Apiculture and food safety

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Considering that the beekeeping sector faces important productive challenges, caused by the anthropic effect on the ecosystem and the climate change, there is a need of policies that visualize this sector as an important branch to be taken into account when designing the environmental, commercial, educative and social strategies and the ones for productive development. It is stated the bond between apiculture and the objectives of the feed production according to quantity, quality, innocuity, traceability, and sustainability, necessary for reaching the food safety and sovereignty aspired by the peoples. Subjects related to the development of the ecosystems, the bees, the apiculture within the agricultural and livestock context, the food safety and the apiculture in general are analyzed. The strengths of the Cuban beekeeping sector are stated, connected to the national food safety and sovereignty. It can be concluded that apiculture takes a part in food safety due to the important role of bees in pollination and the nutritional value of their productions. Cuba has strengths that assure this condition on the commercialized productions.

Introduction

The world demographic growth needs the optimization of the food production for fulfilling the increasing requirements of the countries. It is estimated that in 2030 the food demand would have increased 50% at global scale. A similar situation is estimated for the water and energy requirements, which will increase in 45 % and 30 %, respectively (Figure 1). Due to this, agricultural policies are needed, which will be capable of assuring the conservation, use and multiplication of the plant and animal resources balanced with the ecosystems and the sociocultural characteristics of the countries (Porto 2011).

Around 7 billion of people coexist in the planet. From them, 18 % suffer from hunger and the 50 % are gathered in cities. An increase in the global population up to 9,700 million is expected for 2050 (Porto 2011).

This anthropization makes humans more vulnerable to diseases, provokes the acceleration of the environmental pollution with green house effect gases, increases the urbanization, threatens the biodiversity and reduces or fragments the fertile lands for cultivation. Latin America is the most urbanized developing region of the world, with almost 80 % of its population located in cities. This figure fits, statistically, to the Cuban situation of (Lazo 2008 and Martín and AA.VV. 2009). The coastal areas of the planet support 60 % of the global population, two thirds of the big cities, as well as the greatest urban centers of 130 countries with coasts (70 %) and most of the international tourism (Fonticiella 2010).

Due to the urbanization and the new life styles, great extensions of mangrove swamps are lost. These lands are used to settle substructures for tourism hotels, factories, houses and other social objects, which puts in danger the coastal ecosystems that are important providers of carbon dioxide (CO_2), regulators of the global warming and natural barriers against the entrance of salty water to the land. These ecosystems are also reserves of biodiversity, habitat of different species that are part of the human food chain and providers of profitable resources. In Cuba, they cover -according to calculations- almost 5% of the whole territory (De

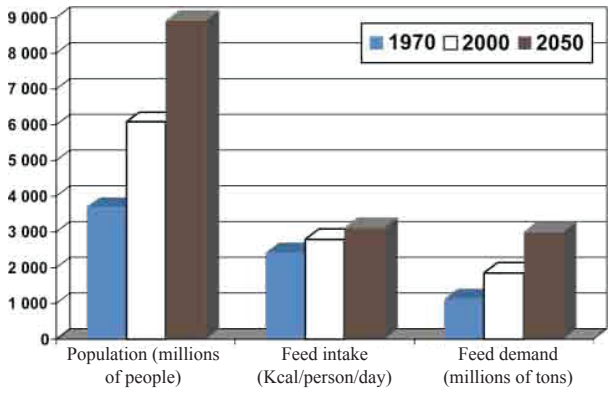

Figure 1. Population growth, consumption and demand of feed (Porto 2010)

Armas 2006).

Gurría and da Silva (2012) indicated, in a report of the OECD-FAO about the agricultural perspectives, that 25% of all the agricultural lands are highly degraded. In this context, the extreme meteorological phenomena are becoming more frequent, with important changes of the climatic patterns in many areas of the world. These events bring awkward consequences (figure 2) for the life quality of humans, biodiversity and the possibilities

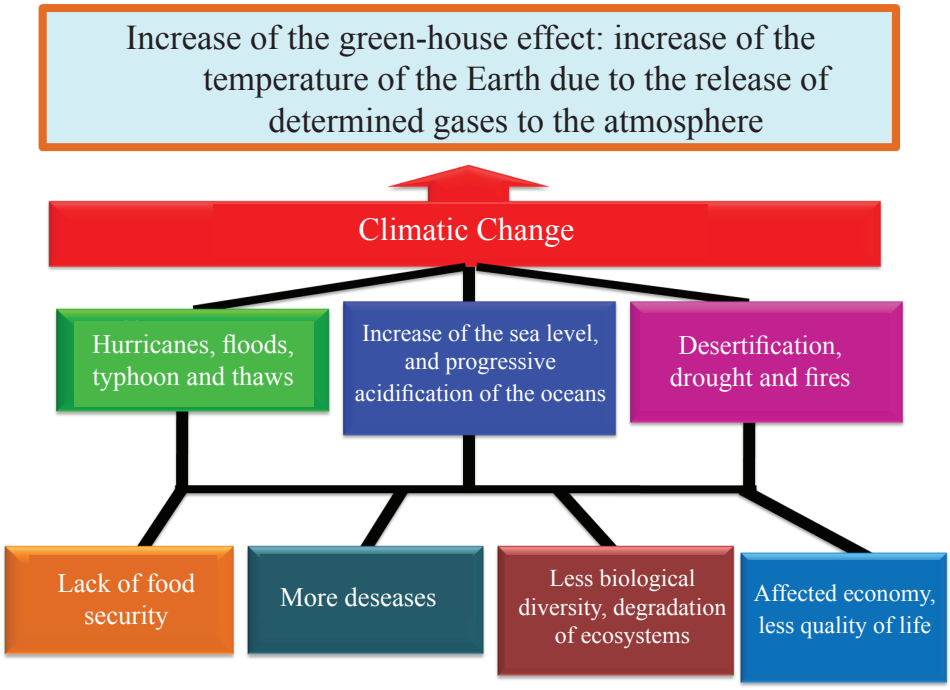

Figure 2. Consequences of climate change

for obtaining food in a sustainable way (Labatut 2013).

Taking these conditions into account, the specialists expect a decrease of 1.7 % in the agricultural production, as annual average for the next ten years. That is why the governments should quit the practices that distort commerce and create a favorable environment for achieving a sustainable and favorable agriculture, supported by the raise of productivity (Gurria and da Silva 2012). In this context, honeybees (*Apis mellifica* L.) play a leading role due to their irreplaceable pollinating activity in an increasingly modern and intensive agriculture. The humans cannot handle butterflies, beetles, bats or birds for these purposes. Bees, plant dependant and a dense population, pollinate many crops that are part of the human trophic chain (Verde *et al*. 2013).

The objective of this study is to explain the connection between apiculture, safety and sovereignty of food in the countries before the new production systems and anthrophized ecosystems affected by the climate change. The beekeeping sector has to confront the current circumstances with the support of policies that consider this sector as an important line to be included in the agricultural, livestock, environmental, commercial and educative strategies, established by the governments in order to achieve optimal results in the food production, and, at the same time, to assure that it would be innocuous, profitable, sustainable and with great quality.

Ecosystems and bees. The Law 165 for the Agreement of United Nations about the Biological Biodiversity (ONU 1994), in the article 2, defines the word ecosystem as a dynamic complex of communities of plants, animals, microorganisms and their non-living environment, that interacts as a functional unit. In fact, the functional unit in apiculture is the hive. The hive is formed by a group of individuals (the bees) and the organic and inorganic elements that interacts, as a dynamic complex, with the communities of plant and animal elements, and their non living environment (Verde 2010).

An ecosystem is a group of mutually connected living organisms, occupying an area and forming a recognized unit that has a biological correspondence with the physical and chemical environment in which they develop (biotope). They are included into a functionally defined structural unit whose components keep a tight independence (Ávila *et al*. 2011).

These definitions allow to understand that a lone honeybee, from the productive point of view, represents nothing, it is short-lived and futureless. On the other hand, the colony, working as a whole, is the functional biological unit that relates and takes important part of the ecosystem it lives in. It is marked by the gregarious conduct of this species.

The evolution of Insecta class from the Hymenoptera order, where the bees that live in crops, woods and gardens are included, occurred during the Jurassic period

around 180 millions of years ago. This evolution resulted from the coevolution of plants with flowers which, due to having ovaries and stigmas (phanerogams and angiosperms), depended on insects for carrying out their reproduction (entomophilous pollination). This fact also determined the evolution of the Apidae family and the Apis genre during the Eocene period from the Cenozoic or Tertiary era. These reasons have been documented from the fossil findings (Carpana 2004).

From the three subfamilies that constitute the Apidae family (Meliponinae, Bombinae and Apinae), the Apinae achieved the best adaptations which allowed it to be more cosmopolitan. The Apis genre achieved the greatest distribution all over the world, with ecotypes of temperate and tropical climates, and a wide diversity of subspecies. This fact led to the constitution of different bee breeds, like *Apis mellifera* mellifera or German black bee and *Apis mellifera* ligústica or Italian bee, making part of the genetic background of the Cuban bee (ACPA 2010).

The African bees, grown in regions of Africa, were considered of economical and social interest only when they were introduced in America by men, and were crossed with local breeds, originating a hybrid that spread all over the continent.

Each of them has anatomical, physiological and behavioral characteristics that make them plant dependant because they need pollen and nectar for feeding, reproducing and maintaining their larvae. They also need resins (propolis) to seal and healthily protect the colony. They are "perfect mechanisms", designed by nature for pollinating it (ACPA 2010).

Humans appeared after bees. The bee did not change, but adapted to different habitats and modified their behavioral answers, like an adaptational option before different changes that humans imposed to this insect (figure 3) in order to cover their productive needs or due to the transformation they made and do to the ecosystems and productive scenarios.

The evolution of insects, entomophilous plants and bees dates approximately from 50 millions of years. The hominids, family that human species belong to (*Homos sapiens*), have left fossil evidences only from 600,000 years ago. Humans recognized bees, and with them, the honey as a sweet food, until a long after they had assumed the important function of pollination, main contribution of this insect to the dynamics of the biological diversity and the balance of ecosystems (Carpana 2004).

Bees assure 65 % of the plant reproduction, and represent the 20 % of the 100,000 insect species included in the Insecta class and the Hymenoptera order. They depend on the flowers to live, and many of the plant species that are included in the human food chain depend on the Apis genre to survive and reproduce (Carpana 2004)

Out of the 100 plant species that provide 90 % of the food supplies in 146 countries, 71 are pollinated by bees, while the 80 % of the wild plant species are fertilized by insects. Without bees, there is no pollination. Without pollination, there are no seeds. Without seeds, there are no fruit, nor yields of the entomophilous crops or enough food for animals and humans. Without all these, the trophic chain would break, the animal and plant species would disappear, the water cycle would be affected, and hunger and desertification would take our fields (Yangari 2008).

Bee pollination represents between 73 and 88 % of the entomogamous pollination (entomophilous), while the pollination of other hymenoptera (bumblebee, lonely bees, among others) represent between 6 and 21 %. The rest of the insects only represent between 6 and 14 %. The survival and evolution of more than 80 % of the plant species of the planet depend on bees. Every year, honeybees pollinate plant and plantations of an estimated value of 40 trillions of dollars, which represents more than a third of the food production of many countries. In Europe, 84 % of the production of grown species depends directly on the entomophilous pollination (APITRACK 2008 and Noticias ApiNews 2013).

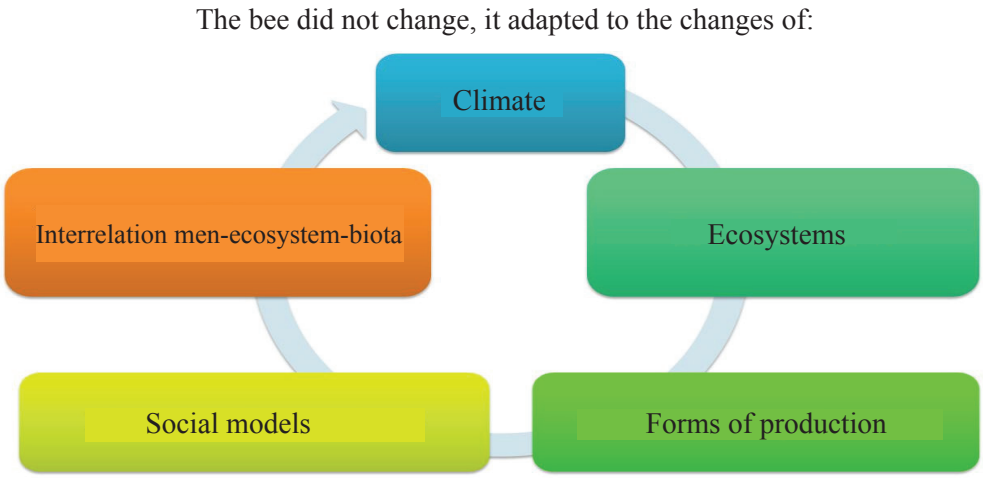

Figure 3. Elements outside the colonies of honeybees that change and induced the adaptation of this insect.

In agriculture, bees practically assure the production of all the species of fruits and citric (avocado, mango, orange, lemon and tangerine) and of cucurbitaceous (pumpkin, melon from Castilla, watermelon, cucumber, and some others). They also take part in the productions of strawberry, apple, peach, cherry, onion, tomato, pepper, okra, eggplant, green beans, beans, pear, kiwifruit, alfalfa, clover, sunflower, cotton, carthamus, soy, species of palm trees, white mulberry, plum trees, and cherry trees, among others (Demedio *et al*. 2011).

Apiculture in agricultural and livestock context. Until the middle of the 18th century, most of the countries practiced a survival agriculture, which changed in the last century because of the pressure of the demographic development and the increase of the food demand. Therefore, the agricultural productive systems had to be redesigned (mainly in developed countries) into modern and intensive systems and add new agricultural areas, many of them with crops- even transgenic or non melliferous single crops in fields of great extensions- for producing bio-combustibles or food. All of them depend on fertilizers that, like in the case of entomophilous crops, depended also on bees as pollinating agents (Yangari 2008 and Ribeiro 2008).

These productive or agricultural ecosystems have marked differences (figures 4 and 5) that have an impact on food availability for bee families and on the way of practicing the apiculture. Likewise, the changes in the food demand transform the beekeeping productive systems into other modern and intensive systems for fulfilling the needs of new contexts, as part of the relations established between agricultural and livestock systems. This turns the men into the main mediators between animals and ecosystems where they are inserted and produce.

The global apiculture is managed nowadays in ecosystems that, mostly, are damaged due to anthropic causes. This includes the drastic impact of wars, loss of the melliferous flora due to the indiscriminated cutting of trees, urbanization, displacement of human settlements towards areas populated before by entomophilous wild flora, the plentiful crops of melliferous flora, the native woods full of arboreous vegetation and melliferous underbrushes, as well as the introduction of invading species, environmental pollution or the fragmentation of natural habitats.

In the agricultural ecosystems, the intense working of the land tends to reduce and even destroys the natural niche of pollinating insects. This way, the intensive agriculture is developed according to models each day more dependent on the modern and intensive apiculture (almost always transhumant) with honey bees, subjected to pressures and complex anthropic changes or at the limit of their existence, which leads to a precarious balance. However, the human intervention is rational and effective as mediator between bee colonies and productive ecosystems, where these insects continue to be the protagonists as pollinators (Natalichio 2008).

The effect of the intensive agriculture on biodiversity should be recognized, where the nutrient conservation is low due to the leaching of the field and the exporting of harvests which carries the contribution of these components and water. There are few studies about the effect of this type of agriculture on nutrition and the balance of bees within these agroecosystems.

Food safety and apiculture. The physical, social and economic access of the people, at any moment, to enough innocuous and nutritive food for fulfilling their food needs and preferences, in order to have an active and healthy life, are the features that characterizes food

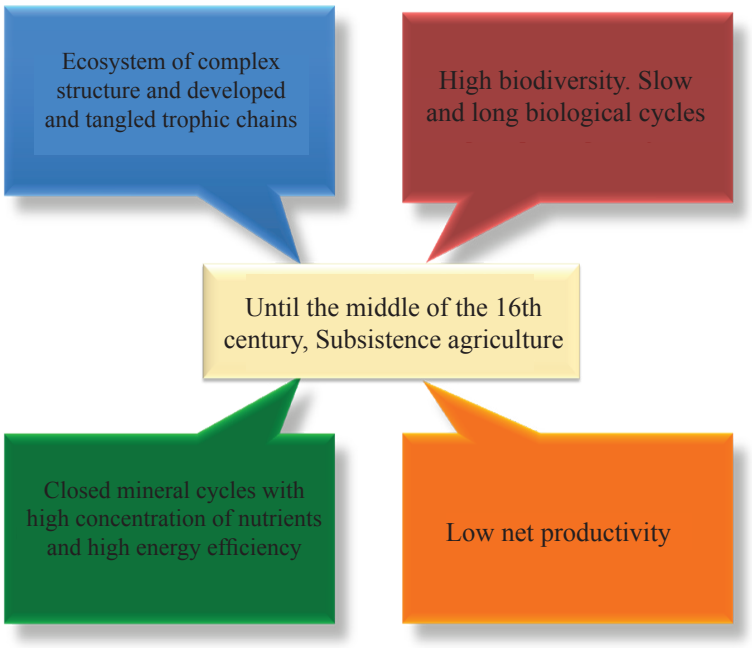

Figure 4. Characteristics of the agricultural ecosystems of survival

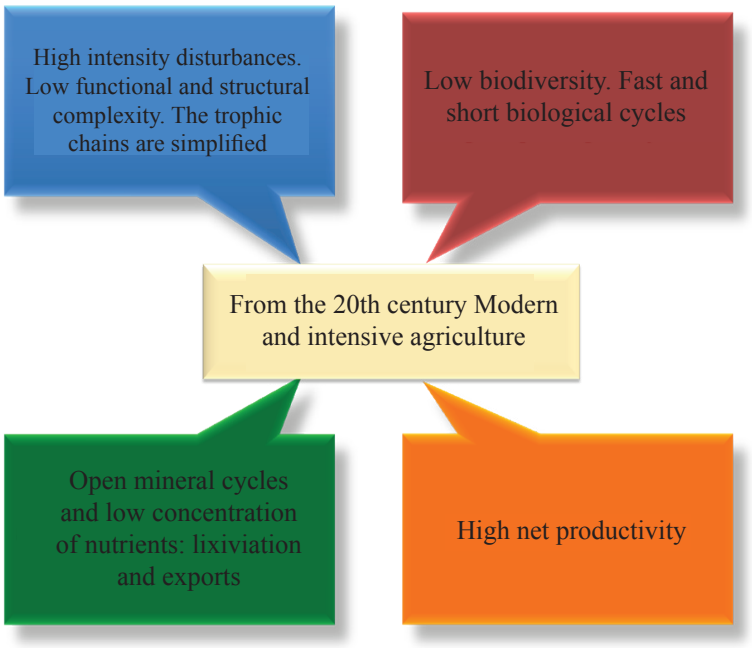

Figure 5. Characteristics of modern and intensive agricultural ecosystems

safety. It is also talked about this concept when healthy food is assured for every person (Martín and AA.VV. 2009).

The animal production is an important component of food safety. The products of animal origin, like milk, eggs, and meat are an essential part of any policy of food safety. The world demand of these products is high and tends to grow even more. Humans see tangible feed in these products and not in bees. That is why they can disregard a spoon of honey, but not these essentially energetic and protein feed, in which bees intervened, in a way or another, for their production.

In the case of apiculture, its bonds with food safety should be seen from different perspectives. First, it is an essential biological element for assuring pollination, quality and yield of entomophilous crops. Second, because of its impact on the biodiversity and water balance that guarantees and favors the planting of feed, which are part of the trophic chain of humans. Finally, due to the feed productions with the proper innocuity, needed for the direct intake of humans

Regarding the food shortage and the unequal way of distribution of the available ones, Castro Ruz (1996) stated that the bells that toll today for those who die of hunger every day, will toll tomorrow for the entire humanity if it did not want, did not know or could not be wise enough for saving itself. Jacques Diouf (2008) described the current food crisis as the chronicle of an announced catastrophe. However, the Summit of Copenhague, carried out on December, 2009, where important agreements for stopping the environmental deterioration of the world were expected, sadly turned out to be a failure and there has been few advances on the matter until this moment.

Most of the hunger victims, 870 millions of people, live in developing countries -around 15 % of the population-. However, 16 millions of people are malnourished in developed countries. Around the world, only 38 countries have fulfilled the internationally established objectives of fighting hunger before the deadline set in 2015. This results proof that it is possible to achieve fast and lasting reductions of hunger in the world with a strong political will, as well as cooperation and coordination.

In this respect, Graziano da Silva (2013) states that hunger, at a global level, has decreased in the last decade, but there are still millions of malnourished people, and other millions of human beings experience the consequences of vitamin and mineral deficiencies, including child growth.

Only 20 countries have fulfilled the Millennium Development Goal number one (MDG-1), since they reduced the amount of starving people between 1990-92 and 2010-2012. Out of these nations, 18 also reached the most demanding goal of the Global Summit on Food (GSF) which is to reduce the total number of malnourished people to the half between 1990-92 and 2010-2012. Cuba is one of those countries (FAO 2013).

Apiculture could provide more diversified productions like natural feed enriched with plant protein, vitamins and minerals. Pollen, honey and royal jelly are lost, or stop being produced because of ignorance or lack of technologies, mainly in the fields of Latin America and Africa, which could decrease or remove the hunger of these peoples.

Innocuity of food is an inherent condition in the concept of food safety. The hive products have to fulfill the parameters established for this purpose. The World Health Organization (WHO) has repeatedly pointed out that food origin diseases, like foodborne illness

or food transmitted diseases, appear among the most pressing problems of public health systems (Martín and AA.VV. 2009). Therefore, there are international rules that beekeeping industry has to fulfill for the production and trade of feed.

The veterinary services of a country has to establish health controls in all the productive chain, which allow to assure the absence of chemical residues, forbidden substances, microbiological contamination or gross particles from the hive products (Verde *et al*. 2012).

The international trade of honey states quality and innocuity parameters that determine the consumers, as part of the food safety. The use of the bee products for the European market is controlled by laws, guidelines and regulations, established to protect the innocuity of goods, among other objectives. The CODEX Alimentarius protects the health of consumers through the fixation of international standards to guarantee the fair practices in food trade. This way it contributes to the global food safety (Labatut 2013).

The strengths of Cuban beekeeping sector, linked to the national food sovereignty and safety, lie on the following aspects:

- Systematization of the actions for updating the knowledge, directed to the beekeepers and the specialized technical force. In the modern and intensive apiculture, the beekeepers turn to be essential mediators between bees and ecosystems. The workers of this sector need theoretical and practical knowledge for establishing a balance relation among the bee, the hive and the productive ecosystems, and for assuring good practices of production and manufacture, in order to reach innocuous, traceable, and sustainable productions.
- Reordering and modernization of apiculture. Under scientific basis, a new method was established to adapt the amount of hives to the available honey potential in the economical flying radio of the apiary, through a rational, balanced and sustainable intervention the economic ecosystems. This is a tool used in the epidemiological work with this specie, focused on the prevention and control of transmissible diseases. This avoids the presence of forbidden residues within the hive products.
- Integrated management for disease control. This is a method for controlling transmissible diseases without the use of medicines, which helps to achieve innocuous productions.
- Bee covering for agricultural ecosystems. Mapping of apiculture (fix or migrating) and the interrelation of different participants on the productive stage offer security for the pollination of entomophilous crops, activity that, using legal regulations, avoids the contamination of the gathered productions.
- Relation between the environmental legislation and the beekeeping legislation. The country has laws, decrees, rules and regulations with different social reach, which allow the harmonic coexistence of apiculture in different productive scenarios, without reduction of the activity, the integrity of colonies or ecosystems, and benefiting the pollinating activity of the insect for producing food.
- Inclusion of apiculture as an agricultural branch of interest for the Ministry of Agriculture. Apiculture is considered among the strategies of agricultural and livestock development of the country and it is supported by policies that favor the cohesion of the sector. This contributes to the inclusion of this sector into other spheres of society: universities, technical schools, research centers, ministries, and some others.
- Spreading of the beekeeping activity through the mass media. It is directed to the population in order to increase the general culture. This teaches people the importance of this activity for the production of food and medicines, and the conservation of the biodiversity from ecosystems, among other economical and environmental benefits.

Conclusions

Due to the important role of bees in pollination, the development of this production area takes part of the food safety; therefore, it should be included in the agricultural and livestock policies of countries. The beekeeping productions provide foods that contribute to fulfilling the growing demands of vitamins, proteins and minerals, needed for feeding the most vulnerable and unprotected population areas. Likewise, they should be innocuous, traceable and sustainable in order to fulfill the requirements established by the food safety regarding the foods for human intake. Cuba has strengths that assure this condition on the commercialized productions.

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