

# eSmallFarmer: Improving of Rural Agriculture

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**Abstract:** The introduction of concepts such as IoT or cloud computing is increasingly common nowadays, in different sectors of activity where the agricultural sector is not an exception. The use of drones for pesticide application in pest control, or even the use of sensor networks to control the growth of crops, are quite common in the context of Agriculture 4.0. However, this technological advance does not happen at the same speed in remote regions where traditional agriculture is still dominant. These differences even contribute to increasing the gap between urban regions, where modernized agriculture predominates, and rural areas, are still strongly rooted in traditional agriculture. In addition to these technological differences, there are still major differences regarding access to market outlets, where the pandemic COVID-19 further aggravated the situation. Given the measures to contain the pandemic, which has resulted in the closure of virtually all services (for example, butchers and small markets), many of the small producers have been left without their only means of disposal, which has contributed strongly to the weakening of small agriculture. To mitigate the differences between the rural and urban areas, but also to mitigate the negative impacts caused by the pandemic COVID-19, the need for new livestock/business models was raised to create conditions to allow producers, in regions with low population density, access markets that until now were impossible. This paper presents a viable business model that contributes to reduce the differences between urban and rural environments, as well as, mitigate the economic impact of the COVID-19 pandemic in this sector.

**Keywords:** small producers, production flow, agriculture, internet of things, ecosystem, reuse

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## 1. Introduction

Since the early times, the practice of agriculture has been common in society. As an activity that generates wealth, it's extremely important in several countries, including Portugal. Since agriculture is the main source of food production in the world, it's extremely important to develop this sector to reduce costs and increase profits by means of optimization of processes and technological innovation. By 2050, the human population is expected to rise to 10 billion, leading to an increasing demand for food (FAO, 2017). To accommodate this increasing evolution, total food production must increase, thus, making it necessary to have a rational expansion of the agricultural sector, which may occur at a slow or fast levels, depending on the capacity of the population in the acceptance of new technologies (FAO, 2016) (FOOD, O, 2016) (Powell, Nicola et al, 2012). However, despite the need for an expansion of the agricultural sector to tackle the problems mentioned above, Portugal is increasingly abandoning rural areas and inevitably abandoning rural agriculture, and is increasingly losing jobs in the agricultural sector (PORDATA, 2021).

Analysing figure 1, it's possible to observe that the Portuguese population is not distributed uniformly throughout the country, having a higher concentration in the coast than in the interior (a more rural zone).

Because of this variation in population, development is not carried out in a distributed and equitable way between urban and rural regions (European Union, 2021a).

Another important point can be observed in the figure 2, which is the percentage of the population that is older than 65 years old per municipality. As we can observe the majority of the municipalities that have an older population are located in the interior of the country.

Analysing these two facts we can conclude that the population that is living in the rural areas of Portugal is aging and decreasing, being two of the critical factors of the rural agriculture in Portugal. Another least favourable points of the rural agriculture in Portugal are low levels of education of agricultural producers (PORDATA, 2015), low level of adherence to technologies, and consequently, a lower connection with Industry 4.0.

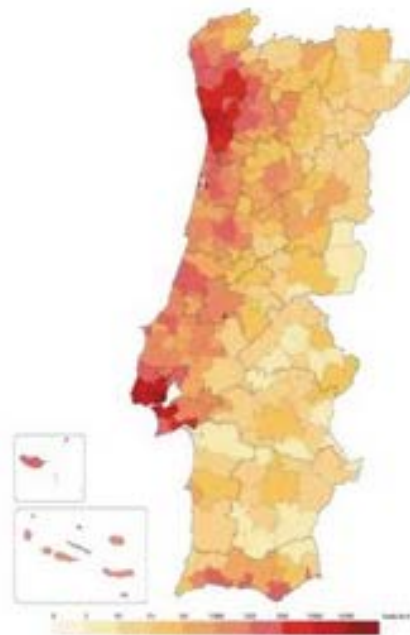


Figure 1: Portugal population density (Wikipedia, 2021)

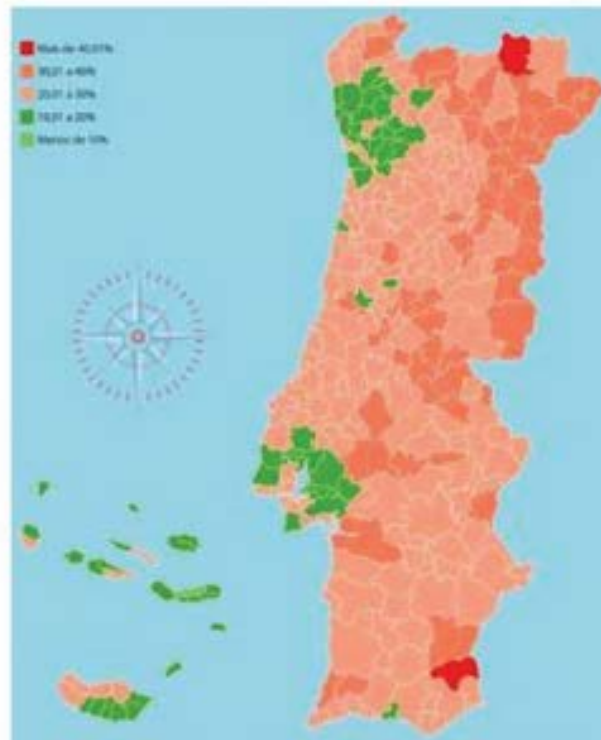
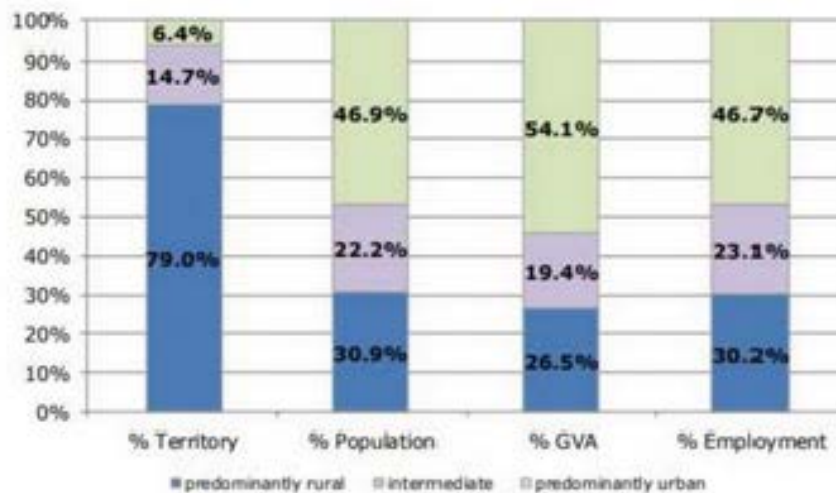


Figure 2: Percentage of Portuguese elderly population per municipality (Curvelo, 2020)

The Portuguese territory covers about 92,000 km<sup>2</sup> and maintains a population of near 10 million habitants, which despite being a small country, in 2019 has exported 6322 million euros in the agricultural sector. This value corresponds to about 7% of all national exportations in all sectors that year (European Union, 2021b). Of the 92,000 km<sup>2</sup>, 79% corresponds to rural territory, showing its potential. However, only close to 31% of the population lives in these territories, against almost 47% living in the urban areas, showing the differences between the two geographic realities. Something important, is the Gross Value Added (GVA), which is the result of productive activity over a given period (European Union, 2019). It results from the difference between the value of output and the value of intermediate consumption. This value corresponds to 26.5% in rural territory, and increases to 54.1% in urban territory as illustrated in the figure 3.



**Figure 3:** Portuguese distribution (European Union, 2021b)

Although Portugal having a huge rural territory, investing in the agricultural sector of these areas cannot simply be investing monetarily, there is a need to know how to analyse investment opportunities and how to apply them. Thus, the Portuguese agricultural sector needs to innovate and follow technological trends, and that can be accomplished by following the concept of agriculture 4.0. That concept consists of a set of technologies with the objective of optimizing agricultural resources, enabling the use of new, more accurate and modernized methods (De Clercq, M. et al, 2018). Some of these methods are:

- Drone technology - The method of using drones to perform agricultural tasks;
- Data analysis - The method of analysing raw data with the goal of extracting information;
- Internet of Things (IoT) - The concept of interconnectivity of objects with access to the internet (Ascensão, Joao et al, 2021).

These technologies have not been used in the *Trás-os-Montes* region due to the several reasons referred previously, however in this paper is presented a business model that follows the concept of the agriculture 4.0. The business model illustrated in this paper, contributes to reduce the differences between urban and rural environments, by means of a web platform, an IoT device, and integrations with several external entities.

The remainder paper is organized as follows: section 2 describes the *Trás-os-Montes* region and a questionnaire; section 3 presents the solution designed to respond to the identified problems; section 4 presents the conclusions of the work and guidelines for future work.

## 2. Trás-os-Montes region

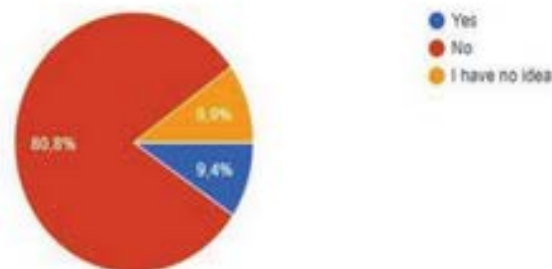
Primary sector activities, such as agriculture, play a key role in the economy of *Trás-os-Montes* region. According to INE (2020) in 2019, *Trás-os-Montes* in the same year had the largest number of individual farms per region, with more than 63,000. In the same year, the value of agricultural production in Portugal exceeded 6.7 billion euros (Cordeiro de Sá, 2021), where this region contributed with 585 668 million (+ 8%). However, these values could be improved if not for the structure of this region, since it's practiced for an aging population, have high production costs, poor market relations, predominance of small agriculture, among others (Lima, n.d). Some of the aspects are partly related to the lack of agriculture 4.0, or the lack of solutions that could improve agriculture in some way (Norte2020, n.d).

However, the construction of solutions that solve part of the problems is no easy task, since in these regions, the use of internet, something common in modern solutions, is a critical point. Although 5G technology is already becoming a reality in several parts of the country, the *Trás-os-Montes* region still suffer from weak connections to the Internet (Lopes, 2018).

As for the disposal of agricultural products by the producers, this becomes a more difficult task, where in many cases, it's created food waste that could be avoided.

To help the development of this paper and the public in general to understand more specifically the theme, a questionnaire was developed to be answered by the locals of *Trás-os-Montes*. The questionnaire, until the moment, has more than 213 answers and it's still on going. Due to covid-19 pandemic, it wasn't possible to contact and personally ask people about this questionnaire, but it's expected, in a close future, to reach 3 or 4 times more the number of answers.

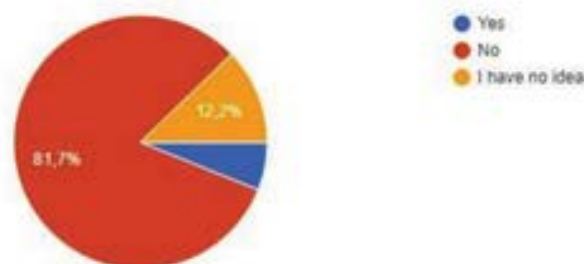
Do you think that everything produced in the agriculture of your region is fully exploited/sold?  
213 respostas



**Figure 4:** Questionary question #1

Observing the figure 4, people were asked if they thought that everything in the region is sold/used, and analysing the answers, its clearly visible that the majority tends to say no, with almost 81% of answers. The others 19% are divided between "Yes" and "I have no idea".

Do you consider that crop productions in the region are sold by a fair value?  
213 respostas



**Figure 5:** Questionary question #2

The figure 5, prompting the question "Do you consider the crop productions in the region are sold by a fair value?", had similar results to the previous one, since almost 82% answered it no. Near 18% are divided also between "Yes" and "I have no idea".

Do you think that the existence of an online portal of domestic sales would serve to bring final customers closer to small producers in your region, allowing the growth of agriculture?  
213 respostas



**Figure 6:** Questionary question #3

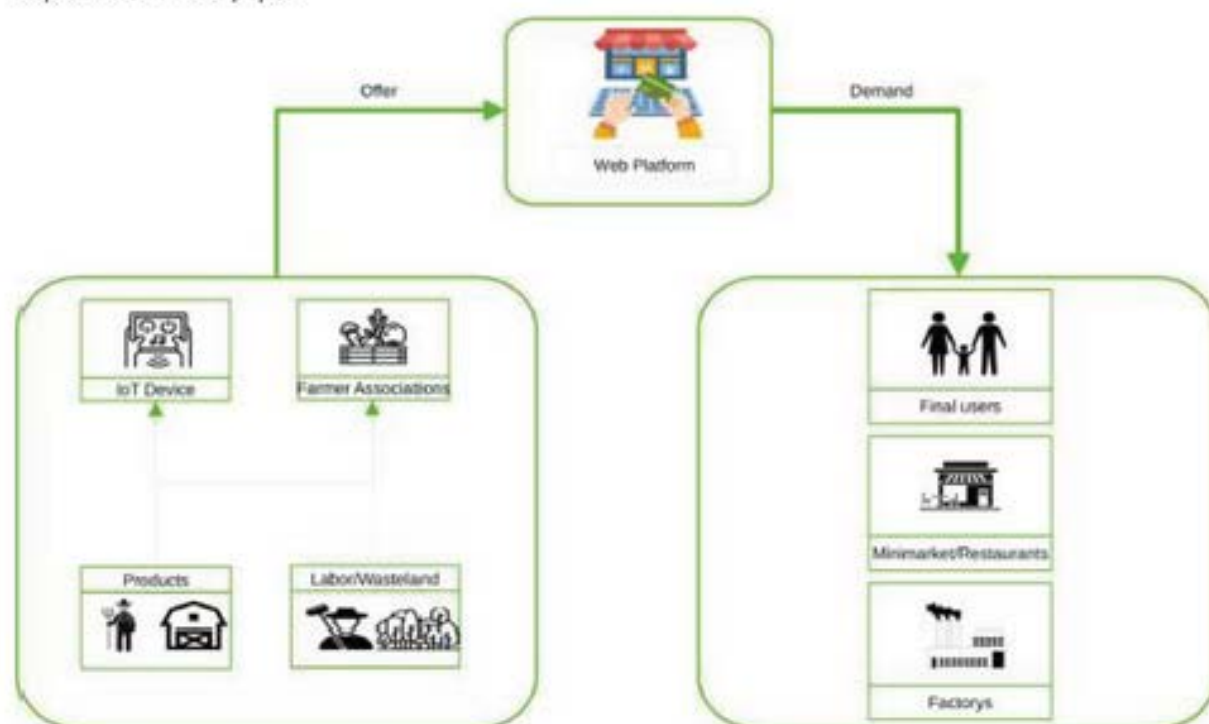
This last figure 6, show that more than 93% of the people inquired answered that the existence of a web national portal is needed, bringing consumers and producers close to each other, allowing the agriculture to increase.

With these questionnaire answers, it's possible to understand that the problems written previously, such as the waste of food and the need to producers sell their products, are very real and the society it's aware. Due to this, new solutions need to step up and try to solve some of the well-known problems, helping the people of *Trás-os-Montes*, and other regions in the same position, to be more efficient.

### 3. Our business model

In this way, eSmallFarmer (D. Pinto et al, 2020) can be a possible solution to mitigate the problems presented. This solution, in short, consists of a web platform and an IoT device. In addition, it has the integration of several entities such as governmental entities (e.g., parish council) and farmers associations, which play a very important role in the business model presented. The figure 7 presents an overview of the built business model.

The solution proposed is intended to facilitate the products sale of small-case producers in remote regions, such as the region under study. Thus, the design of the eSmallFarmer architecture considered the fact that, as already mentioned in the previous sections, the majority of the population in the region under study is aged, which sometimes, in the opinion of the authors, generally departs, the population of the use of technological solutions as presented in this paper.



**Figure 7:** Business model

In this way, the possible problems that small producers may have in inserting their products directly into the web portal can be easily overcome with the acquisition of the IoT Device. This device, whose use is very similar to that of a telephone, connected to several sensors, allows the weighing of the products to be made available, in addition, can identify its producer, location and telephone contact. After the collection of this information, the product is automatically inserted into the web platform. However, this device uses NB-IoT to send data to the web platform, and this technology in some areas may not be available, since NB-IoT is a LPWAN and it needs to be connected to a cell tower to work (I-scoop, n.d). Thus, for these situations, the introduction of associations of farmers and/or governmental associations was the solution found to overcome the problem of limiting the NB-IoT network. These associations often have a good relationship of trust with small farmers and both computer resources (good Internet connection and computers) and human resources, which allows them to, at the request of small farmers, place their productions on the web platform.

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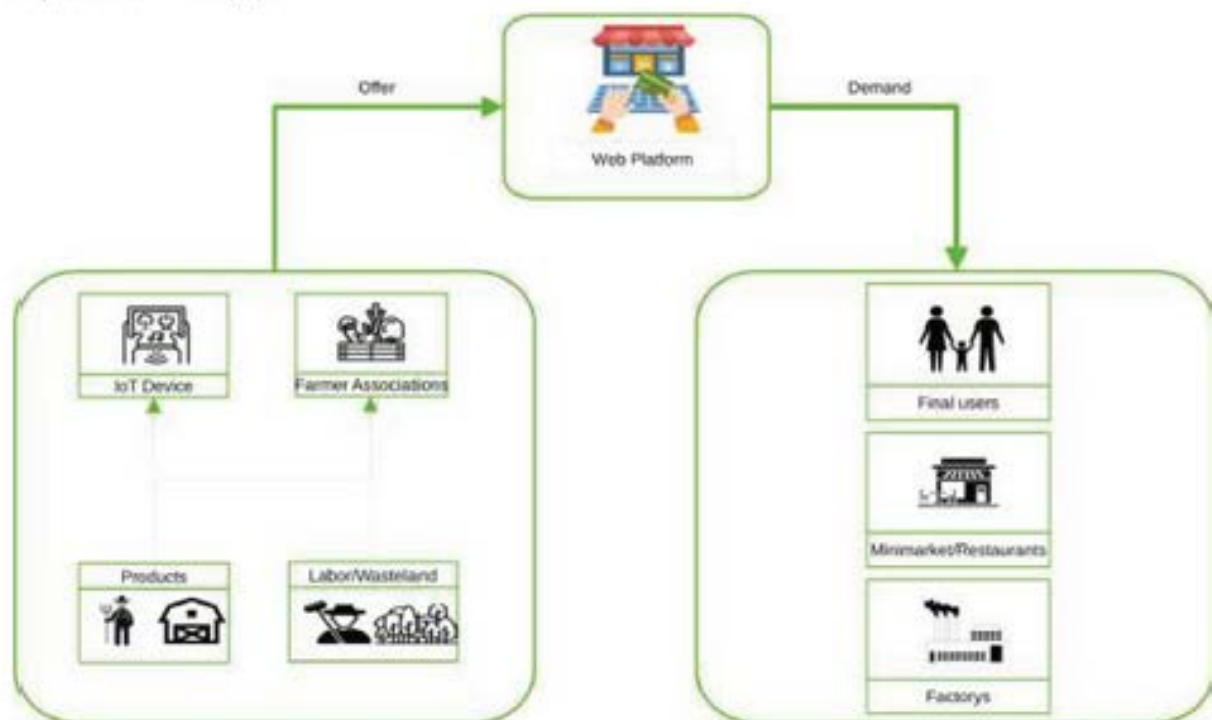


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In addition, this solution can contribute not only to boosting small production but also to solving the problem of labour shortages, another of the problems affecting agriculture in the region under study. So, in short, the web platform, makes it possible to promote the rental of human labour, agricultural machinery and land. In this way, end-users (both individual users, minimarkets and restaurants) have access to a set of high-quality products at a combined price. In parallel, factories that need agricultural material to make their products can look at this tool as an opportunity to explore new business models, since, as already said, the tool promotes the sale of products and leasing of land, making it possible to exploit it.

#### 4. Conclusion

As described throughout this work, the *Trás-os-Montes* region faces problems that constraints its development when compared with urban areas. Such problems, as previously said, are based on the ageing population and the weak connection between the region and agriculture 4.0, including the limited use of internet.

This paper was written with the intention to let people know about eSmallFarmer. With it, it's possible to bring together farmers who do not have high knowledge in informatic areas, allowing them to sell their products more easily and effectively. eSmallFarmer counts with an IoT device and an e-commerce web portal.

Other advantages that can be obtained with this business model, includes the possible reduction of food waste, as well as a viable option in the case of this COVID-19 pandemic, which has accentuated the problems of small and medium-sized agriculture.

Another point that is present is the concept of circular economy, which is essential for a greener future (Ellen MacArthur Foundation, n.d). It is based on an idea of reduction, reuse, recovery and recycling of materials and energy. Through the solution proposed in this paper, it is possible to offer a cycle for producers that was once non-existent or made in a more difficult way. If we make available the farmer's products to general population, we tend to reduce the waste, reusing something that previously wasn't reused.

In case farmers start to observe their waste decreasing, abandoned fields can be reused, promoting their exploration by these farmers that now can sell more. This can also bring indirect advantages, such as reducing the probability of forest fires since these fields are now treated and monitored.

#### 4.1 Future work

To future work, the main priority is to be able to build a prototype that is possible to install in a more realistic scenario. So, in summary form, despite the great potential presented, this solution still has a long way to go. Thus, the following points were left for future work:

- Study a possibility to reduce the Architecture complexity.
- Understand the real impact of controlling the food waste that this solution provides to producers.
- Present a study on the acceptance of this solution in the target regions.

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