The Future of Farming

MAS.S61

MIT Program in Media Arts and Sciences

Fall 2019

Meetings:
Wednesdays, 10:00 am-12:00 pm
E14-393

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Course Description:

Farming has been central to the progress and survival of humanity. How will we craft the future of this essential human practice? How can we learn from the past to invent new ways of farming that will do the most good for the largest and most vulnerable populations? This survey course will dive deep into the agricultural impacts of emerging technologies including precision agriculture, IoT, machine learning, GMOs/gene editing, vertical farming, drones, imaging tech, water tech, soil tech, supply chain optimization, and other innovations influencing the quest to feed the world. Through lectures, discussions, special guests, and student-led discovery, we will explore exciting possible solutions along with the multifaceted challenges facing the future of global agriculture. Students will complete an agriculture-related project during the course.

Course Objectives:

- To provide a comprehensive introduction to emerging agricultural technologies.
- To provide a grounding in the rich history of past agricultural innovations.
- To provide an overview of the current Agritech industry.
- To provide a survey of the Agritech technology development process from concept to implementation, including common and critical knowledge required for Agritech innovations.
- To identify the key tasks, decision-making points and workflows for technology development in Agritech.
- Topics to be covered include precision agriculture, IoT, machine learning, GMOs/gene editing, vertical farming, drones, imaging tech, water tech, soil tech, supply chain optimization, and others.
- To reinforce the above objectives through experiential industry case examples.
Learning Objectives:

1. Investigate the connections between past knowledge, future tech, and scientific inquiry (Analyze)
2. Present synthesized knowledge of the ways that humans have farmed and will farm in the future. (Comprehension)
3. Integrate knowledge from multiple disciplines to formulate comprehensive views of the workings of the Agritech industry (Integrate)
4. Apply such views to understand the process of value creation and the role of emerging technologies in the Agritech industry. (Apply)
5. Apply best practices for planning and implementing the development of Agritech technologies. (Apply)
6. Apply acquired skills to work as individual or team contributors in research and commercial Agritech organizations. (Synthesis)
7. Integrate knowledge in order to prioritize and select appropriate technical options, balancing business objectives with regulatory constraints, in the development of Agritech technologies (Integrate)

Assessments:

Quality of work will be graded as indicated in the assessment guidelines. High quality work will insightfully incorporate the aspects of the four pillars of understanding outlined above.

Formative assessments:

Class discussion participation: Every class, students must prepare a 1 paragraph reflection and 1 question from the reading that we will discuss in class.

Seven short presentations (5-10 slides) Subjects will comprehensively cover essential agricultural innovations, past and present.

Summative assessments:

2 paragraph rough draft paragraph and proposed sources. By the 3rd class students will deliver 1 paragraph (plus 5 potential citations) for the midterm report for the 6th class (This will allow us to review, discuss, and define before you begin the bulk of your writing.)

There were be three drafts of the final project presented to the class before the final project is due on the last class of the semester. Each draft will build on

Written midterm paper: The midterm paper will focus on a human farming innovation from the past and the ramifications on society
**Final Project and Presentation:** The final project will focus on a human farming innovation that is emerging or might emerge and the possible ramification on society.

**Assessment guidelines:**

**Reflection and discussion question submitted by the start of every class:**
1 paragraph plus 1 question. Questions will be chosen for class discussion. 5 points for submitting questions quality and insightfulness as applicable for the current reading assignment. (12 x 5 = 60 points)

**Short presentations (5-10 slides)** on the reading, presented in every class. Subjects will comprehensively cover essential agricultural innovations, past and present. 10 points per presentation. (7 x 10 = 100 points)

**Midterm written paper** (5 pages, 50 points) **Farming Past:** will focus on a human farming innovation from the past and the ramifications on society

**Final project and presentation** (Equivalent of 5-10 pages, 100 points) **Farming Future:** will focus on a human farming innovation that is emerging or might emerge and the possible ramification on society. The structure of this project is flexible, but should focus on a topic of specific interest of the student. The form is also flexible. It could be a position paper, an editorial, a zine, a website, an actual technology or object. The project must be presented in the last class.

**Final Grades:**
Based on percentage of cumulative points attained. See above.
Texts and materials

Books:

An Edible History of Humanity
Author: Tom Standage
Published: 2009

The Fate of Food
Author: Amanda Little
Published: 2019

Selected chapters from: (all provided in class)

Plant Factory: An Indoor Vertical Farming System for Efficient Quality Food Production 1st Edition – ebook PDF Version
Kozai et al.
2015

Precision Agriculture Technology for Crop Farming
Author: Qin Zhang
Published: 2015

Agriculture: A Very Short Introduction
Author: Paul Brassley
Published: 2016

A History of World Agriculture: From the Neolithic Age to the Current Crisis
Marcel Mazoyer
2006

Controlled Environment Agriculture - Production of Specialty Crops Providing Human Health Benefits through Hydroponics
Asaduzzaman, Md. ;
2016

The Emergent Agriculture: Farming, Sustainability and the Return of the Local Economy
Author: Gary Kleppel
Published: 2014

A Revolution Down on the Farm: The Transformation of American Agriculture since 1929
Paul Conkin
2008

Selected Literature:
The Future of Farming: Technological Innovations, Opportunities, And Challenges For Producers
Author: Committee on Agriculture, House of Representatives
Published: 2017

Bungle in The Agtech Jungle: Cracking the Code on Precision Farming and Digital Agriculture
Author: Kenneth S. Zuckerberg, Rabobank
Published: 2017

Farming Drones: The Future Of Agriculture?
Author: Tim Jennings
Published: 2017

Author: Anthony King
Published: 2017

Robots – the future of agriculture
Author: Martin Redbond
Published: 2015

Flavor-cyber-agriculture: Optimization of plant metabolites in an open-source control environment through surrogate modeling
Arielle J Johnson ; Elliot Meyerson ; John de La Parra ; Timothy L Savas ; Risto Miikkulainen ; Caleb B Harper

Machine Learning in Agriculture: A Review
Konstantinos G. Liakos ; Patrizia Busato ; Dimitrios Moshou ; Simon Pearson ; Dionysis Bochits
Sensors, 01 August 2018, Vol.18(8), p.2674

Opportunities and Challenges in Sustainability of Vertical Farming: A Review
Fatemeh et al.

Urban Agriculture and Vertical Farming
Chungui Lu and Steven Grundy
Encyclopedia of Sustainable Technologies , 2017, p.393-402
**Future of Agriculture (1948)**
Seaton, H
Town and country planning : the quarterly review of The Town and Country Planning Association. 1948

**Future of agriculture (2018)**
Kohl, David
Corn and Soybean Digest ; Overland Park, 2018.

**Future of agriculture Part II**
Kohl, David
Corn and Soybean Digest ; Overland Park, 2018.

**In Defense of Farmers : The Future of Agriculture in the Shadow of Corporate Power**
Gibson, Jane; Alexander, Sara; Hansen, John K
UNP – Nebraska, 2019

**The little book of big deforestation drivers : 24 catalysts to reduce tropical deforestation from 'forest risk commodities'**
Rautner, Mario
Global Canopy Programme, Oxford, 2013

**Future food-production systems: vertical farming and controlled-environment agriculture**
Benke, Kurt ; Tomkins, Bruce

**Growing sensors: agriculture meets technology: how sensors are changing the world of greenhouse growing.(Sensors)**
Panetta, Kasey

**Sensors key to advances in precision agriculture**
Bogue, Robert

**Precision Farming in India – A Review**
Tiwari, Akhilesh ; Jaga, Praveen Kumar
Outlook on Agriculture, June 2012, Vol.41(2), pp.139-143

**Precision farming for increased land and labour productivity in semi-arid West Africa. A review**
Aune, Jens ; Coulibaly, Adama ; Giller, Ken
Course Outline

Module 1: The Past and Present of Farming
Week 1: Introduction to Farming Concepts Past, Present, and Future
   A survey of Subsistence and Commercial Farming around the World
   The First Agricultural Revolution
   A look at the transition from hunting and gathering to planting and sustaining.
Week 2: The Second Agricultural Revolution
   An analysis of the increase in the productivity through mechanization. This led to access to new market areas due to better transportation.
   The Third Agricultural Revolution
   How hybridization and genetic engineering of products, along with the increased use of pesticides and fertilizers, has led us to the current state of agriculture.

   Due: Final Project Draft 1
   Describe your proposed project

Module 2: Precision Agriculture
Week 3: IoF (Internet of Food): Automation, Sensors, and IoT
   Techniques for the gathering of “Big Data”
Week 4: Drones and Imaging Technology
   Next steps for data gathering tied to image correlations
Week 5: Machine Learning and AI in farming practices
   Using agricultural data for optimization
   OpenAg Guest Speaker

   Due: Midterm Paper

Module 3: Controlled Environment Agriculture
Week 6: Vertical farming
   Investment buzz, impact on supply chain, tuning of crops, and climate prospecting
   OpenAg Guest Speaker
Week 7: Hydroponics and aeroponics
   OpenAg Guest Speaker
Week 8: Solar tech and LED lighting
   New lighting technologies, reduction in cost, and increased access to tech
   OpenAg Guest Speaker

   Due: Final Project Draft 2 update
   Update on status of final project

Module 4: Biotech in Farming
Week 9: Cloning
Tissue Culture, traditional cloning, and bioreactors

Week 10: Breeding, GMOs, and Gene editing
  Traditional crossing and breeding, new techniques, ethical issues, and environmental impacts

Due: Final Project Draft 3 update

Module 5: Emerging Tech
Week 11: Water Tech and Soil Tech
  An overview of the processes to increase productivity, resilience, and reduce environmental impact
  Guest Speaker from IndigoAg

Week 12: Supply Chain Optimization
  Waste reduction, Production, and Transport
  Guest Speaker from United Fresh Produce Association

Week 13: Final Project Presentations

Due: Final Project