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Pre-extension Demonstration of Buckwheat in Diga and Wayu Tuka Districts, East Wollega Zone, Oromia, Ethiopia

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Abstract

Buckwheat (*Fagopyrum esculentum*) is an important plant for honeybees due to its nectar production, nutritional value, and ecological benefits. Here are the key reasons why buckwheat is significant for honeybees. This study examines the impact of buckwheat cultivation near apiaries on honey yield. Data were collected from 36 hives across various districts. The mean honey yield from hives near buckwheat fields was significantly higher (42.29 ± 2.38) compared to hives without nearby buckwheat (33.81 ± 3.62). The average increase in yield attributable to buckwheat presence was 8.48 units, with differences ranging from 3.90 to 16.90. Buckwheat flowers produce an abundant supply of nectar, which is highly attractive to honeybees. Nectar from buckwheat has a high sugar content, providing a rich energy source for bees. The plant blooms over several weeks, offering a sustained nectar flow, especially during late summer when other nectar sources may be scarce. In addition to nectar, buckwheat provides pollen, an essential protein source for bee colonies. Pollen collected from buckwheat helps support brood rearing and overall colony health. These findings suggest that buckwheat cultivation near apiaries can enhance honey production, potentially benefiting apicultural practices.

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Keywords

Buckwheat, Nectar, Honey, plant protection, pollen.

Introduction

Buckwheat (*Fagopyrum esculentum* Moench) is an annual herbaceous plant of the Polygonaceae family originating from Central Asia (Sharma and Jana, 2002; Chauhan *et al.,* 2010). As a flowering crop, buckwheat positively contributes to the insect ecosystems including honey bees, particularly if it is cultivated (Leiber, Florian 2016).

Because of the short vegetation season, buckwheat grows quickly (Romanovskaja *et al.,* 2016)**.** These plants could very well consume mineral matter present in the soil because their roots can absorb them from the hard soluble compounds. Buckwheat is very suitable for cultivation in organic farming, where no industry fertilizers and plant protection products can be used (Loch and Lazanyi, 2010). Buckwheat biology differs from that of other agricultural plants because buckwheat plants form vegetative and generative organs at the same time. Their flowering is long (about 50 days) and very abundant, but the percentage of seed sets is very low (Maletic and Jevdjovic, 200).

Beekeepers like buckwheat for their foraging honeybees, due to buckwheat's extended flowering period (Robert, 2017). Buckwheat also requires minimal fertilizer applications (Bjorkman, 2003). Colony malnutrition may also arise from constraints on honeybee floral sources. No other chemical constituent of pollen influences as many aspects of bee nutrition as protein (Roulston *et al.,* 2000; Charlie Nicholson, 2012). Studies cite that the reasons for recent honey bee losses include a lack of diverse nectar and pollen resources, especially within intensively farmed agricultural landscapes (Winfree *et al.,* 2007; De Courtye *et al.,* 2010; Naug, 2009). The current colony declines might simply be the breaking point where nutritional stress is due to habitat loss. Human disturbance, particularly the loss of natural and semi-natural habitats, is regarded as a primary cause of pollinator decline (Kearns *et al.,* 1998; Kremen *et al.,* 2002; Goulson *et al.,* 2008). A deficiency in nectar and pollen resources will lead to demographic decreases in bee colonies. Buckwheat supply for honeybees both nectar and pollen when in bloom, so buckwheat demonstration for beekeepers is convenient.

Objective

- ✓ To increase the product of honeybees through improved bee forage.
- ✓ To develop nectar and pollen access for honeybees in dearth period

Materials and Methods

Description of the study area

The study was conducted in East Wolega Zone where found in west part of Oromia located at latitude 80^0 31 “52 South and longitude 360^0 07“51 East. The highest point in this zone is Mount Garochan (3,276 m). Nekemte is capital city of East Wollega zone. Administratively managed into 17 Woredas, 1 Special woreda, 43 towns and 287 rural kebeles. According CSA 2007 report, the total population is 1.5 million. In the zone, agriculture is the dominant livelihood the population. Most their agricultural activities cash crop like maize, teff, sorghum and other pulses. The activity will be conducted in East Wollega zone (Wayu Tuka the capital city Gute and Diga districts (Diga).

Site selection

For the activity, the Selection of sites and farmers were conducted with the collaboration of word experts and DAs. PAs and beekeepers were selected purposely based on: the potentiality for beekeeping and accessibility for routine inspection. Accordingly, Bikila and DamaksaPAs in Diga districts and Migna Kura and Wara babu Minya Pasfrom Wayu Tuka District were selected as demonstration sites of the buckwheat based on accessibility and potentiality for the honeybee colonies. Two apiary sites in each district 1 apiary to cultivate buckwheat nearby and 1 apiary as control on buckwheat cultivate nearby apiary site and total for both districts two apiary sites for cultivating buckwheat as bee forage, while the other 2 apiary site were as control (farmer practice) not buckwheat cultivated nearby apiary site.

Farmers (FRGs/FREGs) selection

Selection of FRGs/FREGs members was based on farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and genuineness and transparency to share innovations to other farmers. Consequently, one FRG/FREG having 60 members with the composition of resource rich, medium and poor category of farmers including men, women and youth farmers was established at each kebele. Gender and youth balance in each FRG/FREG unit was strictly considered. After establishment of the FRGs/FREGs, a theoretical training session was arranged to farmers, DAs, and experts at Diga and Gute Town. Multidisciplinary team of researchers from Bako Agricultural research center delivered training to 60 FRGs/FREGs members, 8 DAs, 2 supervisors and 8 experts on the following topics: participatory agricultural research and promotion on bee forage technologies through FRGs/FREGs (considering gender and youth balance) based on: willingness to be held as a member, accessibility for supervision, genuineness and transparency in sharing the technology, availability and accessibility of sufficient land loyalty to handling experimental sites properly), suitable agro-ecologies and weather condition for bee forage, honey production and honeybee colony management, buckwheat agronomic practices, economic and nectar and pollen source of importance of buckwheat, bee product managements and storage of the honey. Farmers (FRG/FREG members and other follower farmers) were encouraged to participate in the physical activities from the beginning up to the end of the demonstration activity

Implementation Procedure

Two buckwheat varieties (brown seed and white seed) were used for the demonstration process by using each farmer’s field as replication *i.e.* the demonstration activity was replicated on five farmers per kebele. Buckwheat was sown in late July on each selected experimental farmer's plot. Land preparation was done by conventional tillage and harrowing with plot and buckwheat seed was planted on 1-2 ha (FRG) per individuals 0.25-0.5 plot. Within this area, 1×1 m2 was taken as experimental unit for honey bee foraging intensity data recording. The space rows, seed rate of buckwheat and recommended fertilizer amount was used. Three to five zander beehives were used per individual farmer and a total of 50 zander beehives. As part of the intervention of activity training on Overall buckwheat plantation, management and utilization aspects will be given to farmers, DAs, and experts by the technical staff of Bako Agricultural Research Center.

Equipment provision

Most of the specialized equipment was, 36 Zander bee hove, 36 honeybee colonies, 4 apiary site established, supplementary feed for dearth period synchronization

Training and experience sharing

As the technologies are new for the community, the training will be given in two phases. In the first phase, theoretical training was given to the youth and women beekeepers, Development Agents (DAs), and agricultural experts. The training was mainly focused on two phases. In the 1st phase theoretical training on bee forage cultivation, time of honeybee colony supplementary feeding, beekeeping system, seasonal colony management, and site selection, hive product handling, honeybee diseases and enemy control, and bee product marketing. In the 2nd phase, practical training was given on honeybee colony transferring from traditional hives, honeybee colony arrangement and placements, foundation sheet making, crude honey and bees wax processing methods, colony inspection, and feeding methods. FRGs/FREGs members and other follower farmers were encouraged to participate in different extension/promotional events organized at each demonstration site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as training, field visits/tours, experience sharing, and field days. To undertake this activity, 36 traditional bee hives were established and then bee colonies were transferred to the Zander beehives, and the honeybee colonies foraging activities were inspected regularly to follow up on the progress of buckwheat nectar and pollen secretion dynamics.

Farmers' preferences and selection criteria

The two varieties were demonstrated, evaluated at the crop maturity stage, and validated by farmers, agricultural experts, development agents, researchers, and other stakeholders based on the following selection criteria. The criteria were starting blooming, long flowering time, disease tolerance, honeybee visit frequencies, brunch per plant, plant height, seed color and size, early maturing, adaptability to their locality, uniformity, and crop stand, forage by honeybees and overall yield. Each selection and evaluation criteria were rated using the following rating scale; 1= Very poor, 2= Poor, 3= Fair, *4*= Good, and 5= Very Good

Data collected

Both qualitative and quantitative data were collected using appropriate data collection methods such as focused group discussion (FGD), direct field observation, and measurements. Agronomic data and grain yield per plot were recorded and honey yield. The total number of farmers who participated in extension/promotional events such as training, field visits, and mini-field days was recorded by gender composition.

Data analysis

The collected data was analyzed using SPSS and descriptive statistics such as mean, frequency distribution, and percentages. Besides, the pairwise ranking matrix was used to evaluate and select the best-performing varieties and rank the varieties in order of their importance.

Results and Discussion

Training

Participatory training was given by Bako Agricultural Research Centers, researchers (Apiculture Researchers) to a total of 60 participants: - 20 farmers (in to 2 FRGs), 8 DAs and 2 Supervisors, 8 experts and 4 researchers. The theme of the training were included the availability buckwheat technologies for mid altitude areas of East Wollega zone and utilization, buckwheat wheat with beekeeping technologies (both in quantity and quality) production and management packages, participatory agricultural research and promotion on bee forage technologies through FRGs/FREGs, suitable agro-ecologies and weather condition for bee forage, honey production and honeybee colony management, buckwheat agronomic practices, economic and nectar and pollen source of importance of buckwheat, bee product managements and storage of the honey as integration on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures.

Yield performance of Buckwheat varieties

The overall mean yield of black buckwheat and white buckwheat varieties on farmers' field were 18.15 qt/ha and 20.34 qt/ha, respectively. The grain yield of buckwheat with highest grain yield for black buckwheat 20.34qt qt/ha and white buckwheat 18.15 qt/ha.

Training on buckwheat cultivation

Tanning was given for farmers and concerning bodies to improve the productivity of bee forages, time of sowing and seed harvesting time**.**

Training on honeybee colony managements

Tanning was given for farmers and districts DA (development agent) on Bee management, Hive stand construction, and proper placement of honeybee colony, dearth period feeding and colony catching and transferring. Buckwheat flowers are a rich source of nectar and pollen, essential for honey production and colony growth. The abundant resources reduce foraging distances and energy expenditure for bees, leading to improved productivity. Honey yields were higher when buckwheat was grown near the apiary, with a mean yield of 42.29 and Yield range: 38.10 to 46.90kg/year/colonykg/year/colony, compared to without buckwheat nearby apiary sites with average yield: 33.81 kg/year/colony and yield range: 26.40 to 41.50 kg/year/colony (table 2). The data reveals a significant increase in honey yield when apiaries are located near buckwheat fields, with an average yield difference of 8.48 units. This indicates buckwheat serves as an excellent forage source for bees, providing nectar and critical for honey production. The data confirms that its proximity to apiaries. The consistent flowering period of buckwheat ensures a stable and reliable food source for bees, minimizing fluctuations in honey yield that could occur due to environmental or seasonal factors. The data shows less variability in honey yields with buckwheat (standard deviation: 2.38) compared to without buckwheat (standard deviation: 3.62). The higher standard deviation in areas without buckwheat (3.62) compared to areas with buckwheat (2.38) suggests that the absence of buckwheat introduces variability, possibly due to no accessibility of nectar and pollen for honeybees to produce honey. The lower variability in honey yield where buckwheat is present suggests a stabilizing effect on production, likely due to consistent floral resources throughout the growing season. Beekeepers can achieve higher profitability by strategically locating apiaries near buckwheat fields. The observed yield difference translates to potential economic gains, depending on the market price of honey. Integrating buckwheat into agricultural systems can improve pollinator health, support biodiversity, and boost overall ecosystem services.

Table.1 Yield performance of the buck wheat varieties

variety	Mean/qt/ha	min qt/ha	max qt/ha
Black buckwheat	18.15 ± 0.09	18.32	19.63
grey buck wheat	20.34 ± 0.04	20.38	20.74

Table.2 Summery of honey yield

Metric	Honey yield With Buckwheat nearby apiary	Honey yield Without Buckwheat
Mean	42.29	33.81
Median	42.19	33.88
Standard Deviation	2.38	3.62
Min	38.1	26.4
Max	46.9	41.5
t-statistic	20.57	N/A
p-value	3.94×	N/A
Correlation	0.735	N/A

Figure.1

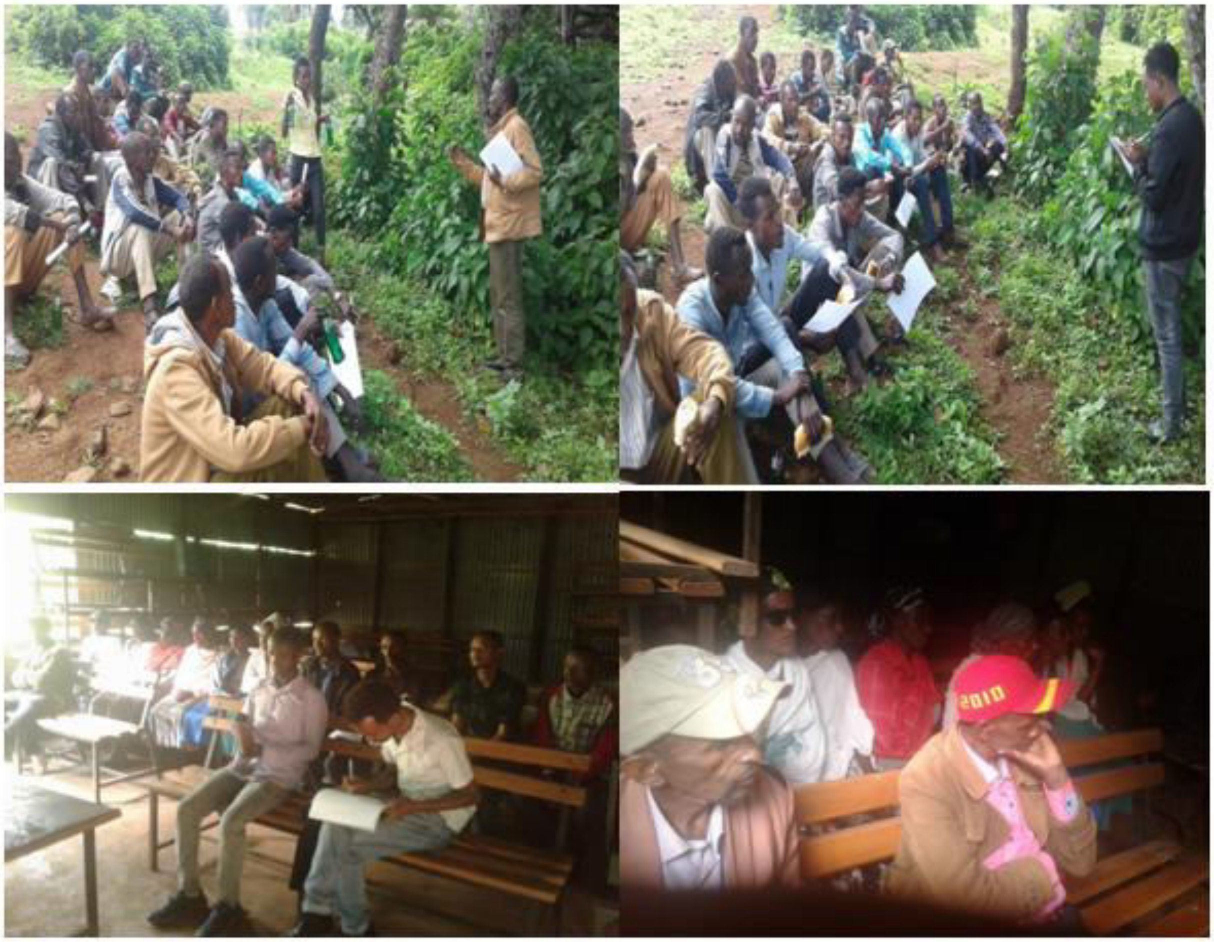


Figure.2

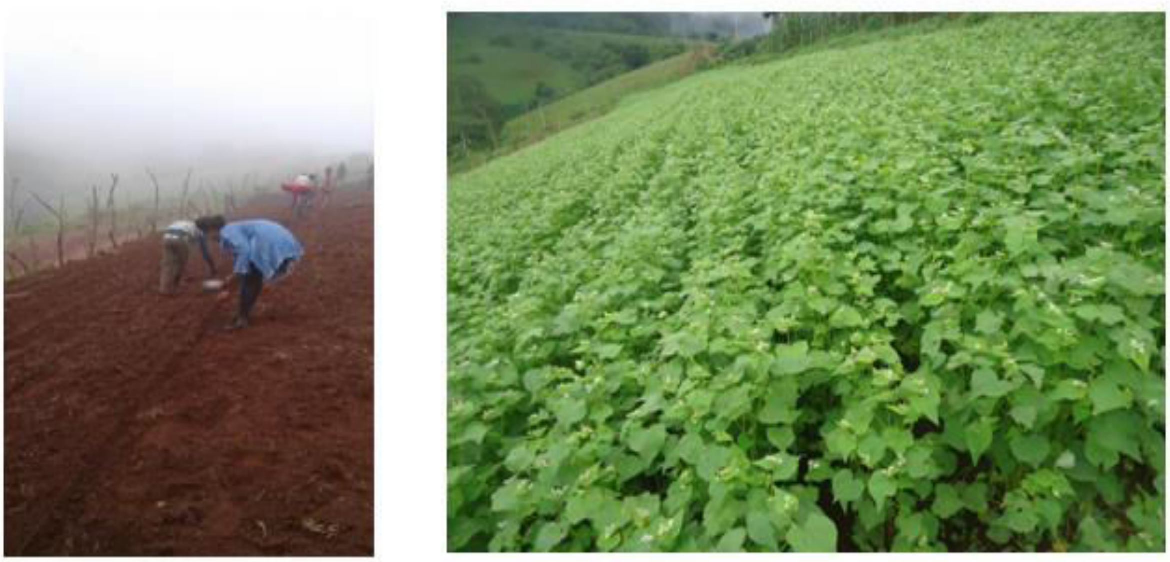


Figure.3

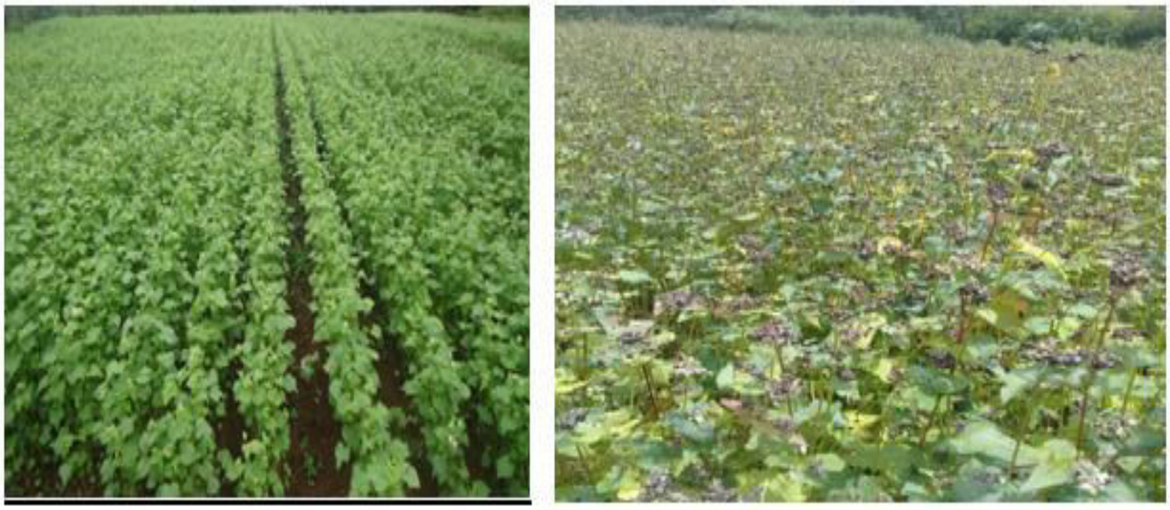
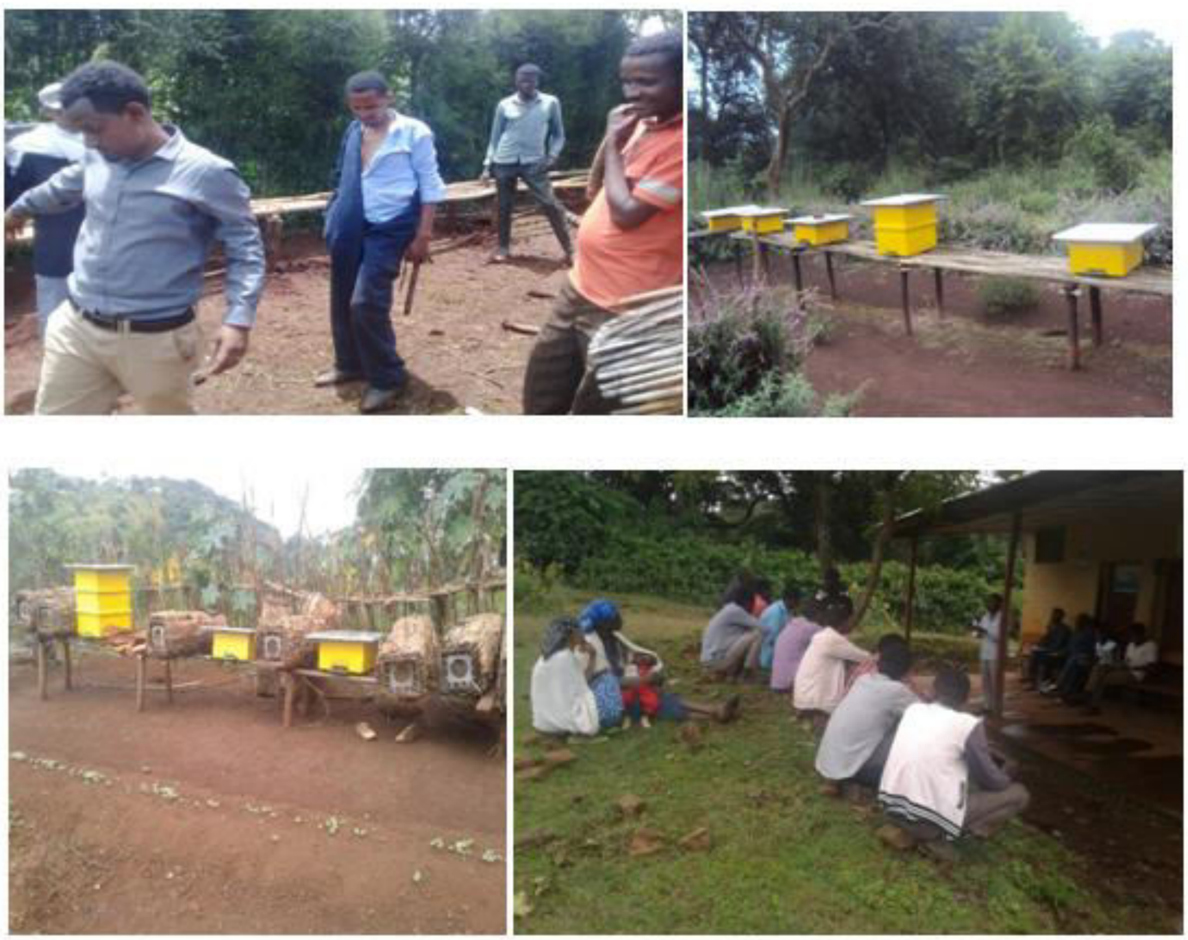


Figure.4



Conclusion and Recommendation

Buckwheat is a crop that produces nectar and pollen for pollinators, such as bees, and can be a significant source of food for them. Buckwheat produces a large amount of nectar that's high in sugar and is attractive to pollinators. The flowers open in the morning and secrete nectar until around noon. Buckwheat's nectar is made up of glucose, fructose, and sucrose.

The analysis demonstrates that honey yields are significantly higher in apiaries located near buckwheat fields compared to those without buckwheat nearby. Specifically, the average Honey yield where buckwheat grown nearby is 42.29 kg/year/colony, while it is only 33.81kg/year/colony where buckwheat is not grown. This represents an average yield increase of approximately 8.48 kg/year/colony, highlighting the positive impact of buckwheat on honey production.

The significant difference in honey yields suggests that buckwheat is an important nectar source for bees. The data and analysis highlight the critical role of buckwheat in improving honey yield, supporting bee health, and fostering sustainable agricultural practices.

The findings justify the promotion of buckwheat cultivation near apiaries as a strategic intervention to boost apiculture productivity, strengthen pollinator populations, and enhance environmental sustainability.

Buckwheat's flowering period and nectar production could align with the needs of bees, leading to higher productivity. Base on significances of buckwheat for honeybees as source of nectar and pollen for honey production it is recommended as;

Integration of Buckwheat in Beekeeping Systems: Encourage the integration of buckwheat farming near apiaries to enhance honey production and support beekeepers' profitability.

Diversification of Nectar Sources: While buckwheat is beneficial, encouraging diverse nectar sources may provide resilience in honey yields, especially during periods when buckwheat is unavailable and during dearth period.

Awareness Programs: Educate farmers and beekeepers about the benefits of cultivating buckwheat near apiaries to improve overall yield.

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