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Final Report Summary

FarmReal



Introduction

In recent decades, Europe has experienced an increase in its forest area (including bushes and scrubs), mostly as a result of the abandonment of agricultural activity in areas of poor productivity and fragmented land, and alongside with the process of depopulation and ageing of the rural territories.

In practice, this context means that the structured mosaic landscape ceases to exist and that these areas are subject to a poor management. One of the effects of these changes of land-use is the increasingly dense undergrowth, with a greater accumulation of biomass that, in turn, increases the risk of forest fires.

In fact, the increase in biomass accumulation and continuity at landscape level has contributed significantly to the occurrence of large fires in the last decade in Portugal, especially in the Center region.

One of the most effective ways to prevent forest fires and their propagation is the opening of firebreak areas.

However, the maintenance of these strips constitutes a problem, as mechanical interventions involve high costs and there is a lack of specialized human resources linked to this kind of activity.

One alternative is the maintenance to be carried out by grazing, thus reducing costs and allowing local populations to be involved in fire prevention. Though, the number of domestic livestock in these areas is limited.

The FarmReal project's main objective is to contribute to the preservation of the traditional agro-forestry system, where goat production, namely focused on cheese production using the milk produced by small herds, is a traditional activity and may contribute significantly for the economy of rural communities, while contributing for the prevention of forest fires. This is the case for the village Ferraria de São João.

FarmReal consists in an online platform that allows registered users to adopt and monitor the daily life of the herd of goats (in the pilot it was used the herd pertaining to the Association of Residents of Ferraria de São João).

The platform gives accurate and real time data on livestock grazing paths, provides the information needed to make quick decisions, ensuring that pasture is utilised in the best possible way and at same time create firebreaks– really important for fire prevention in Penela.

The animals' activities are monitored in real time through smart collars using internet of things (IoT).

The FarmReal user, in addition to the social added value of adopting an animal to help with the community's herd sustainability, there is environmental benefits from protecting the forestry areas against fires. Moreover, the platform has a recreational component, in which the user can observe the animal remotely, know its location, access data on its productivity and behaviours. The users may also physically visit the animals and engage in day-to-day activities carried out in the village.

The first phase of development was guided not only by the innovation in some of the technological solutions implemented, but above all by having the most adequate response to the needs of the community.

It should be noted that in addition to the direct benefit for goat farming in the region, there are also social, cultural and economic benefits for the region. Tourism is one of the main economic activities and the FarmReal platform can act as a mean of dissemination of locally produced products and of activities in which visitors and tourists can engage with the local inhabitants.

In short, it is believed that this initiative has the potential to improve the quality of life of the inhabitants of the village and the rural area.

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Context

SECTION

01

Goat grazing as a wildfire prevention tool

Introduction

The general response of most Mediterranean countries to the problem of an increasing number of fires and burned areas has generally been to strengthen fire suppression capacity (Costa Alcubierre et al. 2011). France, Greece, Italy, Spain and Portugal spend around 2 500 million Euros annually in the fight against forest fires, only 40% of which is invested in activities targeted to prevention (EFIMED 2012).

Despite the high investment to improve fire suppression, the phenomenon of forest fires is showing a progressively reduced time interval and increased severity. This context demonstrate that a different approach must be considered for addressing this problem.

Fuel treatment and wildfires minimization

One of the most appropriate approaches to wildfire prevention must be aimed at both reducing the possibility of a fire occurring and minimizing its spread should one occur. This can be achieved through fuel treatments (biomass reduction), which are paramount to wildfire decrease (Omi & Martinson 2002).

Fuel treatments are considered a key factor to decreasing wildfire risk (Omi & Joyce 2003) and to reduce the likelihood of fire spread. These treatments are mainly aimed at eliminating the vertical and horizontal continuity of forest biomass (low vegetation, woody fuel, shrub layer) in order to disrupt the vertical progression of fire (passage from surface to the tress canopies), and its horizontal progression, especially from crown to crown (Scott & Reinhardt 2001, Graham et al. 2004).

The range of possible treatments to modify forest fuels is rather wide. As an alternative to some techniques often perceived by the public opinion as aggressive such as prescribed fire (Knapp et al. 2009, Vélez 2010) or herbicides, the use of grazing animals could be an efficient method for controlling shrub invasion and reducing the risk of fire through the elimination of the biomass continuity.

All these practices are considered as “preventive silviculture”. Their main target is to modify fire behavior sufficiently so that wildfires can be more easily suppressed (Graham et al. 2004).

This report emphasizes the importance and the role of grazing, mainly by goats, as a prevention tool against wildfires. Goats can help to mitigate the devastation caused by wildfires by consuming forest fuels and, thus, creating discontinuities able to minimize the risk of fires and reducing their progression.

The role of grazing on fire prevention

Although goats for many years had a negative connotation since they can easily climb young trees and eat the leaves from branches, this species is, at the same time, the most suitable for this purpose because of its browsing ability, this is, its feeding from a variety of shrubs and predilection for woody forage (Dimanche & Coudour 2005).

The grazing of goats can impact the amount and arrangement of these fuels by ingestion or trampling (Nader et al. 2007). Grazing at moderate levels has been shown to change wildfire behavior, by slowing its spread, shortening flame length, and reducing fire intensity, although it does not significantly reduce the risk of fire ignition (SRCD 2006).

If properly managed, grazing can play a positive role on fire prevention. Grazing is probably the most ecologically sound technique for creating discontinuities in fuels, mainly at the shrubby layer, and disrupting fuel ladders. For this reason, it is officially considered as a wildfire prevention tool in some countries, e.g. Italy.

Use of goats for wildfire prevention

For wildfire prevention purposes, goats cannot merely be put out to eat a plant, it is needed an appropriate prescribed grazing system, taking in consideration factors such as season of the year, livestock density, social structure of herd, grazing time per day, type of fencing and size of pens (Taylor 2006).

The use of grazing as a wildfire prevention tool can either be treated as a short-term measure to reduce flammable vegetation or a long-term measure to change vegetation composition as it has to consider the need for ensuring the soil seed bank for annual plants. The main objective of wildfire prevention through grazing is to change fire behavior by the modification of the fuel composition (load, cover percentage and ladder configuration).

References are duly indicated in the main document.

The FarmReal Concept

SECTION

02

The FarmReal Concept

The online platform FarmReal represents an innovative solution for monitoring the removal of the excessive forest fuel by goats' grazing and, in this way, contribute to forest fire prevention. For this purpose, smart collars were developed with sensors and actuators capable of transmitting the animals' behavior by Internet of Things (IoT) technology.

In addition to assuming an essential role in the prevention of forest fires, this platform allows users to be “virtual shepherds” of real goats. By adopting a goat, users can follow its day-to-day life, monitor their behavior and socialization through updated photos and videos, be aware of its real time location, as well as the amount of vegetation deforested by the herd.

This comprehensive set of information gives shepherds a powerful tool to help make long-term herd management decision, that ensures both reduction of biomass and appropriate feeding of the milking goats. Data can be accessed on individual animals or on the herd as a whole. The platform provides graphs and reports on movement patterns, grazing routes, level of activity, distance traveled and time spent resting. Maps show routes traveled by animals during a given time period.

The FarmReal concept was designed through joint efforts from Instituto Pedro Nunes (technology developer) with the village Ferraria de São João and the Municipality of Penela. The platform was piloted in the real conditions of Ferraria de São João, using the herd own and managed by the Association of Residents (it can be considered a community heard).

Besides these objectives, and during the piloting phase, it was understood the importance of using FarmReal with a wider scope: to attract visitors and tourists to the village and rural area.

Validating FarmReal

SECTION
04

The FarmReal Solution

The identification and validation of current needs of the village Ferraria de São João enabled to co-design the corresponding specific key areas and functionalities of a user centric and integrated digital solution for smart farming and fire prevention, and also to tourism sustainable development.

The requirements documented in this report represent the features defined for the FarmReal platform. These requirements were co-developed with village stakeholders during 2021 and 2022.

Engineering Standards Specification

Safety

Standard	Use
Pet Friendly	In no way harmful to any animal
User Friendly	Cannot shock or harm the user

Communication

Standard	Use
RS232	GPS module interfacing
GNSS	Satellite signal communication
LoRaWAN	Data transfer from device to gateway
WIFI	Device tracking, short range

Data Format

Standard	Use
NMEA	Standardized GPS data format
LoRa	Standard LoRa
802.11	Standard WIFI

Design Methods

Standard	Use
LTspice	Circuit design
Teseo-Suite	GPS module configuration
Flutter	Smartphone application design
Atom-Pymakr	Programming Pycom
Eagle CAD	Schematic layout
Android Studio	Integrated development environment

Programming Languages

Standard	Use
C	NMEA data translation
MicroPython	Pycom programming
Dart	Flutter programming for application

Connector Standards

Standard	Use
RS232	GPS module to microcontroller interfacing
MicroUSB	Recharging of device

Technical validation of developed prototypes

The validation of the developed prototypes has been carried out by a pilot at Ferraria de São João. However, for demonstrative purposes, we present the pilot that took place in the period between January 14 and May 2, 2022, that used 5 smart collars, that included the installation of video cameras were installed in the immediate vicinity of the animals' grazing site and the aggregation, processing and video sending module installed in an indoor environment.

During the pilot, the animals were monitored daily by the collars and photos and videos.

The cameras transmit the videos, through a Wi-Fi *router* to the aggregation module, which, in turn, processes and temporarily stores the data until they are sent to the Web server, via 3.5G modem every hour during the day time.

At the same time, the *collars* acquire information regarding the goats' movements, grazing paths and GPS location. These data are aggregate from the

different nodes forming a WSN. Every two hours, the collected information is sent to the web server via GPRS.

On the web server, the information is validated, processed and stored in the database for later presentation on the web platform, together with additional videos and photos sent by a specific application on the shepherds Android devices.

Taking into account the presented scenario, the tests were carried out. (The systematization of information regarding the various modules of the web platform is presented with detail in the main document).

Below are some examples of images that can be displayed in FarmReal.

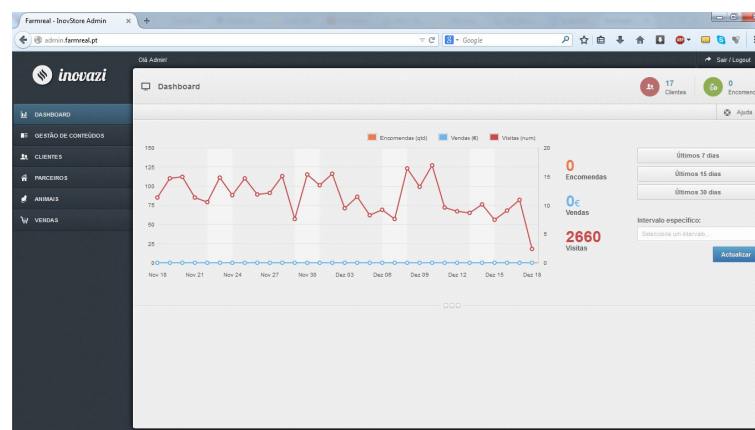
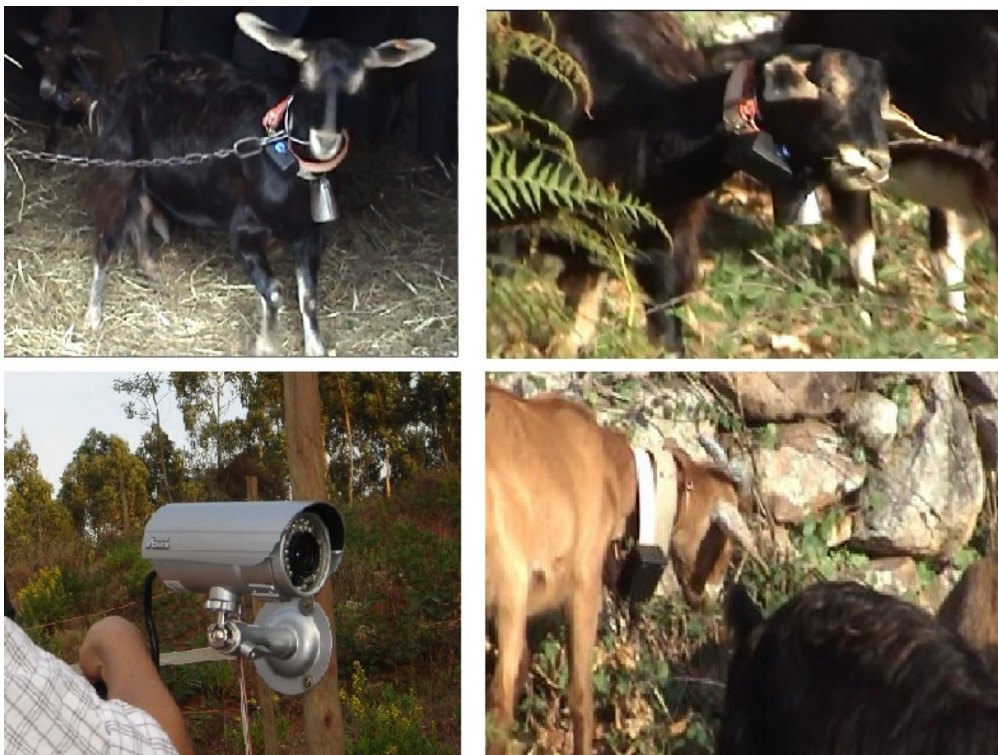


Figure 1– *Backoffice dashboard* with platform statistics.

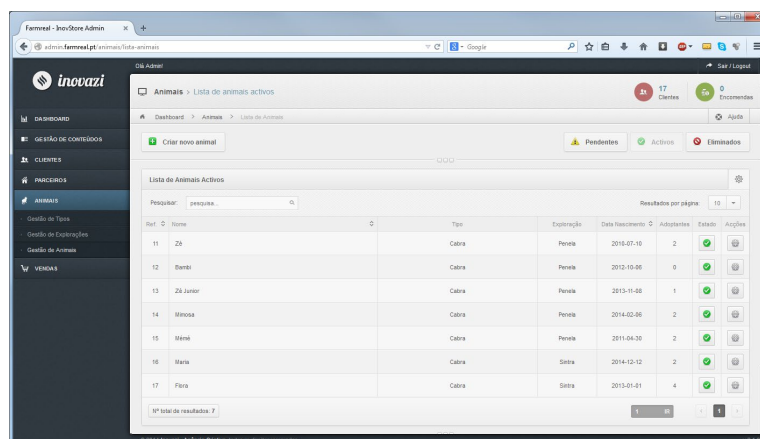


Figure 2– Animal management separator dashboard.

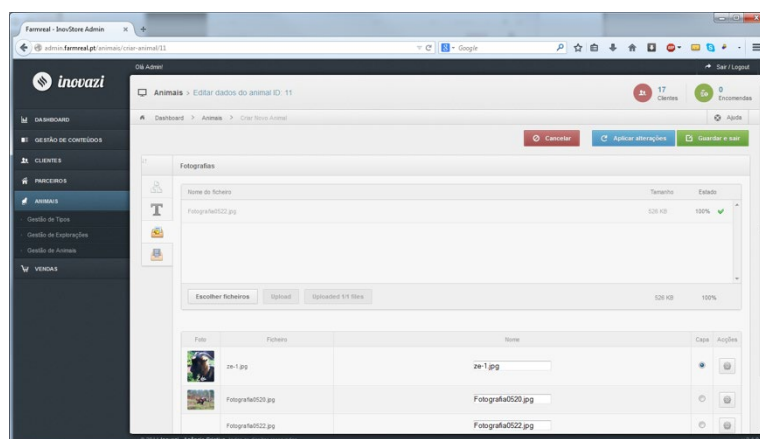


Figure 3– Dashboard separator for adding photos to animals.

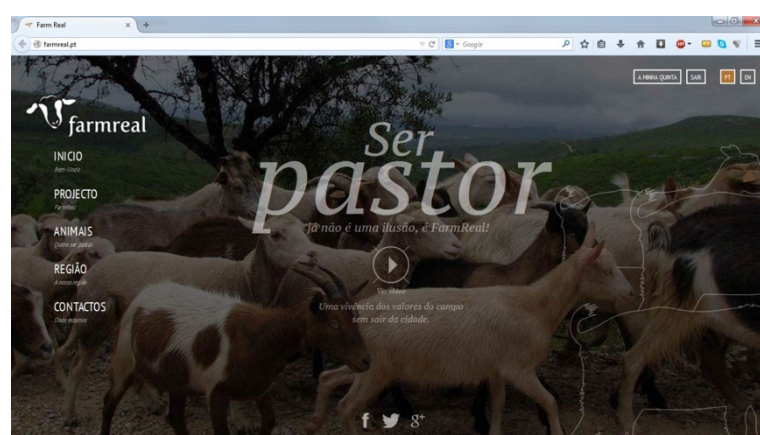
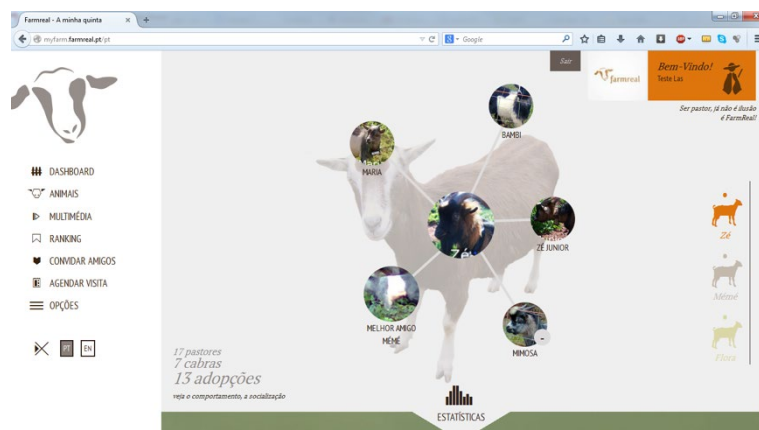
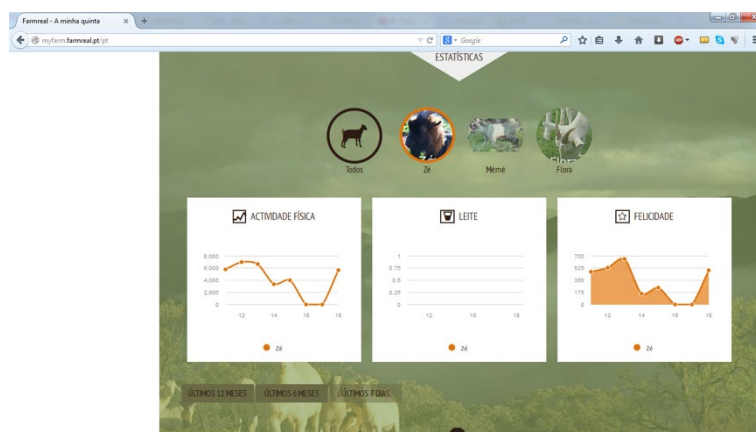


Figure 4– Platform home screen.

Figure 5– Animal adoption tab.

Figure 6– Animal socialization tab on the web platform *dashboard*.Figure 7– Animal statistics tab on the web platform *dashboard*.

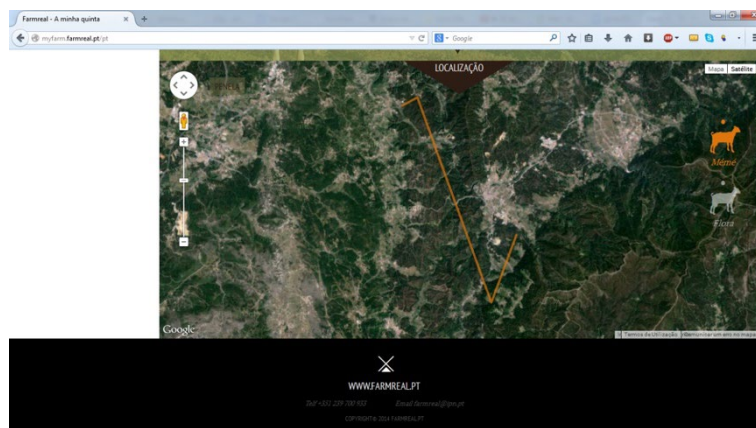


Figure 8 - Web platform *dashboard* location statistics tab .

Key Message from the technical validation

The test scenarios were built in order to validate in the field the implementation of all the requirements initially specified. With the execution of scenarios' testing, it was possible to carry out the validation of the system.

It is concluded that the project's objectives were fully achieved, with the development of the proposed system, having reached a high level of maturity, very close to the market.

Potential users' Feedback

For the acceptance tests, a testers group was created, where daily questions were posed, divided by themes, in order to create constructive discussions between the *testers*.

The themes were related to each of the menu entries (animals, adopting scheme, *dashboards*, images and videos, ...) and related to conceptual issues, namely the amount and types of adoption, types of adoption. In addition, it was made possible to have the exchange of ideas.

At the end of the testing phase, all data were analyzed and discussed internally. Consequently, the main result of this test phase was presented in the form of a list of possible *add-ons* to the FarmReal platform.

Data analysis was performed under the following topics:

1. Concept and acceptance: the functionality of the platform was mainly emphasized as a pedagogical aggregator factor, in which it is possible to increase the contact with the countryside;
2. Interaction: it was shown the importance of generating more data on the goats daily life, with positive repercussions to increase the milk productivity and animals' well being ;

3. Available features: the publicizing and possibility of participating in the daily routines of the herd together with the rural community was found important and very attractive;

Conclusion and next steps

Conducting acceptance tests was quite enriching and productive, even taking into account the risk assumed by the premature exposure of the platform to the web community. The testing phase proved to be essential for the good performance of the FarmReal project.

The steps taken were in the sense of implementing the conditions for the platform to embrace the new features, such as providing an area that allows users to book activities in the Village (e.g. cheese making workshops, bike tours, rural tourism).

IMPACT ASSESSMENT

SECTION

04

Impact Overview

Grazing as an efficient way to control the biomass excess in forestry areas

Prescribed goat grazing has the potential to be an ecologically and economically sustainable management tool for the local reduction of fuel loads.

During the pilot phase, the field testing has shown that (in average) each goat **graze 2,42 kg of biomass per day and clear 0,82 m² of forested area.**



Notwithstanding, prescribed goat grazing is complex and requires careful planning, monitoring and evaluation of the results.

The limitations of the fuel reduction by grazing is that it is expensive to maintain a community herd the difficulties are mainly linked with the lack of funds and available budget to do the actions designed. Thus, there is a higher territorial demand than the financial capacity to cover it.

Furthermore, it is also identified that there is a lack of human resources to cover the needs (from administrative technicians to forest workers).

A second limitation that was highlighted was the excess of bureaucracy to develop prevention actions (both, access to funds and to do forest works).

A third important limitation mentioned was the low business profitability and the low market value of some activities (e.g., grazing, resin and forest extraction, etc.), which makes these practices economically non-feasible.

The FarmReal web platform benefits

FarmReal aims to improve the uptake of digital technologies in goat farming and grazing.

The main points raised were related to:

- Foster and promote forest products and livestock as a natural, local and sustainable production, highlighting the added value that they have for the maintenance of the territory.
- Making changes in the funding model to better recognise the contribution of some activities to wildfire prevention.
- Promoting and increasing the revitalization of local economies and the development of marginal territories, either through ecotourism, recreational activities or new business models, while enhancing and managing biodiversity and priority habitats quality.
- Contributing to communicate and disseminate the lessons learnt to replicate this solution, tools and methods.

Using FarmReal to attract tourists and consumers:

One of the added value of FarmReal is that it be customized regarding different needs and interests of the villages.

FarmReal should not only be used as a fire prevention tool but as also a platform to showcase local attractions, activities and products. In the long-term, the FarmReal platform can support villages in various ways. The following are some examples:

- Provide alternative sources of income – Rural people are majorly dependent on farming and nonfarming activities for their livelihood. Rural tourism, therefore, could prove to be an alternative for diversifying community income sources.
- Balanced regional economic development – Development of rural tourism could be a stepping stone for the regions that lack resources to develop economically and socially.
- Means for social inclusion – FarmReal can also be used as a mechanism for making people aware of the local customs and traditions of a given territory. Alternatively, it can also be used as a mechanism to explain and demonstrate the lifestyle of the rural population.

Thank You

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