was available, non-adopters resisted taking any loans due to the high prevalence of honeybees` absconding. There is an urgent need to develop the skill of beekeepers on the management of absconding through organizing practical and hands-on beekeeping training, which will facilitate developing confidence in the technology.

The research and development organizations should identify and document the existing Indigenous Technical Knowledge of beekeepers to integrate it optimally into improved beekeeping practices.

Promoting farmer-to- farmer knowledge sharing: Opportunities to visit other farmers' apiaries were found to significantly influence adoption of improved box hive through developing a positive perception and trust in the technology. This is an effective extension method, but requiring additional resources. Extension strategies need to be rethought to design ways of incorporating such effective methods (including field days) while efficiently utilizing available resources. This requires development agents who are competent, knowledgeable and understand the significance of farmer-to-farmer exchange. In addition to the farmers, DAs also need in-service training on improved beekeeping practices to develop practical knowledge of the technology.

Farmer groups to create learning environment: Cooperative office of the district ARD and NGOs need to come together to strengthen the existing beekeepers cooperative as they can provide a good learning environment for similar areas. Organizing them to operate in enclosure areas has multiple advantages i.e. apiary can be established in the area and they can also protect and conserve it by planting different bee forages.

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Table 3. Partial budget for improved box hive and traditional hive (n=45)

Additional cost (Birr)	Improved box hive	Traditional hive	Additional return (Birr)	Improved box hive	Traditional hive
Transport	12.55	--	Honey yield	945	250
Accessories service charge					
Interest on loan	19	--	Total return	945	250
Feed cost	23.65	0.26			
Pure bees -wax	26.5	8.70			
Labor cost	123.15	--			
Total cost	15	5			
	219.85	13.96			

Net income from improved box hive (945-219.85) = 725.15 Birr
Net income from traditional hive (250-13.96) = 236.04 Birr
Incremental net benefit per improved box hive (net income of improved minus net income of traditional= 725.15-236.04) = 489.11 Birr
(1US dollar= 12.2 birr)

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