Response to UAB Grand Challenge

Lifting Alabama's Economy through Smart Farming

Steve Watts (Biology, sawatts@uab.edu) and

Yuliang Zheng (Computer Science, yzheng@uab.edu)

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Need for smart farming

For millennia, food has been produced in fields and farms. These traditional farms are typically two-dimensional in geometry, and their productivity is mostly dependent on the nature as well as on luck. Globally, population growth, climate change and geopolitical instability are posing enormous challenges to traditional food production. Here in the US the impact of climate change and depletion of ground water has already been felt in America's bread basket the Midwest ("U.S. Bread Basket Shifts Thanks to Climate Change", December 2015, Scientific American). In many other parts of the world, loss of farmland due to urbanization, land and water pollution, desertification, climate change and the failure of the State coupled with population explosion has contributed to the growing shortage of food.

Vertical farming has been proposed as a solution for sustainable farming with high productivity. Although it has been experimented in major population centers including New York, Los Angeles and Tokyo, primary products of vertical farming have been mostly limited to fast growing vegetables such as lettuce and garden cress. Another challenge that impedes the wider spread adoption of vertical farming is its relatively large consumption of electricity. It is therefore a yet to be solved open problem to find a new paradigm for farming and food production that is

- highly productive,
- sustainable,
- energy efficient.

And above all it can produce a wide variety of food including

- grains,
- vegetables,
- animals and
- seafood

and ultimately protein.

Why Alabama and UAB

Alabama is well positioned to take advantage of smart farming thanks to many favorable conditions. Its summers are relatively hot and humid, winters are mild and it enjoys a high number of annual sunshine days (around 210). These natural conditions are all important for

reducing reliance on electricity. The State has a multiple number of rivers running through it, providing necessary water supply for smart farming. Its labor and living costs are both competitive. In addition, it is close to major population centers in the southern and southeastern United States, minimizing transportation costs of produces.

Homeland Security expects population shifts to the southeast over the next two decades. We in this state must be ready to support growing populations to avoid conflicts like those seen in Southern California between urban and agricultural water use.

Future smart farming requires an interdisciplinary approach, including biology, computer and data sciences, engineering and nutrition science. UAB has expertise in all the areas required to take up the challenge.

Impact of the project

According to WalletHub.com, Alabama's economy is ranked #41 among all the 50 states in 2017. To improve the ranking the State must think outside of the box.

In the long history of technological advancement, there are numerous examples where the incumbent in an industry is dethroned by an innovative newcomer who makes disruptive progress (think of Motorola, a communication company that invented cell phone, was unseated by Apple, a computer company that had previously had no experience in communication).

We believe that smart farming provides a potential opportunity for Alabama to surpass its peers in the economic stacking order, and UAB can play the role of a disruptive innovator in this new farming revolution to help move the State's economy upward into the top 15 or 70^{th} percentile by 2040.

Specific research areas

- Large scale protein production.
- Large scale mixed seafood production.
- Efficient and resilient smart farms using artificial intelligence, Internet of Things, big data science, robots and drones, solar, wind and tidal energy.
- Resilient and efficient food supply and consumption chain that employs the latest technology including sensors, Internet of Things, data analytics and blockchain to minimize food waste (currently 40% of agricultural products lost to spoilage and other factors).
- Nutrition and health centered food synthesis using 3D printing.

Project Team

Additional members from various parts of UAB with expertise required will be added.