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Constraints and future prospects for beekeeping in tribal forest region of Chhattisgarh

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Abstract

Beekeeping is important for securing food, poverty reduction, health, environmental protection and plant pollination. These important practices are challenged by many biotic and abiotic factors in recent years. These factors affect honeybees and their valuable products either in combination or alone. The climatic factors like extreme temperature, relative humidity, shortage of water, deforestation of floral plants, human factors like poor apicultural practices, synthetic pesticides, diseases, and arthropod pests led to the decline of honeybee colonies and their products. But the world market demand for honey and other hive products has increased tremendously in recent decades since it is important for a wide variety of uses and applications. This review paper, therefore, was aimed at exploring these major constraints in beekeeping. It also outlines the most important cultural methods with emphasis on sanitation, maintaining bee colony vigor and some other management practices. Furthermore, from the conclusion of the review, it became important to recommend establishing specific laws and legislations that might be issued by decision makers to prevent honey adulteration. It also requires organizing honey marketing channels and raising awareness on limiting the use of pesticides in agriculture to protect the bees and the environment as well. The renovations and application of improved beekeeping technologies not only benefits beekeepers but also farmers and the general public in pollinating their crops, maintaining plant biodiversity, and the ecology at large. This review, therefore, addresses the honeybee and its production constraints and puts forward some available management practices.

Keywords: Future prospects, beekeeping, tribal, health, environmental

Introduction

The honeybee is a beneficial social insect. It is important for obtaining honey, securing food, reducing poverty, job employing, getting income, protecting environmental pollution, and caring for human health. Furthermore, the honeybee is reared for producing honey, conserving biodiversity, pollinating crops beeswaxes, propolis, royal jelly, venom, apitherapy, and revenues. Beekeeping and honey hunting practices were begun by human beings 4500 years ago (FAO (Food and Agriculture Organization of the United Nations), 2019).

Apiculture or Beekeeping is the art and science of collecting, processing honeybee colonies of desired species having them in specified and standard boxes, installing at appropriate sites, managing optimum number of colonies scientifically round the year and harnessing both direct and indirect benefits of the activities. As such a degree or high qualification is not essential in order to work in this profession. Apiarists can be developed and trained to handle the enterprise. There is vast potential and scope from diversification in Apiculture i.e. besides honey its offers scope for production and marketing of other bee products like bee pollen, bee propels, bee way bee venom and Royal selling. Honeybees can also be managed as and when required for pollination of field and Horticultural crops and for hybrid seed production in vegetables and other bee pollination crops technologies for the production of different products i.e. Royal jelly, bee pollen, bee porpoise, bee venom, Queen bees, package bees etc. now available in India. Beekeeping is an environmentally friendly and non-farm business activity that has immense Contribution to the economy of segments of the society and to a national economy (Bersmp 2008) ^[5]. In Dantewada district, where land holding is less than 0.5 ha beekeeping can provide better food, balanced nutrition and employment to small and marginal farmers. It can also provide the unemployed and underemployed persons with full employment and extra income. Modern bee hives also enable beekeepers to transport bees, moving from field to field as the crop needs pollinating and allowing the beekeeper to charge for the pollination services. They provide, revising the historical role of the self-employed beekeeper and favoring large scale commercial operations.

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Today, beekeeping is an important, sustainable, integral agricultural activity and opportunity for the farmers to adopt as an enterprise. It provides nutritional, economic, and ecological security and balance. The knowledge of agro-climatic conditions, the diversified flora, changing agri / horticultural pattern of the crop, the types of bees, the management practices etc. play a pivotal role in transforming the beekeeping industry in the Chhattisgarh. Rural poor dependent on subsistence agriculture and small farm lands often rely on alternative sources of income for their livelihoods. For such circumstances, (Yap, Devlin, 2015) ^[33] propose that beekeeping is often promoted in the context of rural development because the practice provides monetary, nutritional, and social benefits to poor families, without requiring land ownership or large amounts of capital investment. According to (Lietaer, 2007) ^[23], beekeeping can be practiced as an additional source of income for farmers in rural areas and has been successfully implemented in poverty-alleviating projects. (Joni, 2004) ^[17] also states that beekeeping plays a major role in the socio-economic development of rural livelihoods. (Mazorodze Brian T., 2015) ^[24] suggests that beekeeping not only contributes to uplifting the livelihoods of rural communities but protects the trees and ultimately contributes to protecting our planet earth. He further argues that beekeeping is ecological friendly, requires few resources to start up production, can be quickly taken up again after a crisis period and the necessary skills are easily transmitted from one generation to the other making it a sustainable livelihood strategy. Arguing on resource requirement and investment in beekeeping endeavors, (Bradbear, 2009) ^[8] also concluded that beekeeping does not require expensive equipment, as simple hives can be made from local materials by local artisans. Having this background information, the major important constraints of the honeybee and its products, and some important management measures of these challenges reviewed in this manuscript.

Constraints

The prevailing production constraints in the beekeeping development of the country are complex and to a large extent vary between agro-ecological zones and production systems (EARO, 2000). Variations of production constraints also extend in socio-economic conditions, cultural practices, climate (seasons of the year) and behaviors of the bees (Adjare 1990) ^[3]. According to the results of this survey, the main constraints of apiculture sub sector in Chhattisgarh forest region are indicated below:

1. Floral availability

The availability of various floral resources and its species concerning nectar, sugar contents, and pollen are very important for brood rearing (Rucker *et al.*, 2002) ^[30]. Honeybee must be accessing the adequate sources of carbohydrates, proteins, lipids, vitamins, minerals, and waters that collect from the nectars, pollens, honey reserves, and other water supplements. The honeybee is malnourished if exposed to only one source of pollen crops for an extending period in their success of reproduction and overwintering under stress conditions. Worker honeybee collects pollen and nectar from a single source predominantly. These encountered imbalances in nutrition in the colony. Foragers preferred the complementary diet. The nutrition of honeybee that sourced from a diverse floral plants are important to sustain the homeostasis and balanced diet at the colony level.

(Hendriksma & Shafir, 2016) ^[15]. Thus, therefore, the honeybee colonies attempted to foraging nutrients from a diversity of plants for striving of malnutrition. However, bias their foraging towards pollen substitutions of a balanced diet can overcome the nutritional deficits of the colony (Hendriksma & Shafir, 2016; Simpson & David Raubenheimer, 2011) ^[15, 31]. Honeybees and bumblebees served as a model organism for studying the relative uptake of proteins and carbohydrates from the collected pollens and nectars, respectively. Pollen choice by foragers seems unlinked to nutritional values, though non-nutritional pollen traits could induce foraging preference (e.g., color, odor, concentration, pH, or grain size) (Nicholls & Hempel de Ibarra, 2014) ^[26].

Nectar is a source of honey, heat, and energy for honeybees, while pollen provides protein, vitamins, fatty substances, and other nutrients. Therefore, a direct consequence of nutritional deficiency (pollen shortage) has resulted in a decrease in a honeybee colony. The nurse honeybee physiology and its ability to tolerate parasites depend on the quality of the pollen. Pasquale *et al.* (2016) reported that pollen diet diversity had no effect on the nurse of honeybee physiology and it's healthy to survive. Nevertheless, it increased the live longevity of honeybee than honeybee fed on monofloral pollens unless a protein-richest monofloral pollens. The survival period of healthy honeybees correlated to alkaline phosphatase activity and phenol oxidase activities. The quality and diversity of pollen can shape honeybee physiology and land-use intensification of agriculture on honeybee nutrition and health (Pasquale *et al.*, 2016). The presence of quality pollen is a central parameter. It influences the development of honeybee colonies and brood rearing. Besides this, the consumption of high-quality pollen induces the development of an important component of larval food known as the hypopharyngeal glands in young honeybee workers (Keller *et al.*, 2005) ^[19].

The floral availability varied during the dry and rainfall seasons. It is high during the spring than in the winter, summer, and autumn. Moreover, the availability of honeybee forage is high from August to November. However, it becomes decreases and shortens from late December to mid of March. The shortage of floral pollen could have to be solved by planting a drought-resistant flora species (Kebede & Gebrechirstos, 2016;) ^[18]. These indicated that the ample pollen and nectar source of honeybee forage is available following the rainfall season.

The amount of honey produced during the dry season was low due to the scarcity of pollen and nectar. Honeybees pollinate both cultivated and wild flora. During the decline of flowering plants, a deficiency of nutrients occurred, affected the physiology of developing honeybees, and increased the probability of attack by parasites and diseases (Thompson, 2017) ^[32].

The time and duration of the blooming season of flora, environmental factors, and the carrying capacity of the area could be hampering the maximum honeybee yield production. However, assembling a floral calendar for a specific area is time-consuming. It requires complete observation of the seasonal changes in the vegetation patterns. These observations could be an agro ecosystem of the area, the foraging behavior of the bees, a how the honeybee colonies interact with their floral environment. The accuracy of a floral calendar and its practical value depends solely on the careful recording of the beginning and end of the flowering season of

the plants (Kebede & Gebrechistos, 2016) [18].

2. Deforestation

Deforestation contributed to losses of honeybee diversity, the value obtained from the honeybee, and floral plants. This is why the forest provides an excellent resource for honeybees and beekeeping in the ecosystems. Conservation of the forest is, therefore, an imperative for sustainable beekeeping and its valuable products (Mustafa *et al.*, 2015) [25]. Nevertheless, the impacts of deforestation on honeybees are poorly considered. In the short forest, conservation helps to conserve honeybee and their values and vice versa. The forest ecosystem is a home or shelter, and sources of food where different indigenous honeybee races are found. Honeybee gets pollens, nectars, shelters, and water from the forest. This is why deforestation highly treating to local honeybee populations and leads to excessive hunting pressure (Oldroyd & Nanork, 2009) [27]. In addition, the long-term decline of the honeybee colony caused the decline of pollinator ecology of the forests and exacerbates deforesting and wood harvesting.

3. Pesticides poisoning

The use of chemicals and pesticides for crop pests, weeds, Tsetse fly, mosquitoes and household pests control brings in to focus the real possibility of damaging the delicate equilibrium in the colony, as well as the contamination of hive products. Of the various kinds of chemicals only insecticides and herbicides are now major problems to the beekeepers. The chemicals used for crop protection are the main pesticides that kill the bees. Moreover, there are two other circumstances in which bees are killed on plants by chemicals. These are by insecticides applied to non-crop pests such as mosquitoes and Tsetse flies and by herbicides applied to plants on which the bees are foraging. Insecticides have a much more dramatic effect on population of bees, thus, the important contribution made by bees to the production of food and human nourishment is being jeopardized. On the other hand, herbicides, which are commonly not toxic to bees, destroy many plants that are valuable to bees as source of pollen and nectar. The types of chemicals used include Malathion, Sevin, DDT, 2-4 D and Acetone. As it was seen from the beekeeper point of view, poisoning of honeybees by agrochemical has been increased from time to time. Some beekeepers lost totally their colonies due to agrochemical.

4. Lack of skilled manpower and training institutions

Beekeeping is one of the disciplines which suffered and is being suffering from the lack of skilled manpower, appropriately skilled trainers, training materials and training institutions in the region. Majority of the beekeepers lack the knowledge of appropriate methods of beekeeping. In the country there is no concerned college or university which can provide diploma or certificate level course in beekeeping. IGKVV, Raipur Bee Research Center is the only institute that provides basic trainings to farmers, technicians, and experts. However, this doesn't meet the ever increasing demand of trained manpower in the region.

5. Low level of technology used

Some studies indicate that the level of beekeeping in the region still remains in traditional system and about 94 to 97 percent of bees are still kept in local hives with its various limitations. An introduction of improved beekeeping technologies to the rural communities are beyond the buying

power of the farmers and not easily available for those who can afford it. Most of the local beekeepers lack the basic tool that would be needed for private work like bee veil, hand gloves, smoker, chisel, and overall (beekeepers suit).

6. Honeybee pest and diseases

Ethiopia, as one of the sub-tropical countries, the land is not only favorable to bees, but also for different kinds of honeybee pest and predators that are interacting with the life of honeybees (Desalegn 2001) [10]. The existence of pests and predators are nuisances to the honeybees and beekeepers. Pests and predators cause devastating damage on honeybee colonies with in short period of time and even over night. According to Kerealem (2005) [20] ants, honey badger, bee-eater birds, wax moth, spider and beetles were the most harmful pests and predators in order of to decreasing importance. Some studies indicate that Ethiopia appears to be free from various honeybee brood diseases and at the same time at low level of adult bees' diseases incidences. A major category of diseases which cause economic loss comprises amoeba, nosema and chalk brood.

7. Shortage of bee colony

The majority of the beekeepers interviewed said that one methods of obtaining bees is by capturing a wild colony during the reproductive swarming season. However, wild bees habitats are increasingly being destroyed as a result of expansion of farmland and are often suffer from total destruction of their nest. Recent studies also revealed that in most part of the region acquiring honeybee colonies is a major problem to start bee farms and to expand the existing ones.

8. Marketing problems

It has been observed that in the region the marketing system of honey has many problems. Most of the local markets are far away from the beekeepers and are inaccessible. Beekeepers travel on foot for several hours to sell their honey. The lack of grading systems does not encourage farmers to produce high quality products, thus, the price of honey changes widely based on the good will of buyers. Gezahegne (2001) [14] discussed the constraints to marketing of honey and beeswax in the country and these include low and discouraging price of honey and beeswax in local markets, lower quality of products, lack of market information, absence of organized market channel, transportation problem, lack of appropriate technologies for collecting, processing, packing and storage of honey to keep its natural quality, lack of government support in promoting market development, and low involvement of private sector. Because of beekeepers have limited knowledge of the preferences of their target market, they do not try to make any changes in the quality of their product. Presentation of quality honey is generally poor. Most honey come to market is un-extracted, unstrained and poorly managed.

9. Absence of policy in apiculture

The livestock sector in Ethiopia has probably suffered more than the crop sector from inappropriate government policies and the apiculture sub sector is no exception. Chhattisgarh forest region doesn't have any development strategy and policy in apiculture.

10. Poor handling practices

The poor post-harvest handling (like storing in poor

containers, storing at room conditions, exposing the storage to dust and pests without covering the storage materials, during storage and transportation) of honey, absence of market linkage between producers, retailers and consumers affected negatively the quality of honey (Bahta, 2018) [4]. Honey is widely consumed as food and medicine. So protections of honey from contamination of different factors are very important to minimize the health-related problems after consumed and medicated.

11. Smoking

Smoking is used for masking the alarm pheromones like isopentyl acetate that used for moving honeybees from the honeycomb in the hive during harvesting and inspecting. It interrupts the honeybee colony's defense during opening the beehive and harvesting because it hinders the ability to sense of smell and triggers their survival response (Gage *et al.*, 2018; <http://www.fao.org/3/i0842e/i0842e06>) [13].

12. Human factors and public services

Harvesting at night, gathering wild honey, processing crude, following inadequate techniques, or without sanitary protocols, surveillance, diagnostics, prevention, control, treatment protocols, contaminate hive, tools, equipment, and lack of care honeybee disease during movement of honey and other hive products resulted in contaminating, poor handling, disposal, and unregulated trading (Bett, 2017; Ababor & Tekle, 2018; <https://www.au-ibar.org>) [6, 1]. Because the honey harvested under those circumstances, is poor and contaminated. The product from honey hunting is usually a mixture of ripe and unripe (i.e. high water content) honey, beeswax, dead bees, and other debris. Traditionally, men are responsible for honey harvested at night because they are scared of honeybees during the day (Lalika & Machangu, 2008) [21].

13. Temperature and relative humidity

Temperature and relative humidity affects the homeostasis of the honeybee colony in the hive (Abou-Shaara *et al.*, 2017) [2]. Collins (2015) [9] stated that the percentage increment of temperature, relative humidity, wind speed, and intensity affected honeybees negatively. As the temperature rose beyond the optimum ranges the activities of honeybee decreased, phenologically flowering plant is varied to collect pollen and nectar or mismatch or of asynchrony to give good outputs. Langowska *et al.* (2016) [22] showed that the yield of honey decreased in the summer season as the temperature increased in the United Kingdom. In this season the most of the annual floral plant species become dried or unavailable due to a shortage of moisture in the soil, while others found dormant, except the evergreen plants. In the spring season, the honeybee phenology had a strong negative relationship with temperature (Langowska *et al.*, 2016) [22]. Similarly, in this season the flowering plants exhaustively available for foraging than the other season of the year.

14. Water availability and its provision

Water availability strongly affects the honeybee colonies. It is used for maintaining the amount of moisture evaporation from the hive, fluid homeostasis of adult bees, producing glandular secretions, diluting honey for feeding the brood, relieving brood nest, hyperthermia, cooling or buffering their colony against future extreme water stresses or desiccation of the stored brood crops in the combs of the hive (Ostwald *et al.*,

2016). A honeybee collected water with nectars or pollens and moistens the environmental surfaces of the wetland areas (ponds, canals, near river water basin and ditches), guttation dropping from plants (xylem fluid excrete droplets along with the edges of the plant leave) and an axial leaf of plant surfaces (Joachimsmeier *et al.*, 2012) [16]. Honeybees did not distinguish between dew, rain, and guttation droplets. However, they often observed by scanning the leaf edges (Joachimsmeier *et al.*, 2012) [16]. Therefore, filling the saucer or bucket with marbles or stones, corks, sponges, sticks, straws, or anything that floats over water in order to avoid easily drown of the honeybee to water. In addition, beekeepers have devised all kinds of bee watering stations (Burlew, 2020) [7].

Future prospects for beekeeping development

Beekeeping is a sustainable form of agriculture, which is beneficial to the environment and provides economic reasons for the conservation of native habitats and potentially increased yield of food and forage crops. In Chhattisgarh region beekeeping provides a good example of one activity which has a strong local tradition, where there is a local market, and which is environmentally beneficial. Besides the challenges mentioned above, the main opportunities for beekeeping development in the region are:

- There is still huge potential (local honeybee races and forages) to increase honey production and to improve the livelihood of the farmer beekeepers;
- The Government has recently put in its agenda the need to develop apiculture as one of the strategies to reduce poverty and to diversify national exports;
- Since recently, the users of improved hives and appropriate beekeeping equipment and accessories are increasing;
- The presence of micro finance institutes at grass-root level;
- Some NGOs are also giving more attention to the sub sector than ever before as an important intervention areas to support the poor and particularly the women. This will give farmers the opportunity to access improved technologies and capacity building; and
- The establishment of bee products development and marketing cooperatives and union. These institutional changes will provide good opportunity to create increasing demand and competitive market for organic honey. This will in turn result in endogenous technological change and overall development in the sub sector.
- Beekeeping is a non-physically demanding work; it is also favorable for women and landless youth. So if such like off-farm activity be encouraged through special attention of women and youth, one step forwarded in terms of the country's plan of Krishi Kalyan Abhiyan (KKA) which Emphasize greater participation of women and young people.
- The Indian government has recognized the role of the apiculture and has put in its development agenda, mainly as a non-farm income generating activities, to increase income of the rural and urban households and to promote the export sector. There is an encouraging support from the government and NGOs to develop micro and small scale enterprises in apiculture. It should be also understood that the market problem, beekeepers _knowledge gap and extension support increasingly

improving (though a lot still remains). This will give a possibility of increasing bee product export revenue and improving the production efficiency.

- Indian government has initiated the programme KKA in state level which including all the sector where Krishi Vigyan Kendra Dantewada played a vital role in dissemination of knowledge, encouragement and support to the farmer and rural people of the district to adopt beekeeping as livelihood so it may great opportunities for the farmer to get additional income.
- Application of advanced technology for collection, and processing of honey.
- Recognition of bee keeping as agro-industry.
- Developing an efficient export marketing network to optimize the production and exports.
- Livelihood of communities in rural mountains is mainly dependent on subsistence agriculture; they always require an alternative source of income.

Conclusion

Beekeeping is a well-established practice in the farming communities of the Chhattisgarh region and it plays a significant role as source of additional cash incomes and nutrition for many thousand subsistence farmers. However, in spite of its significant economic contribution and its great potential for sustainable development for the region, the attention given to the sector until recently was not satisfactory. Beekeeping has been left for nature with little attempts to support it with technological packages to improve its production and productivity. Thus, the farmer beekeepers in particular and the region in general are not benefiting from the sector as the high level of the economic potential of the apicultural resources would allow. In this paper the constraints to production and strategies to enhance development are discussed. Based on the result of this study, the major challenges were shortage of bee forage, pesticides poisoning, lack of skilled manpower and training institutions, low level of technology used, honeybee pests and diseases, shortage of bee colony, marketing problems and absence of policy in apiculture. Despite the different challenges encountered the sub sector, the opportunities for beekeeping development in the region were the presence of natural resources (bees and forage), the current attention of the government to develop apiculture as one of the strategies to reduce poverty, high demand for hive products, the establishments of beekeepers co-operatives/union, the involvement of NGOs in sub sector and the presence of micro finance institutes at grass-root level. Therefore, beekeeping could probably be a profitable activity to undertake in most parts of the region. The ownership pattern of honeybee colonies is widespread and nowadays the previously neglected 'micro-animals' are gradually gaining a respectable place in research and development programs. Thus, developing appropriate policy and beekeeping development strategy that would be applicable to the different production systems and agro-ecological zones of the region and give a clear sense of direction is vital to improve the utilization of the region's apiculture resources with a promising economic future.

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