Abstract: In order to deal with the effects of globalization, urbanization, increase in world population, global warming, and climate change; and according to the Sustainable Development Goals (SDG) 2 targets, which aim to end hunger, achieve food security and improved nutrition and promote sustainable agriculture, it is urgently needed to transform our agriculture and livestock farming systems by taking into account the environmental considerations. The Breeding and management practices of indigenous bovine breeds: Solutions towards a sustainable future (BOVISOL) project is a scientific cooperation between three Mediterranean countries (Greece, Tunisia and Algeria) supported and funded by the European Commission under the European Research Area Networks (ERA-NET) scheme of the 7th Framework Programme. This project has been formed around the hypothesis that the local bovine breeds must be preserved since they possess a valuable genetic pool, and they are a part of the landscape and the biodiversity of rural areas. Moreover, their products (milk, cheese, meat, etc.) could contribute significantly to the local economies as they could easily be associated with recent food trends like “local” and “slow food”, which are considered today, as, not only a mean of nutrition, but also a way of living and a part of people’s identity. BOVISOL project aims to: (i) identify the local breeds and populations in a national level, (ii) describe the existing farm and breeding practices, (iii) analyze the quality of the main local animal products, (iv) propose solutions that will promote the sustainability of the traditional farming systems, especially nowadays that climate change proposes new challenges on animal production, and (v) disseminate the solutions on all the levels of the sector (farmers, scientists, local communities, governmental agencies).

Keywords: animal products; climate change; local bovine breeds; Mediterranean basin; sustainability; traditional farming systems

1. Introduction

In 2015, world leaders adopted a blueprint towards 2030; it comprises 17 interconnected Sustainable Development Goals (SDGs) to achieve a better and more sustainable future for all. They address the
global challenges, including those related to poverty, inequality, climate change, hunger, environmental degradation, peace, and justice (https://www.un.org/sustainabledevelopment/). The SDG 2 (Zero Hunger) aims to (a) end hunger and improve nutrition, (b) promote sustainable agriculture and double the productivity and incomes of small-scale food producers, and (c) maintain the genetic diversity of seeds, cultivated plants, and farmed and domesticated animals and their related wild species [1].

Under this spectrum, the European Initiative for Coordination of Agricultural Research in the Mediterranean (ARIMNet) bears the ambition to enhance and improve coordination of agricultural research programmes and cooperation within the Mediterranean area. The ARIMNet funded research programs were undertaken in order to face a number of common problems linked directly to agriculture and food security. Their main context is the use and management of natural resources, such as soil and water, as well as crop protection and promotion of sustainable agriculture by taking into account the environmental considerations (fight against climate change, genetic characterization, and monitoring of local indigenous breeds which are well adapted to their local environments, preserving and redeploying biodiversity endangered breeds).

With this in mind, and to continue to promote research in this field of Sustainable Agriculture, the ARIMNet coordination has granted funding to a 3 years scientific research project entitled BOVISOL (Breeding and management practices of indigenous bovine breeds: Solutions towards a sustainable future). BOVISOL is a scientific cooperation that brought together 3 research teams from three Mediterranean countries: Greece, Tunisia, and Algeria (Figure 1). Moreover, to provide the best answers to the project objectives, a multidisciplinary approach that combines animal scientists, food scientists, microbiologists, biologists, and Biostatisticians has been adopted.

![Figure 1. The Mediterranean Countries participating in the “Breeding and Management Practices of Indigenous Bovine Breeds: Solutions towards a Sustainable Future (BOVISOL)” project (Algeria, Tunisia, and Greece).](image)

2. Project Summary

Mediterranean communities have been, traditionally, formed around animal husbandry. In fact, domestic animals provided all the necessities for the households e.g., food, clothing, labor etc. Bovine farming especially, constituted an essential primary sector since cattle produced a variety of products (milk, meat, and hides) and also helped in soil cultivation. The indigenous breeds evolved under specific local environments and became very well adapted to microclimate conditions and the needs of the communities that became larger and their need for higher production has emerged.
Because especially of the rural exodus, both the local breeds and the traditional farming systems were more or less abandoned, and the modern way of production replaced them. Improved breeds were selected and imported, and a more intensive way of production became the rule. This does not mean that the traditional bovine farming became extinct. Several farms still exist and produce local animal products, but they face a number of challenges that need to be addressed, if the traditional farming system is to be sustainable in the future.

If something is traditional, it does not mean that it is also suitable for the modern production environment. Sometimes, farmers insist on practices that are outdated and counterproductive just because they follow the traditional animal husbandry methods inherited from their ancestors. On the other hand, these traditional animal husbandry methods have a strong bond with the breeds and the local products produced. Under this spectrum, it is of great importance to document and describe the entire spectrum of the husbandry practices of local bovine breeds, as well as their productive characteristics and importance of the products produced. As soon as there is an overall perspective of the breeds and production systems there are a number of improvements that could be proposed in terms of animal breeding, feeding practices, hygiene conditions, and product quality certification that would improve the productive system without altering its traditional label. Nowadays, the consumers are extremely demanding in terms of traceability and quality of animal products as well as environmental sustainability. Moreover, the consumers need a clear correspondence between the quality characteristics and the price of a product.

Therefore, there is a need for cooperation between the traditional farmers and the scientific community in order to bring the traditional bovine farming to the next level. The local bovine breeds are part of the landscape and the biodiversity of rural areas. Their products could contribute significantly to the local economies for the benefit of the communities. These products could also easily be associated with recent food trends like “local” and “slow food” and can claim to provide good products for consumers, good for those who produce it and good for the planet. Furthermore, food today is considered not only a mean of nutrition, but also a way of living and a part of someone’s identity. Finally, an upgraded bovine farming could also serve as a reason for the people to stay and prosper in the sparsely populated rural areas.

3. Scientific Quality of the Project

3.1. Concept and Objectives

The local bovine breeds and their traditional management practices are essential because they are an integral part of the rural area’s life and culture. At the same time, they represent a way of farming that is difficult to cope with the high productivity rhythms of modern animal production and needs to focus on their relevant strengths in order to survive. The overall goal is to improve simultaneously the productivity of the systems and their sustainability. This can only be achieved by protecting the valuable genetic diversity of the local breeds but with the necessary evolution of the current production practices in order to contribute to the economic and social development of the local communities.

Cattle worldwide population is about 1.4 billion animals [2]; they are one of the most important livestock species. As the major source of milk, meat, hides, and draught power, cattle may be considered as multi-purpose livestock. Because of the animal’s size, the husbandry of cattle requires more organized management than the keeping of other livestock, which may well have made a major contribution to the growing complexity and stratification of early agricultural societies. As with other domestic species, their dispersal over different continents and adaptation to various environments has led to the development of many types of cattle [3]. This wide variety of characteristics evolved over thousands of years, but was accentuated by the development of well defined, specialized and genetically isolated breeds during the last centuries. After the Second World War and even more in the last quarter of the 20th century, this process has resulted in the global use of only a few of the most productive of these specialized breeds, which expanded at the expense of local, seemingly less
productive populations. Nevertheless, there is now a growing awareness that the diversity of cattle should be conserved, and local breeds should be protected from extinction, although commercial interests still promote the ‘industrial’ breeds [4].

In Greece, according to the Ministry of Agriculture, in 2015, four indigenous breeds were referred, which are farmed mainly for meat production: the “Greek Red” (with 12,800 females) “Vrahykeratiki” (Shorthorn, with 6800 females), “Katerinis” (with 500 females), and “Sykias” (approximately 100 females, endangered breed) (Figure 2). These animals are farmed mainly in the mountainous grasslands of the country; they are reared all year long in the fields and only in very extreme weather conditions they are housed in rough housing. Their dietary needs are covered mostly by grazing and complementary feed is provided only in the winter. Currently, the importation and use of foreign breeds and the disorganized breeding schemes have resulted in a variety of phenotypes.

In Tunisia, local cattle population with Iberian origin counts 191,920 female units (www.oep.nat.tn) and are mainly (87%) localized in the North especially in the mountainous area (120,000 heads). In this zone, local cattle breeds contribute to 15–26% of the milk and meat production [5]. This population has suffered from anarchic crossing which affected its genetic structure [6]. Nevertheless, studies concerning this breed were mostly interested in genetic aspects. In fact, two breeds were identified: Atlas Brown and Blonde of Cap Bon (Figure 2). Moreover, the population of Atlas Brown has been declining over the years, and the population of the Blonde of Cap Bon is very small, indicating that it is exposed to extinction [6]. The study of phenotypic variability based on a qualitative description of the characters showed that the differences between individuals are mainly due to the color and general conformation of animals [7].

Algerian autochthonous bovine populations resemble the Atlas Brown, whose pure breed subjects are still preserved in the mountainous regions. It is subdivided into several subpopulations, namely “Guelmoise”, “Cheurfa”, “Krouminiène”, “Chelifienne”, “Sétifienne”, and “Djerba”, which are clearly differentiated from the phenotypic point (Figure 2). These populations are characterized by good rusticity, and constitute a very important socio-economic element, contributing to a large part to the feeding of the rural people. Indeed, these populations have brought together qualities of adaptation to the environment, to the food resources available, to the pathological contexts and the modes of exploitation. Despite the perfect harmony between these indigenous cattle populations and the conditions of the natural environment, productivity remains modest, both because of the often-unfavorable rearing conditions and the animal material used. Several trials for dairy intensification, which were based mainly on the importation of exotic breeds, led to a profound mutation in the genetic structure of the dairy herd in Algeria, resulting in a drastic fall in the numbers of local cattle. Thus, the share of local breeds is reduced from 82% of the total in 1986 to about 48% of the total in 2016.

In all three countries, the local bovine breeds’ populations face similar problems such as fear of extinction, anarchic breeding schemes and unfavorable rearing conditions. At the same time these populations are extremely valuable both in local and in regional level since they combine unique qualities: valuable genetic pool, substantial income to the local economies, and added-value animal products. Consequently, the concept of this project arose as a necessity between the partners. Efforts should be made to preserve these populations by trying to find the best solutions that will improve the production systems in terms of productivity and sustainability (Figure 3). Table 1 presents some preliminary results so as to explain the status of the analyzed breeds and farming systems.
Figure 2. Local bovine breeds photos taken in the three partner countries involved in BOVISOL project: In Greece, we can found the Greek Vrachykeratiki breed (shorthorn) (A.1.), the Greek Katerinis breed (A.2.) and the Greek red breed in the mountainous region of Kastoria (A.3.); in Tunisia, we can found the Atlas Brown (B.1.) and Blonde of Cap Bon (B.2.); In Algeria, we can found the gray twig represented by the Guelmoise breed (C.1.), the tawny twig represented by the Chelifienne breed (C.2.), the white twig represented by the Cheurfa breed (C.3.), and the black twig represented by the Sétifienne breed (C.4.).
The background of BOVISOL project
The need for higher production has led the local bovine breeds close to extinction along with the traditional farming systems.

The benefits
Low input animals. Perfectly adapted to the local conditions. Holders of a valuable genetic pool.

The problems
Anarchic crossing, unfavorable rearing conditions, no traceability or certification of products.

The challenge
The preservation of the local bovine breeds by improving the profitability and sustainability of the farming systems.

The partner countries
- **Greece**: 3 breeds (Vrachykeratiki, Katerinis, Sykia). Farmed in the mountainous grasslands for meat production only.
- **Tunisia**: 2 breeds (Atlas Brown, Blond de Cap Bon). Farmed in the mountainous areas for meat and milk production.
- **Algeria**: 1 breed (Atlas Brown), 8 subpopulations. Farmed around forests, mountain areas or lakes for meat, milk and hide production.

The vision
3 countries, around the Mediterranean sea, with common experiences, ideas and problems, and a global goal.

The importance
The local bovine breeds are the living part of mankind’s cultural heritage and an integral piece of the landscape and the biodiversity of rural areas.

Figure 3. BOVISOL project: benefits, problems, challenge, partner countries, vision, and importance for farming systems.

Table 1. Preliminary results of the BOVISOL project on the status of the analyzed breeds and farming systems.

| Local Breeds | Greece | Tunisia | Algeria |
|--------------|--------|---------|---------|
| Greek Red, Vrachykeratiki (Shorthorn), Katerinis | Atlas Brown with 3 main ecotypes: Blonde of Cap Bon, Grey Brown of Atlas, Tawny Brown of Atlas. | Atlas Brown with several subpopulations (Guelmoise, Cheurfa, Krouminiène, Chelifienne, Sétifienne, Djerba etc) |
| Populations | Approximately 22,000 heads | Approximately 200,000 heads | Between 900,000 and 1,500,000 heads |
| Locations of farms | Northern and Central Greece | Northern and Central Tunisia | Northern Algeria, mainly East |
| Production system (main characteristics) | Traditional extensive (mixed herds, free grazing, complementary feed in the winter) | | |
| Animal products | Meat | Meat, Milk | Meat |
| Labor | Mostly family members, wage labor is scarcely used, where it is absolutely necessary | | |
| Feeding | Grazing during the spring, summer and autumn. In the winter, if the weather conditions are difficult, some kind of hay, straw and small quantities of concentrates. | | |
| Reproduction | Natural mating | | |
| Selection | National program that finances creation of databases of animals and their genetic relations. | No national programs | No national programs |
| Health management | Rustic animals, perfectly adapted to their environment, so less prone to diseases. Veterinary help available only in urgent cases. | | |
| Product certification | No certification of any kind | | |

In addition to the overall goal, other concepts will be taken into account in the realization of the whole project: Vulnerability is the propensity or predisposition to be adversely affected [8]. It is a dynamic concept, varying across temporal and spatial scales and depends on economic, social, geographic, demographic, cultural, institutional, governance, and environmental factors. Measuring vulnerability is complex as it needs to be considered across various dimensions. The concept has also been used in livestock farming systems approach in order to explore the range of adaptation traits [9]. Flexibility is the ability to recognize changes in goals and make rapid alterations to achieve
these new goals but additionally suggests that flexibility is achieved by anticipating change rather than reacting to it [10]. In livestock farming systems are used in order to analyze how farmers cope with uncertainty [11]. Resilience is the positive adaptation despite adversity and is considered a construct with two distinct dimensions: significant adversity and positive adaptation. From this perspective, resilience is never directly measured, but is indirectly inferred from the evidence of these dimensions [12]. In farm animal production, resilience is defined as the capacity of animals to cope with short-term perturbations in their environment and return rapidly to their pre-challenge status [13].

Objectives and Hypotheses

The aim of this project is to contribute to the sustainability of the local bovine breeds’ farming systems by taking into account (a) the adaptability of the animals to the local environment, (b) the quality of the animal products, and (c) the economic and cultural value of the systems.

The objectives of this project are:

(a) The identification of the local breeds and populations in a national level.
(b) The analytical description of the existing farm and breeding practices.
(c) The analysis of the quality of the main local animal products.
(d) The proposition of solutions that will promote the sustainability of the traditional farming systems, especially nowadays that climate change proposes new challenges on animal production.
(e) The dissemination of the solutions on all the levels of the sector (farmers, scientists, local communities, governmental agencies).

The hypothesis of this project is that the local bovine breeds farming is worth to be preserved since, (a) these animals are a valuable genetic pool, (b) the traditional farming systems provide a substantial income to the local economies and keep the people in unprivileged rural areas, and (c) these animal products have an added value in comparison to the conventionally produced ones. Table 2 presents a SWOT analysis on the perspectives for sustainable development of farms based on local bovine breeds.

### Table 2. SWOT analysis on the perspectives for sustainable development of farms based on local bovine breeds.

| **Strengths**                          | **Weaknesses**                           |
|---------------------------------------|------------------------------------------|
| ✓ Local bovine breeds are an integral part of the rural landscape. | ✓ Aged farmers. |
| ✓ These animals represent a valuable genetic pool. | ✓ Low education level of farmers. |
| ✓ Rustic animals, low expenses on feeding and health management. | ✓ Lack of qualified labor. |
| ✓ Possibility of creation of added-value products. | ✓ Low productivity. |

| **Opportunities** | **Threats**                           |
|-------------------|----------------------------------------|
| ✓ Product analyses to certify added-value products. | ✓ Anarchic breeding schemes. |
| ✓ Certification of products could lead to higher selling prices. | ✓ Unfavorable rearing conditions. |
| ✓ Association with modern food trends like “local” or “slow food”. | ✓ Fear of extinction. |

### 3.2. Quality and Effectiveness of the Scientific Project, and Associated Workplan

#### 3.2.1. Overall Strategy, Work Plan, and Project Target Objectives

BOVISOL projects’ overall strategy is founded in two major axes: the clear, analytical, and precise recording of the local bovine breeds, populations and farming systems and the proposal of solutions in order to promote their sustainability. In order to complement this strategy, the overall work plan is complete with activities that promote these two axes. On the one hand, it aims to collect all the available data, from every source
appropriate, so that the consortium can describe the current situation on local bovine breeds farming. Moreover, it aims to help the researchers understand deeply the advantages, disadvantages, strengths, and weaknesses of the farming systems so that the consortium can propose solutions. The target objective is to secure the sustainability of the traditional farming systems by the valorization of the local animal products, especially now that the climate change threatens to overthrow everything that is being known about animal production on a local level.

3.2.2. Methodology and Innovative Approach

The methodology of BOVISOL project is constructed on a standard scientific approach of the subject incorporating although some innovative approaches. The first step in this project is the precise and analytical recording of the local bovine breeds and their populations. This is something new for all the three countries involved because some efforts have been done in the past, but they were fragmentary. In addition, the consortium will record all the farming and breeding practices of the traditional production systems, something that has not been done in the past.

The second step of this project is the product analysis. Meat and milk samples will be collected from the farms and they will be analyzed in terms of quality. This is also innovative for these products because even though there is a general idea on the public that they are better than the conventional ones, there is no solid scientific proof to support that claim. Furthermore, the product analysis will be connected to the recorded farming systems conditions in order to discover a link between the farming system and the quality of the product.

Nevertheless, the core of this project is the attempt to find solutions that will make these farming systems sustainable under the current climate change. This will undoubtfully have a positive impact on socio-economic factors; for example, the possible certification or labialization of dairy products can improve farmers’ incomes, especially in South countries (Tunisia and Algeria), where these notions do not exist. The results of this project will be communicated to all possible directions in order to promote the local animal products. This task could contribute to the creation of specific public policies that will benefit the farmers and help their progress towards food quality labels (PDO, PGI, BIO . . . ). In the long run, the project could have a positive impact on rural economy and increase life quality of farmers.

Finally, the partners will utilize the experience of the African countries, where the climate is hotter, in order to attempt a projection of the weather conditions in Greece, which nowadays has a mild climate. To the consortium’s knowledge, such an attempt has never been performed in the past and it is a pleasure to establish institutional connections that can perform such tasks.

4. Expected Impacts

The BOVISOL project is addressed directly to the farmers in order to provide them with solutions that will allow them to upgrade the traditional farming systems and make them more productive, competitive and sustainable. It will also help them to document the superior quality of their products in order to benefit from their added value. Nevertheless, the impact from this project is expected to be far wider that originally designed. In particular, the target groups that will also use the project’s outputs are: (a) Teaching/academic staff of higher education institutions, because new data will be available that could be used in structured courses and presentations. (b) Relative technical specialists, like veterinarians and animal science experts that will benefit from access to the newly acquired methodologies. (c) Students in the animal sciences, who will have access to modern data regarding the local bovine breeds as well as the effects of climate change on animal production, and the possible measures to be taken. (d) Enterprises, businesses, commercial, and other companies, through the documentation of the added value of the traditional bovine products and their added value. (e) The society in general and the local communities in particular, through the proposition of the sustainability of these farming systems and the opportunity for young people to stay and work in the rural areas.

Furthermore, proposed approach used in BOVISOL project might not be restricted for local bovine breeds of the Mediterranean area, but also for any sensitive local breeds to climate change worldwide.
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