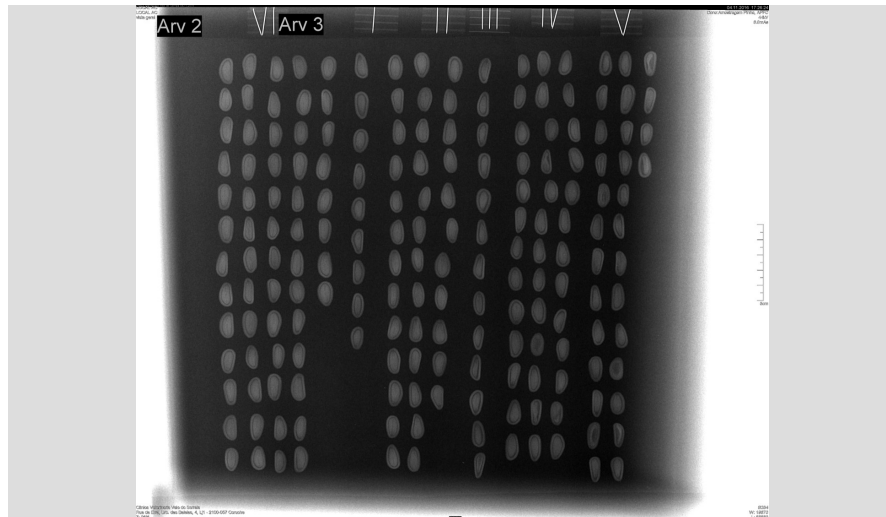


## Pine cone quality assessment with X-Ray



Conceição Santos Silva

### Keywords

forest nuts

orchard plantation

pine cone quality

X-Ray

*Pinus pinea* L.

wild harvested

### NWFP

Wild Nuts & Berries

### Scale

National

### Context

In recent years, stone pine cone buyers have reported a loss of [kernel per cone yield](#), associated with pests, namely the bug *Leptoglossus occidentalis* and/or climatic phenomena. This loss of income has a direct impact on the purchase price of pine cones from producers, and there are currently no mechanisms for assessing kernel yield a priori at the property level. The knowledge of the real yield is an information only available to the industrial after processing the pine cone in batches at the factory. As the pine cone market price begun to decrease due to the alleged yield decrease, farmers need information about their pine cones quality before selling.

### Objective

The objective is to analyze the possibility of modeling the kernel weight from biometric and morphological parameters of the pine nuts from *Pinus pinea*, measured through X – ray and image analysis. The overall objective is to support the definition of a pine cone quality assessment methodology at the stand/ farm level in order to provide the landowners with tools for pine cone commercialization and increase by this mean the market transparency.

## Results

With the present work it was possible to conclude on:

- the variability of the pine cone yield in pine nuts between sites and between trees in the same site;
- the use of X-ray technology applied to inshell pine nuts, where it is possible to identify sound and damaged pine nuts;
- the potential of seed image analysis tools, available in open source, namely SmartGrain to perform inshell pine nuts measurements from X-ray images;
- the possibility of reliably estimate the kernel weight from the measurement of the outer area of the sound inshell pine nuts (without damage), identified through visual X-ray analysis.

The relationship between the modeled variables - weight of kernels by area of sound pine nuts - is a linear relationship, with the model presenting a high coefficient of determination ( $R^2 = 0.83$ ).

## Recommendations

- As the pine cone yield in pine nuts kernels varies between farms and years, the pine cone sampling must occur annually at the farm level;
- Adequate amounts of pine cones must be processed to obtain a representative value for the pine cone yield from the sample: at least 30 pine cones randomly collected, but in some cases this quantity is not sufficient to obtain reliable yield values (this study was performed with 60 pine cones/ site);
- Annual sampling is needed in the pine cone harvesting season;
- Empty shelled pine nuts float in water, being an easy way to a first assessment of the pine cone yield, but the X-ray is needed in a second stage to identify the damaged pine nuts (e.g. partially developed, destroyed or consumed by *Leptoglossus*);
- Awareness of the intensity of annual pest attacks is important to avoid perform business based in unreliable information.

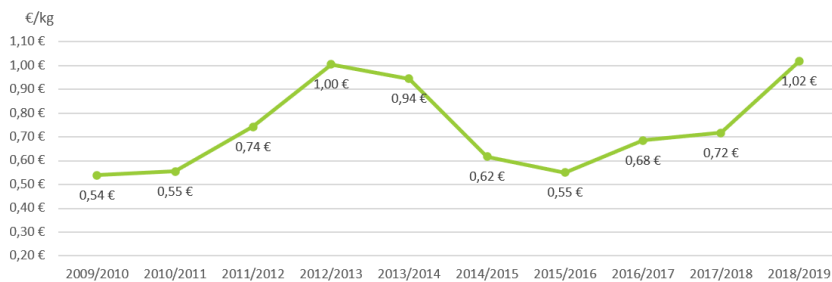
## Impacts and weaknesses

The simplicity of the model, with a small number of variables, potentiates its wide use by forest producers. The cost-benefit analysis of sampling the quality of the pine cone may translate into an increase in the financial return for producers when the pine cones with best yields are commercialized. The pine cone market still needs to evolve in terms of differentiating prices by qualities and increasing transparency in the trading of pine cones, namely by the disappearance of hidden margins associated with the lack of knowledge of the actual quantity traded or the moisture content of the pine cone, in addition to the estimate of pine cone yield.

## Future developments

The sample size is a very relevant aspect in the sampling and must be dependent on the variability of the parameter to be estimated. Additional work in this area is necessary to guarantee the representativeness of the sample as well as the protocols to be implemented for the sampling methodology in stone pine stands, to assess the yield of pine cone in pine nut at the farm level.

The development of automatic classification processes for the segregation of sound and damaged pine trees based on the X-ray will allow a larger number of samples to be taken and a quicker results delivery to the landowners.



Annual pine cone market price evolution in Portugal between 2009 - 2019. UNAC (2019)

## Further information

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## About INCREDIBLE Project

INCREDIBLE project aims to show how Non-Wood Forest Products (NWFP) can play an important role in supporting sustainable forest management and rural development, by creating networks to share and exchange knowledge and expertise. 'Innovation Networks of Cork, Resins and Edibles in the Mediterranean basin' (INCREDIBLE) promotes cross-sectoral collaboration and innovation to highlight the value and potential of NWFPs in the region.



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