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Rural beekeeping: Eco-friendly complement to traditional agriculture

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Absract

The objective of the work was to characterize rural beekeeping for its promotion as an eco-friendly complement to traditional agriculture, through a situational diagnosis of rural beekeeping and the determination of the feasibility of rural beekeeping activity through 3 financial evaluation methods; developed in 45 apiaries of peasant communities in 8 cantons of Manabí: Portoviejo, Rocafuerte, Bolívar, Santa Ana, Montecristi, Tosagua, Chone and Pichincha, chosen by non-probabilistic convenience sampling; the qualitative-quantitative approach was applied, a descriptive non-experimental design; the beekeeper survey technique to determine the feasibility of rural beekeeping, and the participatory interview to raise the diagnosis of the beekeeping sector. The feasibility of the rural beekeeping activity was obtained as results through the cost-benefit analysis of 1.17. The diagnosis of the current situation of rural beekeeping showed a strength in the endemic biodiversity of the study area and threats such as the few blooms per year, whose external factors evaluation matrix referring to 9 identified opportunities yielded a weighted from 2.82; and in terms of 11 threats identified, a weight of 0.79; the internal factors evaluation matrix inherent to 10 strengths and 10 weaknesses, showed a weighted weight of 3.03 and 0.94, respectively. It was concluded that beekeeping is the ideal complement for traditional agriculture, due, among other reasons, to the ancestral knowledge of the peasants who promote the conservation of ecosystems.

Keywords: Honey bee, Beekeeping activity, Farmer, Flowering, Honey

1. Introduction

Agriculture is as old as humanity, its beginnings date back to the Neolithic era, since it began to sow seeds of herbs that grew in different parts of the world such as China, the Near East and America, dating back to the year 5200 BC. of time it is called traditional agriculture known as "a model of agricultural production and way of life for the social communities that have exercised it" (Sánchez J. , 2021), which is characterized by the scarce technification and application of technologies, the use of manual tools such as the machete, pickaxe, hoe, etc., the application of empirical knowledge and ancestral practices; a combination with livestock activity; very low productivity and yield (Sánchez F., 2020).

They are indigenous agricultural practices, a consequence of the joint evolution of indigenous social and environmental systems and that show a high level of ecological sense expressed through the intensive use of indigenous knowledge and natural resources, which include the management of agrobiodiversity through systems diversified farms. Traditional agriculture is often based on practices handed down from generation to generation for a long time (FAO, 2009).

In Ecuador, according to the study by Loyola (2016), approximately three million people are dedicated to traditional agriculture, there are around 250,000 family farms, of which 33% of the cultivated hectares are destined for this activity, 1.4% is consolidated while 61.6% barely survives and 37% is in transition.

Family farming as an agricultural and social activity considers the cultivation of an area of land for the production of food for internal consumption and the surplus for marketing. Family members participate in work, decision-making in these aspects. Family farming is based on cultural processes at the farm, locality or territory level, preserving traditions and knowledge, not only regarding food production, but also in ecological practices that respect nature. For this reason, the role of traditional peasant agriculture in safeguarding nature is widely recognized.

On the other hand, the first record on beekeeping corresponds to Egypt in the year 2400 BC, in which the use of hives, handling and harvesting of honey from honey bees is detailed (Lino, 2002). Beekeeping is a very broad scientific issue, which has to do with agriculture, nutrition, medicine, industrial products and the environment (Saha, 1999). It is one of the productive activities that has been practiced many centuries ago, in the torrid regions of the planet, and in America especially, countries like Mexico and its Mayan culture, have promoted knowledge from generation to generation, for which it is currently a source of income and employment in rural sectors, acquiring socioeconomic relevance (Magaña et al., (2016).

It is an agricultural activity that contributes to the protection of the environment and agroforestry production through the pollinating action of bees" and as such the beekeeping, as an agricultural activity, and from the point of view of organic, sustainable production

or good practices, this has always meant a challenge, however for beekeeping, these words make sense considering the particular relationship that bees *(Apis mellifera)* maintain with the environment and in particular with plant species (Mancera & y Sánchez, 2019).This ancient activity that dates back to the pre- colombina and promotes the breeding of bees for the production of honey, has been spreading throughout the world (Contreras et al., (2018), as well as in countries like Ecuador, due to its climatic and geographical characteristics, the potential for beekeeping It is obvious; The last beekeeping census carried out by the Ministry of Agriculture and Livestock in 2018, shows figures of 1,760 beekeepers and 19,155 hives (Ministry of Agriculture, 2018), an increase of 6,967 hives in 3 years, estimating an increase of sixteen times the number of hives producing honey, according to the study by (Velásquez & and Goestchel, 2019).

Rural beekeeping is linked to the knowledge of the peasant farmers of a rural territory, who have been practicing empirically, for mere pleasure, for medicinal, cultural and environmental reasons, and which is currently gaining importance, resuming its use and diverse applications, especially to promote traditional agriculture with the pollination of short and long cycle crops (Macías et al., (2020). Some of its characteristics imply its easy integration with a large number of life and development systems, because it uses the same resources , for example: forestry, agriculture and conservation activities; ensuring nature's continuity in time through the pollination of wild and cultivated plants; ensuring an excellent additional advantage to the harvest, since only bees they collect nectar and pollen, without competing with other insects or animals for these resources that, were it not for them, would be unattainable s for man (FAO, nd).

However, beekeeping worldwide is practiced in ecosystems damaged by the hand of man, such as deforestation that causes the loss of the endemic flora of the area, urbanization of agricultural land, felling of timber trees, pruning indiscriminate, the fragmentation of species habitats, the displacement of man towards areas with ecosystem diversity such as native forests, hills and mountains, the introduction of invasive species, among others (Verde, 2014).

According to data from ECLAC (2016), at the level of Latin America and the Caribbean, traditional agriculture is affected by the high costs of agricultural inputs that require more affordable financing for farmers. Therefore, agricultural ecosystems, whose intensive tillage practices have tended to soil degradation, increasingly demand and require beekeeping to boost agricultural production. Thus, in underdeveloped countries such as Ecuador, this same reality is experienced, which has caused an increase in the sale of agricultural land, currently converted into urbanizations (MAG, 2018). Manabí, an eminently agricultural province, rich in biodiversity, is no exception to this problem, however, there are alternatives, little known by the peasant, but that represent the ideal complement for traditional agricultural activity, this is rural beekeeping.

In this context, it is necessary to ask: How to characterize rural beekeeping for its promotion as an eco-friendly complement to traditional agriculture? with the objective of the work, to carry out a diagnosis of beekeeping activity in rural communities to determine the feasibility of producing derivatives. of the hive through cost-benefit analysis.

2. Methodology

Location

This study was carried out in 8 of the twenty-four cantons of the province of Manabí, Ecuador, these are Portoviejo, Rocafuerte, Bolívar, Montecristi, Pichincha, Tosagua, Chone and Santa Ana. Strategically chosen due to their geographical location in the central zone ( ) and northeastern (Chone) and south central (Santa Ana) microregions of the province, due to the predominance of climates of tropical, mountainous and oceanic origin, whose predominant seasons are rainy (winter) and dry (summer) in addition to 7 specific microclimates distributed throughout the Manabi surface; and as well as by semi-dry and semi-humid tropical climates influenced by the cold and warm marine currents of the eastern Pacific Ocean, the cold Humboldt current (which runs from June to December) that causes a summer of cold nights and the warm El Niño (January- May) that brings with it abundant rains and heat, which make it a sustainable productive territory with great potential. Manabí is geographically located at coordinates 1º 03'08" south latitude and 80º 27'02" west latitude, at 350 meters above sea level (GAD Manabí, 2021). Figure (1) shows the map.

Figure 1. Apiaries studied

Source: GPM (2014)

Approach and type of research

The qualitative-quantitative approach of the research was applied, a non-experimental descriptive and field design, through the application of a survey to the beekeeping sector to determine the feasibility of rural beekeeping, and to raise the diagnosis of the current situation of rural apiaries, the participatory interview technique was used with beekeepers from ASOFAPIMONTUV to produce an open discussion (Cabiria, 2012) about the strengths, opportunities, weaknesses and threats of the Manabi beekeeping sector and be able to capture them in the SWOT / SWOT matrix.

Method

Likewise, to determine the feasibility of beekeeping production, several financial evaluation methods were applied, such as the benefit-cost ratio (B/C), the net present value (VAN) and the internal rate of return (IRR), whose the formulas are expressed below:

$$BC = \frac{\sum B}{\sum C} \quad (1)$$

$$VAN = \sum B - \sum C \quad (2)$$

$$TIR = Tm + \frac{(TM-TM)*VANTm}{(VANM-VANm)} \quad (3)$$

Type of sampling

We worked with a non-probabilistic sampling, of the type for convenience, at the discretion of the authors (Otzen & and Manterola, 2017) to be able to collect reliable field information directly from beekeepers who develop rural beekeeping members of the ASOFAPIMONTUV and who agreed to be included in the research.

Sample size

A representative sample of the population of rural apiaries of the Portoviejo canton was taken, based on convenience sampling, which corresponds to 45 apiaries belonging to beekeepers of the Asociación Fuerza Apícola montuvia, which is shown in the table (1) next.

Table 1. Sample of rural apiaries

Cantons	# Apiaries
Portoviejo	10
Rocafuerte	10
Montecristi	2
Tosagua	8
Chone	5
Bolívar	5
Pichincha	2
Santa Ana	3

For the evaluation matrix of external (MEFE) and internal (MEFI) factors, the equivalence of the qualification indicators to be considered are:

1= low

2= medium low

3= high

4= very high

3. Results and discussion

Diagnosis of the situation of rural apiaries

For the survey of the current situation of the apiaries located in rural communities of Manabí, a SWOT/SWOT matrix was made to be able to evaluate the external (opportunities and threats) and internal (strengths and weaknesses) aspects that affect their beekeeping activities, product of which two matrices were obtained, the evaluation of external factors (MEFE) and the evaluation of internal factors (MEFI). Table (2) shows the MEFE matrix.

Table 2. External factors evaluation matrix (MEFE)

Factor analyzed: Opportunities	Weight	Qualification	Weighted weight
1. Increase in the demand for honey	0.10	4	0.40
2. High demand for products from the hive	0.08	4	0.32
3. Good prices for the sale of honey	0.10	4	0.40
4. Location of apiaries in natural ecosystems	0.10	4	0.40
5. Accessibility to apiaries	0.08	4	0.32
6. Government promotion of the beekeeping sector	0.07	4	0.28
7. Access to the credit system in public and private banking	0.04	2	0.08
8. Accessibility to beekeeping materials and supplies	0.10	3	0.30
9. Accessibility to technical assistance	0.08	4	0.32
Total			2.82
Factor analyzed: Threats	Weight	Qualification	Weighted weight
1. Natural phenomena (floods, droughts, etc.)	0.02	1	0.02
2. Outbreak of pests and diseases	0.07	2	0.14
3. Use of agrochemicals on the farm	0.04	1	0.04
4. Use of chemicals to treat diseases	0.08	1	0.08
5. Few blooms per year	0.04	4	0.16
6. Fall in the sale price of honey	0.02	2	0.04
7. Appearance of diseases due to genetic crossing	0.04	1	0.04
8. Null genetic improvement	0.05	1	0.05
9. Production of non-certified queens	0.01	2	0.02
10. Increase in the price of beekeeping materials and supplies	0.08	2	0.16
11. Increase in the active rate in credits	0.04	1	0.04
Total	1.00		0.79

Source. Taken from Contreras and Magaña (2020)

When analyzing the external factors of the beekeeping sector, because of the 9 opportunities identified, a weighted average weight of 2.82 and 0.79 was obtained for the 11 threats detected. This means that on the rating scale (1-4) the indicator obtained for opportunities is close to 3, indicating that it is medium high, compared to an indicator of 0.79 that is below unity, meaning that it is very low. Contrasting both values, the difference between the two is 2.03, a considerable aspect, which translates into a greater number of opportunities given the weaknesses of the rural apiaries of Manabí.

As a result of the evaluation of the internal factors, the MEFE matrix was obtained, which can be seen in the following table (3).

Table 3. Internal factors evaluation matrix (MEFI)

Factor analyzed: Strengths	Weight	Qualification	Weighted weight
1. Organized beekeeping sector	0.10	4	0.40
2. Honey quality	0.10	4	0.40
3. Accessibility to swarm capture in natural ecosystems	0.10	4	0.40
4. Constant training of beekeepers	0.10	4	0.40
5. Alternability in the treatment of hive pests and diseases	0.08	3	0.24
6. Good beekeeping practices in the sector	0.07	3	0.21
7. Trend towards modernization	0.05	2	0.10
8. High environmental awareness of beekeepers	0.08	4	0.32
9. Considerable distance between apiaries by area	0.06	4	0.24
10. Production of other hive products	0.08	4	0.32
Total			3.03
Factor analyzed: Weaknesses	Weight	Qualification	Weighted weight
1. Empirical practices	0.06	2	0.12
2. Low culture of business of the beekeeper	0.06	2	0.12
3. Low attendance at meetings of beekeeping organizations	0.04	1	0.04
4. Low maintenance of hives	0.08	2	0.16
5. Low incorporation of beekeeping technology	0.03	1	0.03
6. Lack of management of operating capital	0.05	2	0.10
7. Scarce feeding to the hives in times of low flowering	0.05	2	0.10
8. Manual extraction of honey	0.07	2	0.14
9. Low productivity of the apiary	0.05	2	0.10
10. Use of rudimentary beekeeping equipment	0.03	1	0.03
Total			0.94

Source. Taken from Contreras and Magaña (2020)

The MEFI matrix in table (2) shows a weighted average weight of 3.03 for the 10 strengths identified and 0.94 for the 10 weaknesses found in the rural apiaries, whose meaning on the rating scale (1-4) denotes that the indicator obtained for opportunities exceeds 3 points, which corresponds to a medium-high weight, while 0.79 of the weaknesses correspond to a very low weight. The difference is 2.09 between both indicators, whose meaning is that the strengths exceed the weaknesses by more than two points, which involves more advantages for the beekeeping sector, some of them rooted in the endemic biodiversity of the study area.

Similar studies carried out in Spain by (Ruiz, Díaz, Rodríguez, & Sánchez, 2016) have found weaknesses in the practice of eco-friendly beekeeping in terms of sanitary control specifically of varroa, by the responsible state entity due to the lack of personnel. trained, having the beekeepers to face the lack of advice to carry out the activity.

For its part, (Contreras, Magana, & Sanginés, Technical and socioeconomic characteristics of beekeeping in Mayan communities of the Central Coast of Yucatán, 2018) in their situational diagnosis of the Mayan beekeepers of the coast, found weaknesses such as low income generation by sales due to the scarce administrative knowledge of the beekeepers given their age and schooling, the deficient management practices of the hive, especially in feeding, having as opportunities the organization of the sector towards an institutional strengthening that involves training systems tending to train them more productive and competitive in an innovative market.

(Contreras & y Magana, 2020), reveal positive internal and external aspects in their study carried out in the center of Yucatan, in which the strengths have more weight than the weaknesses, and the opportunities are greater than the threats, thus the weighted weight of the matrix of external factors exceeds that of internal factors, evidencing a good performance of the beekeeping activity, however one of the strategies to strengthen the sector is to organize it legally in order to be more competitive.

However, the present study carried out in Manabí, given its edaphoclimatic and geographical conditions, has two defined seasons, winter, and summer, which represent an advantageous condition and marked strengths for the development of beekeeping activity, which differ from the cited investigations. Likewise, it is also important to consider that the apiaries identified in this research are located within the productive estates or agricultural farms, whose production corresponds to both short-cycle and long-cycle crops, and in which flowering is evident, either for any of the types of crops, except for the winter season when the rains turn the fields green and it is, once the season has passed, when summer arrives and the crops begin to bloom.

That said, the bee production season is approximately 6 months; Given the effects of planetary climate change, and according to the experience of the qualified beekeepers of the ASOFAPIMONTUV, the continuous rainy seasons range from 2 to 3 months in the central area of the province of Manabí (Portoviejo, Rocafuerte, Montecristi, Bolívar, Santa Ana, Tosagua, Chone, Pichincha), consequently a pre-flowering is generated with the endemic timber species of the carob tree *(Prosopis juliflora)* and ceibo *(Ceiba trichistandra)*, two months after the last rains, which is an ancestral sign for be certain that summer begins and with it the flowering too, in such a way that beekeepers can start preparing the apiary's hives to facilitate the work of the worker bees; but also, these trees are documented by the FAO in the guide (Aguirre, 2012) as honey species responsible for reforestation and consequently for maintaining the balance of the natural ecosystems of the Ecuadorian coast, of which the province of Manabi.

Another advantage of the rural apiaries studied and settled on farms is the production of coconut *(Cocos nucifera L.)* whose flowering is permanent (winter and summer), due to cross-pollination and self-fertilization, depending on the variability between their types (Granados & y Ríos, 2012), which guarantees the food safety of the hives, making the complementary feeding administered by the beekeeper minimal and carried out occasionally and in strictly necessary situations such as the presence of some disease that afflicts the bee population during the winter season.

Feasibility of rural beekeeping production

To determine the feasibility of rural beekeeping production, a survey was carried out on the sample of beekeepers from ASOFAPIMONTUV, with which it was possible to identify the costs inherent to fixed investment and operating capital, detailed in the following table (4).

Table 4. Fixed investment and operating capital

Fixed investment	*Capital*
Machinery and Equipment:	Production costs:
Beehive with 1 increase	Manufacturing load or general manufacturing costs:
Land:	Glass containers
Agricultural-agricultural farm	Screening and various
Other assets:	Lever
Existing on the farm	Smoker
	Beekeeper equipment

From this identification, it was possible to calculate the total of the investments to implement an apiary with the minimum of 1 hive with rise, in addition with 2 and 5 hives to visualize the increase of the investment, shown in the figure (2).

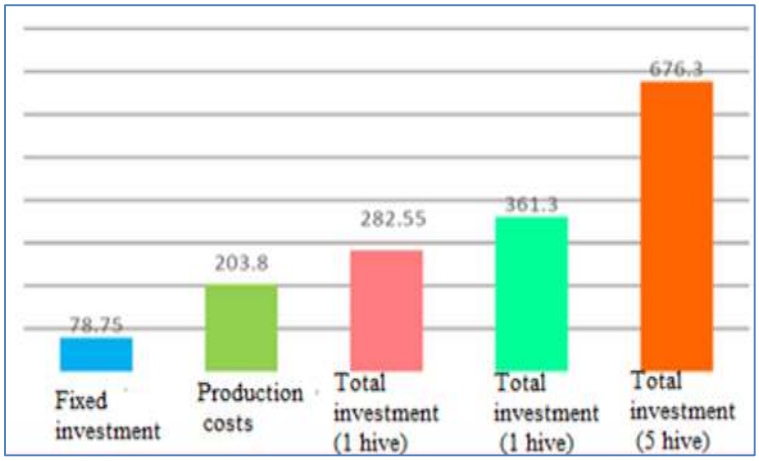

Figure 2. *Investments totals by # of hives*

Source: Elaborated by authors

According to what is represented in figure (2), the total investments to implement an apiary with 1 hive with riser is $282.55, which includes the cost of the hive corresponding to the fixed investment and the minimum production costs to start with the beekeeping activity, however, to start with 2 hives, only the amount of the fixed investment that corresponds to the value of a hive is added, having an investment amount of $361.30, and thus the value of the fixed investment (1 hive) must be added to establish the number of hives required to set up the rural apiary. The value of the land of the farm or the other assets that are part of the agricultural-agricultural activity is not quantified, because they already have them, therefore there is no need to invest in them.

In this way, it is invested, and profits are generated from sales, according to the number of hives, taking into account that a hive can be harvested 2 times in the year, throwing an average of 10 - 12 L of honey in its first production, and an approximate of 700 gr of pollen, without considering the production of propolis, which are complementary products of the hive. Figure (3) shows the estimated sales in the 2 harvests that occur in a year.

Figure 3. *Sales estimated annual*

Source: Prepared by authors

As can be seen in figure (3), sales double as 1 productive hive is incorporated. In this part it is important to keep in mind that not all hives can be harvested at the same time, this will depend on the time when the last hive was incorporated into the apiary, in addition to other factors such as flowering, whether it is winter or summer season. , are conditions that influence the productivity of the apiary.

Consequently, by investing $282.55, the recovery of the capital is rapid, in the first harvest it is possible to recover 97.3% of the total investments in an apiary with 1 hive with a rise, and the recovery being total when the apiary It has 2 productive hives. Figure (4) shows the evaluation methods that determine the feasibility of rural beekeeping, considering the total investments for the minimum of 1 hive with rise.

Figure 4. *Feasibility of rural beekeeping*

According to figure (4), rural beekeeping activity is profitable and feasible to be implemented in peasant farms, demonstrating that both ancestral activities complement each other amicably, thus, the indicator of 1 .17 of the benefit-cost ratio means that by exceeding the unit, beekeeping generates economic benefits for farmers, therefore it can be implemented (Macías, Pin, & Sancán, 2021); For its part, the net present value method expresses an amount of $123.59, which is what would remain in the hands of the beekeeper, when he decided to end the beekeeping activity (Macías, Rodríguez, Mera, Moreira, & Bravo, 2020); and the internal rate of return (IRR) denotes 55.72%, which means that this rate compared to the current opportunity or discount rate in the market (approximately 6%) is higher (Macías, 2021), therefore the farmer can undertake in beekeeping to obtain profitability, at this rate the farmer's investment would return when exercising rural beekeeping.

The study by Corredor and Londoño (2020) concludes the viability of honey production for farmers, which also contributes to the environmental component, due to pollination that in turn promotes horticultural and forage production in the study area, contributing profits to small peasant producers, since honey has a natural demand. Magaña et al., (2016) also determines that beekeeping is profitable and can be carried out by peasant farmers, a reason why rural beekeeping is in a process of revaluation and strengthening for these sectors in Mexico.

Perdomo and Posso (2016) in their research qualify beekeeping as a feasible agricultural and productive activity, which can improve the quality of family life, since it does not require many resources to start it, for which the desirable financial purposes can be achieved for those who undertake, responsibly as well.

Barragán (2014), for his part, establishes that beekeeping production systems bring some benefits to farmers, especially in environmental and economic aspects, but that they also provide productive support to beekeeping, agriculture, activity agriculture as a whole, in which the peasantry remains, and which persists over time, contributing to the improvement of their family economies.

So too, Falquez (2014) concludes that beekeeping as a productive and commercial activity is feasible to be developed by peasant farmers from rural and marginal urban communities, for many reasons such as the minimum resources required to start it, this small investment that could be representative for the farmer is the right one to achieve the goals regarding the production and sales of the products of the hive, to generate economic profits.

Contreras et al. (2016) in their study deduces the price of honey produced in rural apiaries in Peru, which ranges between 30 and 40 soles, which would be equivalent to an average of 9.10 dollars, which corresponds to less than half the price of 1 L of honey in Manabi peasant communities.

Likewise, Contreras et al. (2018) determines that "the profitability of the beekeeping activity is determined by the production costs and the income received from the sale of honey. The income depends on the amount produced and the sale price of the honey", which corresponds to the present findings, in which it can be evidenced that the production of a single hive generates economic income and profit for the producers, taking into account a sale price of a liter of honey at $20, which has not changed for a decade ago, according to the survey of Manabi beekeepers, a price established by the newly organized beekeeping community, in which the nascent beekeepers can support of the rural communities of the province of Manabí.

Conclusions

Rural beekeeping constitutes a complement to traditional agriculture, it is an activity that, in addition to being friendly with endemic and native ecosystems, is also profitable, has low investment, and in the first harvest of honey the initial capital invested is recovered for hive operation, demonstrating the feasibility of honey production. Beekeeping not only represents an alternative to improve rural family economies, but it is also an ideal mechanism to strengthen agricultural ecosystems, endemic flora, surrounding vegetation, harmony between man and nature, since its practice gives back to the beekeeper, understanding and value for their natural environment.

Looking back at agricultural fields, agroforestry systems, the natural environment of hills and valleys, rivers and streams; put a little love to recover them, it is part of what mother earth demands from the human being that she shelters; the combination of sowing and harvesting the land with bee breeding is one of the ideal alternatives to start the rescue tasks, through the work of such noble insects, of the winged pharmacists, of the servile workers, beginning to value the effort, the time and work that requires them to travel kilometers to pollinate so many types of crops and thus extract what will be their food, to reward us even more, through the wonderful and therapeutic products of the hive.

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Our sincere thanks to the peasant communities of the Manabi countryside, for inspiring us to continue this noble task of rural beekeeping, bringing the nectar that revitalizes our lives, our work and our faith in the Divinity that has entrusted us with the noble mission of working together to our winged pharmacists.

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