

Predicting and Modeling the Spread of *Tuta Absoluta* in the United States

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Background

Tuta Absoluta

- The tomato leafminer moth which is native to South America and that spread to Europe, Africa, and Asia rapidly
- Currently in at least 80 countries, where it destroys tomato fields
- Although there are some predators, they have not yet been successfully used

Previous Work

- Up to this point, Dr. Adiga and his colleagues have created a model for Senegal, Nepal, and other Asian countries
- This model was based upon a gravity model, and was heavily limited by a lack of data

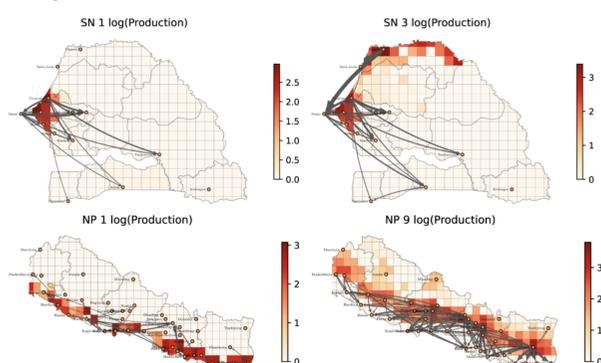


Figure #1

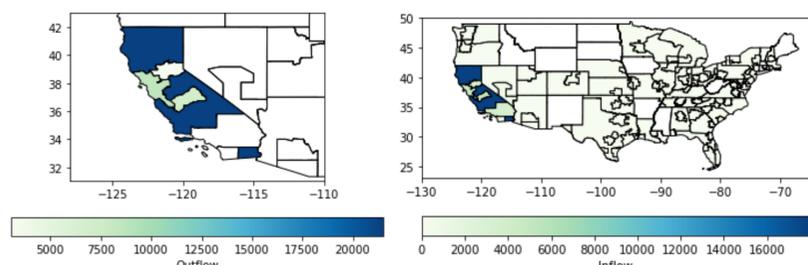
United States Model

- Meant to continue on the previous work and to improve upon it, as the U.S. has much more data publicly available
- Although currently not in the U.S., there is concern that the U.S. tomato market could be significantly impacted by its exposure to *Tuta*
- Plan to create a model that represents how *Tuta* might spread in the U.S. if it was introduced, so that its spread could be prevented

Future Work

Disaggregation

- Currently, there is a lot more that can be improved for our temporal and spatial disaggregation of tomato flows in the U.S.
- We would like to find more data on production, imports, exports, and other similar factors, if possible, as more data can help with construction of our model and with validation of results
- If our disaggregation is good, we may be able to use our method to disaggregate FAF into any commodity, not just tomatoes



Figures #2 & 3

Simulator and U.S. Model

- We still need to finish updating the simulator, but we would like to run it on a model for the U.S., and see how *Tuta* spreads
- Ideally, our findings would lead to the basis for future spread models with different pests and different commodities

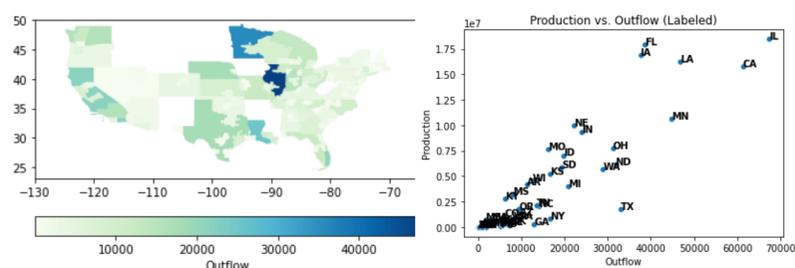
References

- Adiga, A. et al. (2022). Realistic Commodity Flow Networks to Assess Vulnerability of Food Systems. *Studies in Computational Intelligence*, vol 1015. Springer, Cham. https://doi.org/10.1007/978-3-030-93409-5_15
- CA AgStats, https://www.cdfa.ca.gov/Statistics/PDFs/2021_Ag_Stats_Review.pdf
- Freight Analysis Framework. <https://faf.ornl.gov/faf5/>
- NASS VegeSumm, CropSumm, and PotatoSumm. https://www.nass.usda.gov/Publications/Todays_Reports/reports/vegean18.pdf, https://www.nass.usda.gov/Publications/Todays_Reports/reports/pots0918.pdf, <https://downloads.usda.library.cornell.edu/usda-esmis/files/k3569432s/sn00c1252/g158cj98r/cropan22.pdf>
- Dispersal Ecology and Evolution. Eds. Clobert, Jean, Michel Baguette, Tim G. Benton, and James M. Bullock. "Ch 15: Dispersal kernels: review." <https://oxford.universitypressscholarship.com/view/10.1093/acprof:oso/9780199608898.001.0001/acprof-9780199608898>

Current Work

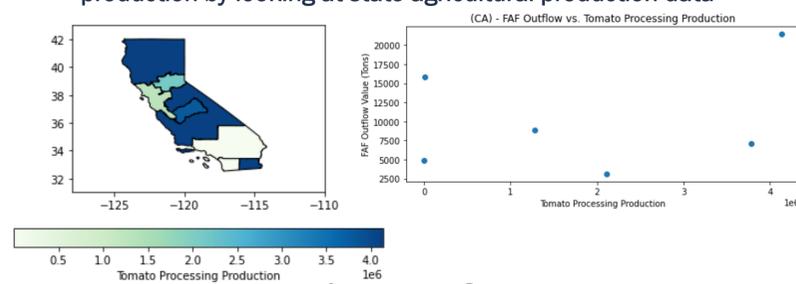
Data Analysis

- The main idea behind the data analysis was to look at various data sources to see how tomatoes were traded in the U.S.
- By seeing the tomato trade flow in the U.S., we would be able to know how *Tuta* might spread throughout states and from state to state from trade alone
- Focused work on a few data sources, primarily the Freight Analysis Framework (FAF), which has data on how freight moves throughout the U.S.
- The main problem with this dataset was that the flows are not disaggregated spatially, temporally, or by specific commodities
- Created correlation and regression studies to try and create good predictors for the inflow and outflow of each state



Figures #4 & 5

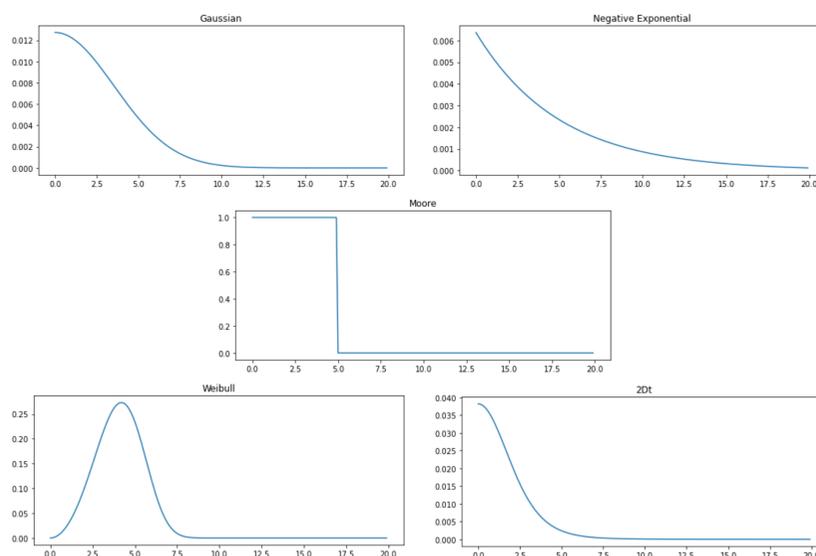
- Begun work on spatial and temporal disaggregation for tomato production by looking at state agricultural production data



Figures #6 & 7

Simulator

- The data analysis performed is meant to inform a simulator that has been used for previous studies by Dr. Adiga and his colleagues
- There are two main ways that *Tuta* spreads in the model: by moving naturally or by being spread from trade
- The trade flow data would inform the trade component, and then some algorithm would represent the shorter-distance spread
- Added functionality that would enable SEI model to change from E -> I on a probabilistic rate
- The model currently uses Moore neighborhoods to represent the short-distance spread of *Tuta*, so I have begun work on implementing different dispersal kernel models to represent the flow of *Tuta*



Figures #8-12

a (scale parameter) = 5, b (shape parameter) = 4