How Dr. Carolyn Mutter and Her Colleagues Help Feed the World

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Agriculture is the world's largest industry; over 30 percent of the global population works in an agrarian related field [1]. Creating predictions in regard to future production is a key feature of every industry; unfortunately, agriculture appears to have the most confounds impeding its growth, especially climate change. It is apparent that the sustainability of crop-abundance and food-availability are severely affected by changes in atmosphere.

However, climate change isn't the only factor in determining the success of future crops. Many other variables such as parasites, diseases, technology, natural disasters, war, energy costs, trade, and acts of terrorism can threaten increasing agrarian production, especially in developing nations. Economic disparagement of agricultural communities in developing nations has prompted prevention-based analysis and of these hazards; this creates the driving force behind agricultural modeling. Dr. Carolyn Mutter, an international program manager for a community of agricultural systems modelers, discusses her role in predicting changes in agriculture and the implications of dismissing the future.

Modeling unveils socioeconomic polarities in agricultural production between the global north and south

Models are utilized to better understand complex, non-linear systems with multiple variables and confounds. The agricultural models Mutter examines anticipate future conditions in quality and availability of food globally as well as in specific regions of the world. By examining various regions around the globe, Mutter, alongside, others in her community, can examine the socio-economic polarity of climate change. She mentions that her research has led her to South Asia and Sub-Saharan Africa; through traveling to these countries herself, Mutter and her colleagues have been able to "successfully engage local, state, and/or national decision-makers" and alter the funding and agricultural behavior of foreign nations, which helps to guide the direction of research in developing countries. Through the consultation of agricultural modelers, the global south has developed a capability to improve upon problematic agricultural practices, and garnered the ability to produce crops more efficiently, even in the face of western manipulation, capitalist interests, and dramatic climate shifts.

Upon examining the BLS world food trade system model and the HadCM3 global climate model, the standard models for examining agricultural effects on a macro level, it is evident that there is a strong increase in the polarity of food availability between opposing socioeconomic classes [2]. As time passes, this gap in food availability between both developed and developing nations will become an increasingly dire issue.

Photo courtesy of Carolyn Mutter

By 2080 it is projected that the northern hemisphere, on average, will be 2°C cooler than the southern hemisphere. This temperature disparity will decrease cereal crop yields — by approximately 10 percent in the southern hemisphere [2]. The agrarian burden of the south is rising too. In 1980 the southern hemisphere only accounted for 20 percent of the world's soybean production, 18 percent of the world's maize production, and 15 percent of wheat exports; those numbers have now risen to 50 percent, 33 percent, and 25 percent, respectively [3]. Studying the differences in models of both developing and developed nations can help scientists like Dr. Mutter understand how to amend future issues in agricultural production and equality.

Modeling is not a one-way street

Models are key to predicting future outcomes in any field, and

like most models, agricultural models rarely form uniform results when examining the same outcome scenario.

"This is important, because the inter-comparison of these model's differences can lead to greater understanding of the underlying systems and helps with overall improvement in the way the models work," Mutter said.

The need to study the model's themselves, as opposed to their solutions, is rendered necessary through this point. Without an accurate base data, created by examining different parameters, it is impossible to create universal measures to bolster agricultural production in different parts of the globe and in different socioeconomic territories. By studying these models, scientists are able to garner an accurate perception of what could happen and propose remediation steps.

System 'shocks' and their effects on production

Currently, Mutter is focusing on a new aspect of modeling which includes system "shocks." According to Mutter, while "agriculture can be devastated by floods, droughts, pests, or disease" and these issues pose a large threat to creating self-sustainability within developing nations, geopolitical shocks can also be significant.

"The availability of affordable and nutritious food can [also] be impacted by shifts in trade policy, spikes in energy costs, and socio-political actions and outcomes (eg. terrorist attacks, war, etc.)," Mutter said.

Mutter states how these 'human caused shocks' are often linked and not easily predicted in current modeling methods. Due to a lacking relevance of old modeling methods in predicting shocks, a new aspect of her career is developing a modeling system to accurately predict the impact of certain shocks and the frequency at which they may occur. Shocks may not impact those in the EU and U.S. significantly, but their consequences can be dire for those inhabiting the global south.

According to Mutter, the west generally views these 'shocks' as isolated instances that rarely have a permanent impact on the sustainability of agriculture. This perspective reinforces the unequal distribution of environmental burden on communities in varying economic states. The occurrences of droughts and extreme heat result in, on average, a approximate 10 percent national decrease in the cereal crop yields of developed nations while in developing nations this decrease is 8 - 10 percent more severe [4].

According to the Federal Agricultural organization; agricultural practices make up about 30 percent of the GPA in developing nations, and generally, the agricultural sector absorbs 22 percent of the damage caused by natural disasters [5]. Two continents who exemplify the global south: Africa and Asia have agricultural systems that are affected heavily by environmental disasters; Africa lost 3.9 percent of its overall agrarian production in 2015, while Asia lost 3.8 percent of its overall agrarian production. As the pressure of agricultural production falls onto the global south, each of these 'shock' scenarios can have compounding effects.

The nutritional degradation of global agricultural yields

Changes in climate have also resulted in the removal of nutrients from produce; this has become an ever-prevalent issue in the eyes of those studying climate change.

"I found a pathway to that [agricultural modeling] by shifting to the work involving the modeling of current and changing climate, and then to a focus on agricultural, food, and nutrition systems," Mutter said.

Her focus shows the specific effects of our changing ecosystems and illustrates that the sustainability of nutritional content is an important feature in food sustainability. A trend in decreasing nutritional content of produce is due to the alteration of cycles native to each area; the changing of these cycles can cause both temporal, niche, and physical changes in the growth of fruiting plants. In northern Europe, changes in the atmosphere and other conditions have caused their springs to carry increased rainfall, effectively waterlogging and deoxygenating the soil; while their summers are tremendously hotter, stripping the soils of microbial activity [6].

These fluctuations in water saturation mainly strip the soil of its carbon content and oxygen concentration, while disabling the uptake of other minerals. In Eastern Africa, with the world's highest prevalence of undernourishment hovers around 31.4 percent; this is due to the harsh conditions facing the crops grown there and the drastic fluctuations in climate. One solution may be to introduce drought-resistant crops to the area; but a funding crisis makes universal distribution of resilient seeds and a goal of making the world hunger free by 2030 impossible [7]. Nutrition is key to the development of a healthy and happy population carrying economic success; without the proper acquisition of nutrients it is impossible for people to maintain their health.

Funding dilemmas under the current administration

The research system in the United States is highly dependent on political and federal expenditures; this can be detrimental towards scientific advancement.

"Funding of US-based scientists in studies in climate and agriculture is of a lesser percentage than in many European countries," Mutter said.

This is because each executive administration has their own viewpoint on the funding they contribute to NSF funded projects. Recently in March, Caitlyn Fife, the National Science Foundation's (NSF) Budgeting Division Director noted the reduced funding environment [8]. The current administration has reduced the scientific funding, dedicated toward NSF projects, by around 12 percent, or 1 billion dollars. The Environmental Protection Agency (EPA) — received a 39 percent budget cut in 2018, their budget currently stands around 8.5 billion dollars [4] (this is in contrast to the current budget of the United States Military at 686.1 billion dollars [9]). The budgeting reductions of our current administration significantly reduces the allocation of the EPA's funds towards university grants.

"The continued intervention of private organizations and international governments has enabled the uninterrupted continuation of research," Mutter said.

A glimmer of hope for the future of agriculture

Agricultural modeling encourages both collaborative behavior be-

tween different scientific fields and preemptive action in the face of diminishing food supplies and equality. The action taken by projective analysis, such as advanced irrigation techniques, farming with nutrient rich substrate, drought-resistant seed varieties, and diversification of income resources can help future farmers, especially those in developing countries [10]. If these motions are taken by either public or private agencies, the impending risk associated with agriculture may be significantly reduced, and the rising economic burden on the agrarian global south may be quelled.

Mutter's job is vital to global expansion and the topic of food equality. By examining agricultural systems and forming projections about crop yields, calamity is avoided and food is distributed with egalitarian considerations. Mutter's work demonstrates the global responsibility to act preventatively in response to international crises.

Mutter attests to the importance to assess the gravity of agricultural situations and how they disproportionately affect people in the global south; these multifaceted issues take meticulous data accumulation to surmise and have received limited funding in the current west. It is an uphill battle to preserve food security within developing nations and the surmounting environmental issues of the underprivileged will soon threaten food security of developed nations. An unpredicted natural disaster could reap catastrophic effects on even the most sophisticated of agricultural systems.