EXPLORATORY ANALYSIS OF CITRUS FARMING AMIDST THE "GREENING" PROBLEM IN POLK COUNTY, FLORIDA

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INTRODUCTION

Florida's signature citrus industry has a tremendous value for the state's economy and contributes substantially to employment opportunities. However, the industry has been threatened by the endemic presence of Huanglongbing (HLB), a fatal vascular disease responsible for the worst citrus harvest crisis in the state in a century. Since the establishment of the disease-causing bacterium known as *Candidatus* Liberibacter asiaticus in Florida in 2005, the disease has caused a colossal economic, environmental and social impact (Bové, 2006). Also known as the citrus "greening", the disease has jeopardized the citrus industry of more than 40 countries around the world (Bové, 2006). Despite over 90 years of research, there is no knowledge of many parameters necessary to develop efficient management measures. It is estimated that 95% of the commercial groves are affected by the "greening" disease (NIFA, 2017), which can be transmitted via grafting, dodder, seed, and *Diaphora citri*, the natural vector Asian citrus psyllid (Figs. 1&2). According to researches, if no remedy for HLB will be found in the next 10 years, by 2025/26 there will be a drop of ~ 90% in orange and grapefruit production compared to the harvest of 2003/04 (Spreen and Zansler, 2015). Considering the degree of devastation of the greening disease with symptoms detectable in the leaves, fruits, or the tree (Fig. 3-5), the guiding axis of this research aims to explore and analyze existing data on the business status, the technologies available to help the existing problem, and the processes used by organizations who are directly and/or indirectly involved in the business planning in the citrus industry of Polk County and the state of Florida.

OBJECTIVES

• Understand and analyze the current situation of the citrus farming industry in Polk County and the state of Florida amidst the challenges brought by the "greening" problem.
• Elaborate a conceptual framework of the possible actions/programs that need to be put in place that can serve as a guiding template for various sectors and stakeholders in finding a better solution to the existing problem.

METHODOLOGY

• The Data was derived from scientific literature, governmental and local sources, such as the United States Department of Agriculture (USDA) and Institute of Food and Agriculture Science (UF/IFAS).
• An email interview was conducted with the Citrus Health Management Areas (CHMA) extension agent in Polk county, Chris Oswalt.
• Records were collected using data available at the National Agriculture Statistics Services (NASS) website - Florida Citrus Statistics from 2003/04 to 2016/17.
• Data analysis and visualization were created using the R statistical programming language

Fig. 1. Image of the adult stage of *Diaphora citri*.

Fig. 2. Image of the nimph stage of *Diaphora citri*.

Fig. 3. Image showing the symptoms of fruits.

Fig. 4. Image showing the symptoms of leaves.

RESULTS

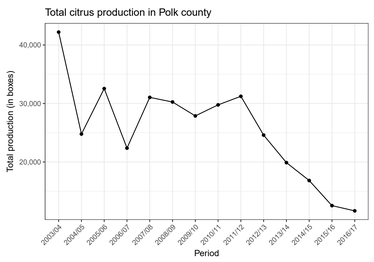

Fig. 6. Citrus production in Polk County from 2003/04 to 2016/17.

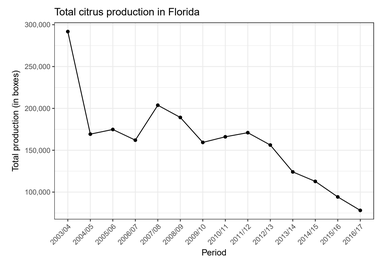

Fig. 7. Citrus production in Florida County from 2003/04 to 2016/17.

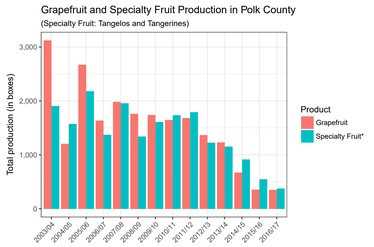

Fig. 8. Grapefruit and Specialty Fruit production in Polk County from 2003/04 to 2016/17.

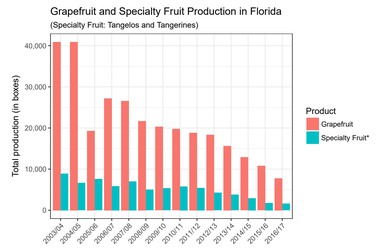

Fig. 9. Grapefruit and Specialty Fruit production in Florida from 2003/04 to 2016/17.

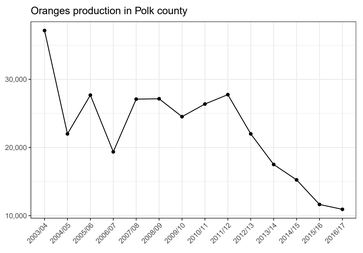

Fig. 10. Orange production in Polk County from 2003/04 to 2016/17.

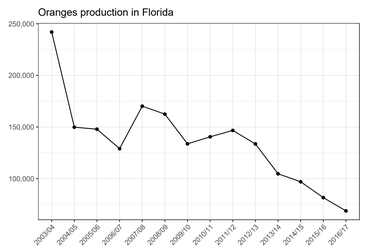

Fig. 11. Orange production in Florida from 2003/04 to 2016/17.

•As shown in Figs. 6 – 7, results of the data analyses showed a decrease of ~74% in citrus production in 13 years in Polk County and in the state of Florida. The same decreasing pattern was observed through the years in orange, grapefruit, and specialty fruit production (Fig. 8-11).

Further analysis of available information/data also showed that:

•In 2015/16 only 45,422 jobs were created for both full-time and part-time (Court et al., 2017) compared to 2003/2004's 76,336 jobs, accounting a 40% decrease in employment contribution (Hodges et al., 2006).
•The University of Florida is the local institution that plays an essential role in helping the Florida citrus industry. It has several research and extension centers that operate on the HLB issue.
•At the state level, the Florida Department of Agriculture and Consumer Services (FDACS) and the Florida Department of Citrus (FDOC) are institutions that promote the citrus industry by assisting growers and stimulating scientific research.
•At the national level, the United States Department of Agriculture (USDA) is the agricultural development center of the country and it is branched out into several agencies. The National Agricultural Statistics Service (NASS) conducts hundreds of accurate surveys covering several aspects of Florida's citrus industry.
•Local farmer partnerships provided by grower's associations ensure practical communication for joint decision-making. These organizations serve as a tool for aligning intervention measures based on scientific knowledge.

Fig. 5. Image showing an affected tree.

DISCUSSION

• It is very clear from the results of the data analyses that the "greening" problem has tremendously affected not only the citrus production in Polk County and the entire state of Florida but also the decline in other fruit production in the area. This seems to correlate with the loss of jobs that undoubtedly affected the economy and the lives of Floridians in general.
• There is no data on the monitoring of physical-chemical properties of trees and soil, the percentages of the trees age, the relation between the differences in the infection between trees of different ages, and information on patterns of the disease spread in Polk County.
• ERADICATION: All trees that show the disease's symptoms at less than 4 years old, are not bearing fruit or are infected up to 50-70% must be eradicated and replaced. Infected older trees must be intensively pruned. However, this method aims to eradicate only organisms that are already expressing symptoms and does not consider organisms in the period prior to the symptoms expression, the cryptic period. Little is known about this latent period, which can last several months depending on the age of the tree. During this period, conventional detection methods do not work, making the spread of disease between organisms and farms uncontrollable.
• VECTOR CONTROL: By means of chemical or biological measures, the absolute eradication of the prolific natural vector *Diaphorina Citri* is probably impossible. On the other hand, the synchronized chemical applications between the neighboring farms reveled to be more effective in controlling the *D. citri* population. Although timing of pesticides is critical, there is not enough research with "soft" (environmentally friendly) pesticides. Also, as the psyllid develops resistance to the pesticides, the growers are finding the sprays less and less effective.

RECOMMENDED ACTION PLAN

Short-term measures:

•A semiannual monitoring should be undertaken by the CHRP-UF (Citrus Health Response Program) pest eradication and control team of each county in all active groves. The eradication and pruning parameters continue the same as previously mentioned.
•The synchronization of pesticide applications in crops must be monitored and demanded by the CHMA-UF (Citrus Health Management Areas) and the region's citrus planter community in local grower associations meetings. It is tremendously important to carry out semiannual analysis of *D. citri* concentration change patterns to identify the effectiveness of chemicals applications.

Long-term measures:

•Standardize scientific researches and increase research funding by NIFA (National Institute of Food and Agriculture), FDACS (Florida Department of Agriculture and Consumer Service), and other investors. Research in the areas related to the development of effective antibiotics, vector control measures and the broadening of the understanding about cryptic period for early disease detection should be strongly encouraged to create more affirmative strategies.
•Following the development of stable antibiotic, a robotic operating system aiming a large-scale targeted drug delivery must be implemented. The first stage of the system would be based on sampling directly from the sap within the phloem in different parts of the tree. Since HLB is a vascular disease, with the extraction of sap samples, it would be possible to develop a software capable of identifying the presence of the bacteria. This way the robot would be able to provide treatment in real-time in the affected parts within the vascular system of the organism by injecting the antibiotic (M.D. Horton, personal communication, December 1, 2018).

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