

# TEACHING 'AGRICULTURE AND RENEWABLE RESOURCES' AT CORNELL UNIVERSITY



SAMIR SOMAIYA

In 2007, I was invited by Professor Paulette Clancy, the then Director of the School of Chemical Engineering to teach a one credit course on Agriculture and Renewable Resources. This would be spread over one month, and would be classified as a Master's level course in the School of Chemical Engineering. Professor Lynden Archer, the present Director also continues the invitation.

American Universities, and Cornell among them, have a lot of flexibility in introducing new courses and to invite faculty to enrich their curriculum, and to give their students a wider perspective on their own field, and the world around them. The course is also open to the entire University, as well as to younger students (3rd year Engineering students onwards). In the past few times that I have taught this course, I have had students from third year engineering to faculty come take this course, and I have had students from Chemical Engineering, Civil and Environmental Engineering, Business Management, City and Regional Planning take this course.

When I accepted the invitation, I thought that teaching would be easy, and that like other faculty, I would come in, say my piece, and that was that. Now, after having accepted the invitation, I was asked to submit my

'lesson plan', meaning, what would I teach in each lecture, and what the readings for each lecture would be, so that students would come to each class ready for the discussion to be had. In every class, I have changed the readings, since the world changes so dramatically, so even though the course skeleton remains the same, the context, the readings, the world has changed.


I thought deeply, about what I would teach, and in which manner. I also thought, that I would keep the course technical, but given that there was already too much science that the students would be learning in their other class work, and that I may have students from other fields, I should keep the technical details simple. I also thought, that I will explain using sugarcane as a feedstock (what I know very well), but the lessons that I would teach, would be applicable to any other feedstocks).

I started by explaining, that there is always a context in which an economy operates. That is defined by the geography, climate, people, demography, and Government policy. For example, if the Government of India creates a ethanol blending programme, that is a policy that creates a market. Similarly, if Brazil has created a minimum blend of 20% of ethanol in its gasoline, and also made a fuel policy so ethanol can be sold as a fuel or in varying blends, this is also a Government policy that creates a market. I also spoke in the past of the EU sugar export subsidy programme, that had the result of distorting international

markets of sugar. These policies, in the context of a country's larger demography, create opportunity in which a chemical engineer, an entrepreneur, can innovate. About 10 years ago, there was not much of an ethanol programme from corn in the USA. But with the announcement of a Renewable Fuel Standard, the ethanol programme in the USA became one of the largest in the world. I would give students readings, of such policies so that they understand this.

I would then explain processing of agriculture as distinct from the use of fossil resources. These are fundamentally different. If the earth is well taken care of, then it has the power to continue to give us resources equal or more to the year before. As I mentioned, this is different from fossil resources, which will always be less going forward, and depleting. That is the key difference between renewable, and depleting resources. And that is also explained. Fossil resources focus on discovery and extraction, whereas renewable resources focus of regeneration and extraction.

I would use sugarcane as a case study, and explain how this is used to make sugar. I would explain the technology, and the mass and energy balances around the mill. In subsequent lectures, like peeling an onion, I would show different facets of the feedstock. For example, I would explain fermentation of molasses (or sugarcane juice) to make ethanol, and the economics of the same as complements, or substitutes, and why one would choose what product mix, and once again, why Government



policy and the local demand supply makes the difference. I would explain the debate between food (sugar) and energy (biofuels). Debate on whether use of agricultural resources are taking away from food would also be discussed in the overall context of the population, and what contributes to their broader welfare.

In a subsequent lecture, I would explain how the bagasse can be used to create surplus power, by burning the same in high pressure turbines, and how Government policies enabling the purchase of power spurred that investment. This discussion would also then lead to discussions on global warming, carbon credits, and why projects such as the cogeneration of power in a cane sugar mill are greenhouse gas mitigating projects. Each of these lectures has detailed discussion in how the mass and energy balance change, with the introduction of a new facet (molasses fermentation, high pressure cogeneration of power) and its consequent effect on economics, and the creation of value.

I then place this in the context of social development, and the productivity on the farm. Agricultural resources are grown, and true stewardship would need the intersection of biology, agronomy, sociology, alongside chemical engineering. Using papers of C K Prahalad and Stuart Hart on 'Fortune at the Bottom of the Pyramid' I would engage the class in a discussion on how resources are plentiful, and we would need to create this bio-economy, one that creates value and contributes to the overall development



of the economy, with due emphasis on the triple bottom line.

Finally, I would explain the amazing world of the future, of bioplastics, of cellulose based bio-refining, of synthetic biology, of green solvents and green plasticisers. I would challenge the students to think of some context, with some agriculture based feedstocks, to be processed into some product that would be converted into a product that world needs, while simultaneously contributing to the development of the people. This project, done in teams, is the basis of the grade (along with student participation in class). Over the years, I have always had, in each class one of two fantastic project reports, on the lines that are described above, processing diverse feedstocks.

For me, teaching is very rewarding. I got three degrees at Cornell, and spent over 6 years there. Teaching at Cornell gives me a sense of

giving back to the University who gave me so much. It also gives me a sense that I never left. I still climb the same staircases that I did as an undergraduate. Teaching at Cornell also gives me a unique insight on how one of the best Universities in the world functions from the 'inside'. Since I actively manage Somaiya Vidyavihar, this insight is very beneficial in how we seek to build Somaiya Vidyavihar and Somaiya Ayurvihar into world class centres of learning, research and service. Finally, my business is Bio-refining. Godavari Biorefineries is at the forefront of using agricultural feedstocks to make foods, fuels, chemicals, pharmaceutical intermediates, waxes, electricity, and a host of other products. Taking a 'sabbatical' like this gives me time to reflect, study, and learn on how the world around us is changing, and what we must do to keep up, if not stay ahead.

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THE AUTHOR: SAMIR SOMAIYA is the Chairman and Managing Director - Godavari Biorefineries Limited (<http://somaiya.com/>). He is also the President - Somaiya Vidyavihar (<http://www.somaiya.edu/>). He was the past Chairman of Western Region - INDIAN CHEMICAL COUNCIL and continues as the member of the Executive Committee, ICC.