

Agrivoltaics: Optimizing Plant Growth in Renewable Energy Systems

course – Devotha Mwazembe, Tuskegee University

Course Description

This course introduces students to the integration of photovoltaic (solar) technology with agricultural practices, exploring its scientific, technological, and socio-economic dimensions. Students will study the principles of agrivoltaic systems, their impact on crops and livestock productivity, and their role in promoting sustainable agriculture and climate resilience. Through a combination of lectures, case studies, field visits, and hands-on simulations, students will develop the knowledge and skills to evaluate, design, and implement agrivoltaic systems in diverse agricultural contexts.

Course Goals

1. Develop a foundational understanding of solar energy, including its principles, photovoltaic systems, and applications in agriculture.
2. Explore the impacts of agrivoltaic systems on crop performance, soil health, and the environment.
3. Evaluate the environmental, economic, and social impacts of agrivoltaics
4. Foster problem-solving and critical thinking to address challenges in agrivoltaic system implementation.
5. Design and simulate agrivoltaic systems for diverse agricultural contexts.

Lecture Topics:

I. Introduction to Agrivoltaics



Foundational Concepts: this includes definitions and historical backgrounds of Agrivoltaic System Design

II. Principles of Agrivoltaic System Design



Agrovolteic components.

- **Solar panel component:** panels (fixed, tracking, or elevated) for electricity generation, inverters, and optional storage systems
- **Agricultural Component:** shade-tolerant crops, soil management practices, and irrigation systems adapted to panel layouts.
- **Supporting infrastructure:** Pathways, rainwater harvesting, and microclimate monitoring systems to optimize both energy and crop productivity.



Things to consider when designing an Agrovoltic system

- **Site Selection and Solar Potential:** Consider terrain, shading from surrounding structures, and proximity to energy infrastructure.
- **Crop Compatibility:** Choose crops suited to partial shading or dappled light conditions, considering local climate and soil characteristics
- **Economic Feasibility:** Assess installation, operation, and maintenance costs relative to expected energy and agricultural outputs.
- **Maintenance and Accessibility:** Design systems for easy access to solar panels and agricultural areas for cleaning, repairs, and farming activities.
- **Regulatory and Policy Considerations:** Ensure compliance with zoning regulations, land-use policies, and renewable energy laws.

III. Environmental and Climate BenefitsOf agrovoltic system



Carbon Sequestration



Agrivoltaics' role in reducing greenhouse gas emissions.



Microclimate Modifications



How solar panels create beneficial environments for crops and animals.



Climate Change Adaptation



Using agrivoltaics to combat extreme weather conditions.

IV. Economic and Social Aspects



Cost-benefit analysis of dual land-use systems.



Assessing the financial viability of agrivoltaic projects.



Government programs and subsidies promoting agrivoltaics.



Benefits to rural communities, including job creation and energy access.

V. Challenges and Solutions



Appreciate the Benefits and Challenges:



Discuss the economic, social, and environmental trade-offs of dual land use.



Identify challenges in implementing agrivoltaic systems and propose potential solutions.



Discuss technical challenges such as Panel durability, maintenance, and crop compatibility,



Discuss socioeconomic barriers including high initial investment costs and land-use competition.



Explore Potential Solutions such as existing research and innovation in agrivoltaic technologies.

Case Studies and Applications

- **Global Examples:** Successful agrivoltaic projects in Africa, Europe, Asia, and North America.
- **Regional examples:** Systems designed for specific climates and crop types across the USA.

Lab Activities

- Demonstration Video showcases agrivoltaic installations and interviews with experts.
- Sketch and simulate different layouts for crop and solar panel integration using software tools.
- Field Visit to a nearby Agrovoltic farm (as they develop).

Assessment Methods

Quizzes on core concepts (e.g., solar energy basics, crop requirements) (15%)

Lab activities Report (20%)

Group discussions on challenges and benefits of agrivoltaics. (10%)

Mid-exam (25%)

A final project where students design a small-scale agrivoltaic system for a specific scenario (30%)