CABBI

CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

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ILLINOIS

U.S. DEPARTMENT OF ENERGY

DOE Bioenergy Research Centers

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CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

OUR TEAM

ILLINOIS

Colorado State University

Berkeley UNIVERSITY OF CALIFORNIA

BROOKHAVEN NATIONAL LABORATORY

Lawrence Berkeley National Laboratory

BOSTON UNIVERSITY

PRINCETON UNIVERSITY

Institute for Systems Biology

USDA Agricultural Research Service

MISSISSIPPI STATE UNIVERSITY

UF UNIVERSITY of FLORIDA

UNIVERSITY OF Nebraska Lincoln

University of Idaho

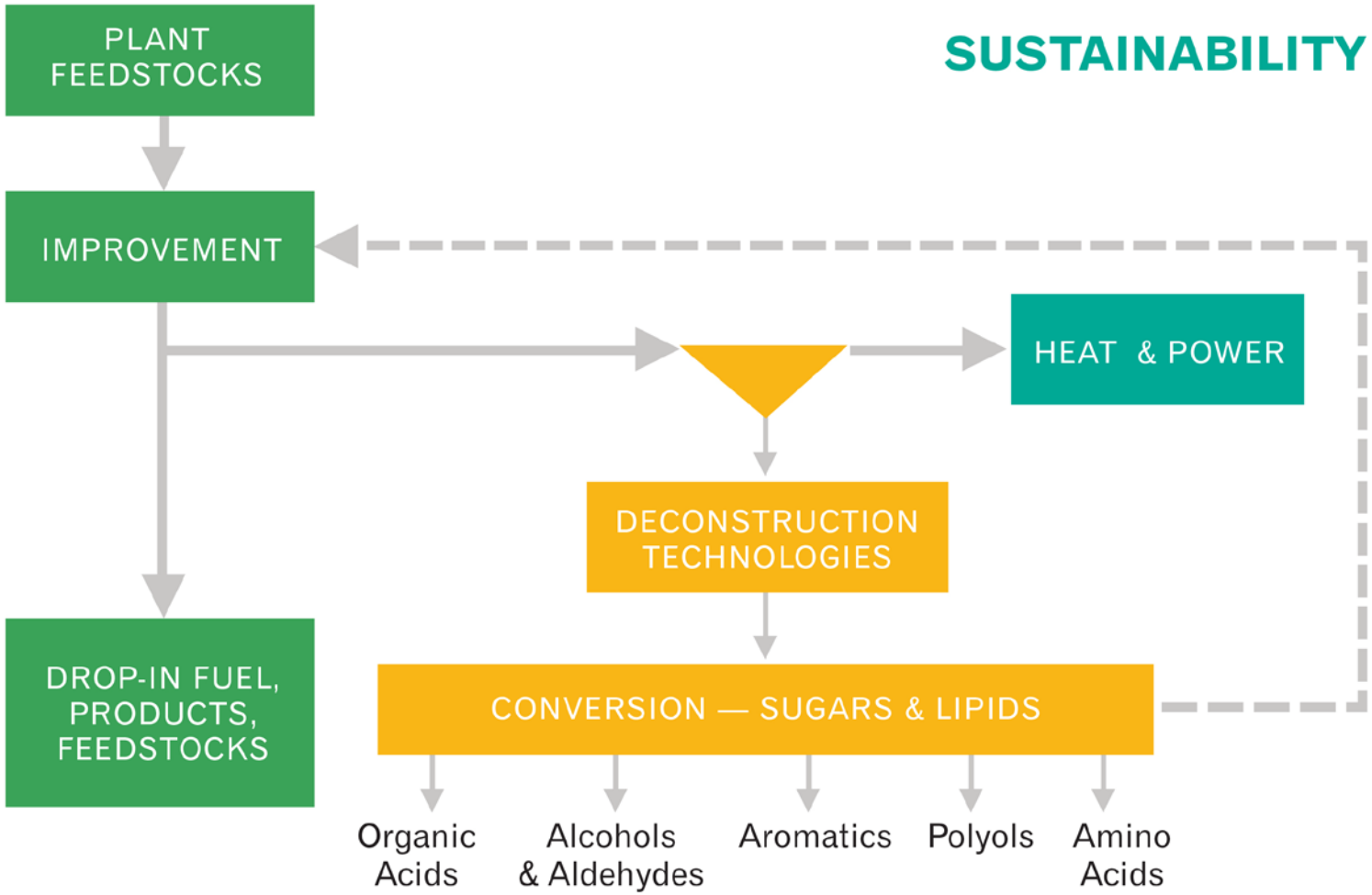
IOWA STATE UNIVERSITY

HUDSONALPHA INSTITUTE FOR BIOTECHNOLOGY

WESTVIRGINIA UNIVERSITY

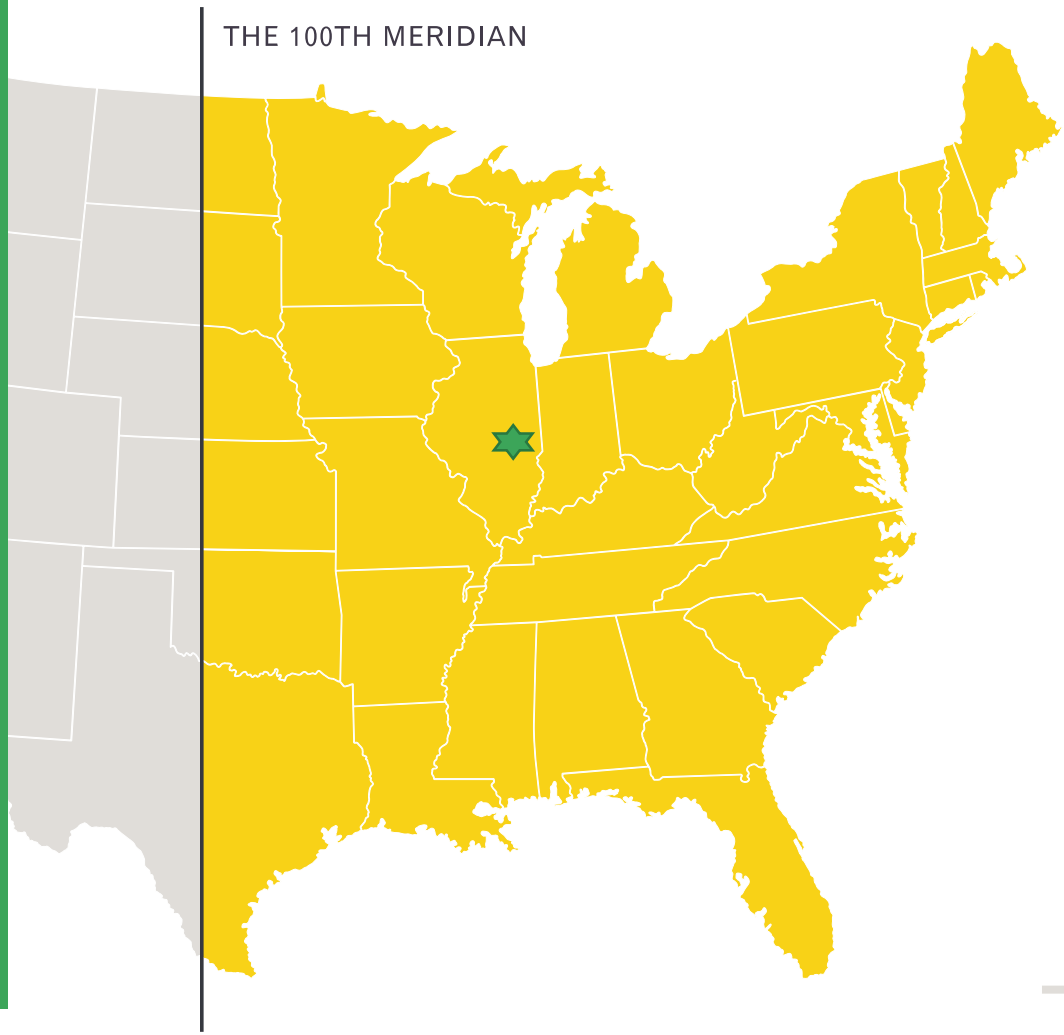
CABBI: AN INTEGRATION OF

FEEDSTOCK DEVELOPMENT, CONVERSION, AND SUSTAINABILITY



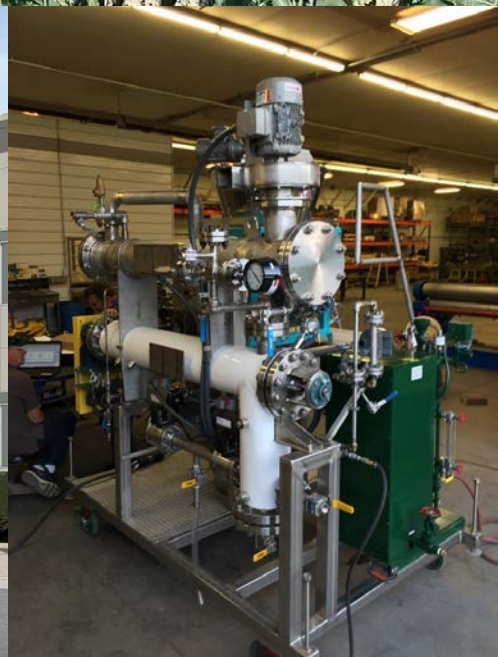
WHY DOES CABBI GROW GRASSES?

CABBI WILL FOCUS ON GRASSES IN THE ANDROPOGONEAE GROWN EAST OF THE 100TH MERIDIAN



- high-yielding grasses including Sorghum and sugarcane
- the Eastern U.S. provides abundant land where crops are predominantly rain fed
- the close genetic relatedness of target grass crops ensures that genetic discovery will be transferable among species
- grasses restore ecosystem services to degraded land

ILLINOIS HUB



THE SCIENTIFIC CHALLENGE...

THE **LOW ECONOMIC VALUE** OF PLANT BIOMASS, WHICH INCREASES ECONOMIC RISK ON THE FARM

DEDICATED BIOMASS CROPS TYPICALLY HAVE ONLY ONE MAJOR END USE (BIOENERGY), WHICH **DECREASES MARKET FLEXIBILITY**

INEFFICIENT CONVERSION OF LIGNOCELLULOSE TO BIOFUELS OR BIOPRODUCTS

THE CABBI SOLUTION

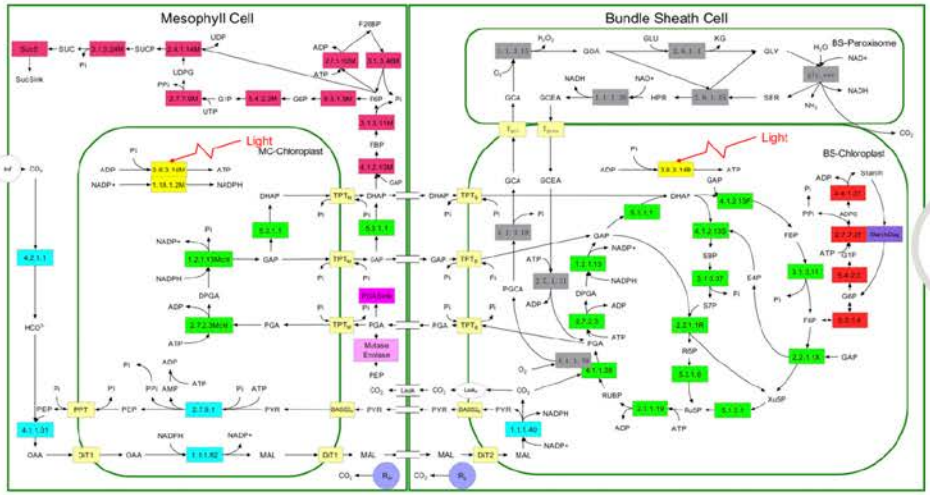
SHIFT STEM CARBON TO MORE VERSATILE AND EASILY CONVERTED CARBON FORMS THAN RECALCITRANT LIGNIN

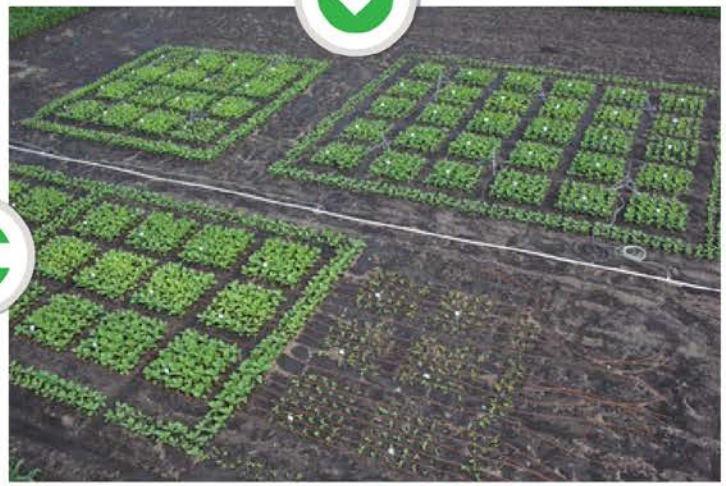
INCREASE THE VALUE OF BIOMASS FROM BEST YIELDING GRASSES AND THE DIVERSITY OF COMPOUNDS THAT CAN BE PRODUCED IN THEIR STEMS

INCREASE YIELD EFFICIENCY AND RESILIENCY TO MINIMIZE ENVIRONMENTAL IMPACTS

BUILD HIGH LEVELS OF OILS AND SPECIALTY FATTY ACIDS IN VEGETATIVE TISSUES

MAKING THE PLANT FACTORY
MORE EFFICIENT



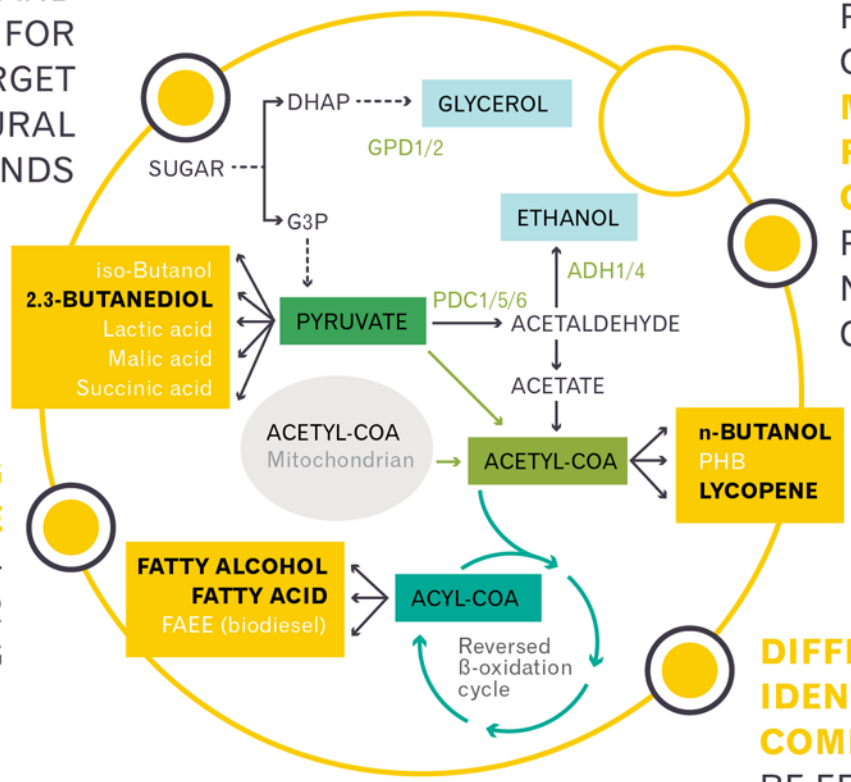


Kromdijk et al. 2016. Science

THE SCIENTIFIC CHALLENGE...

LACK OF KNOWN ENZYMES WITH DESIRED ACTIVITY AND SUBSTRATE SPECIFICITY FOR THE SYNTHESIS OF TARGET NATURAL OR NON-NATURAL COMPOUNDS

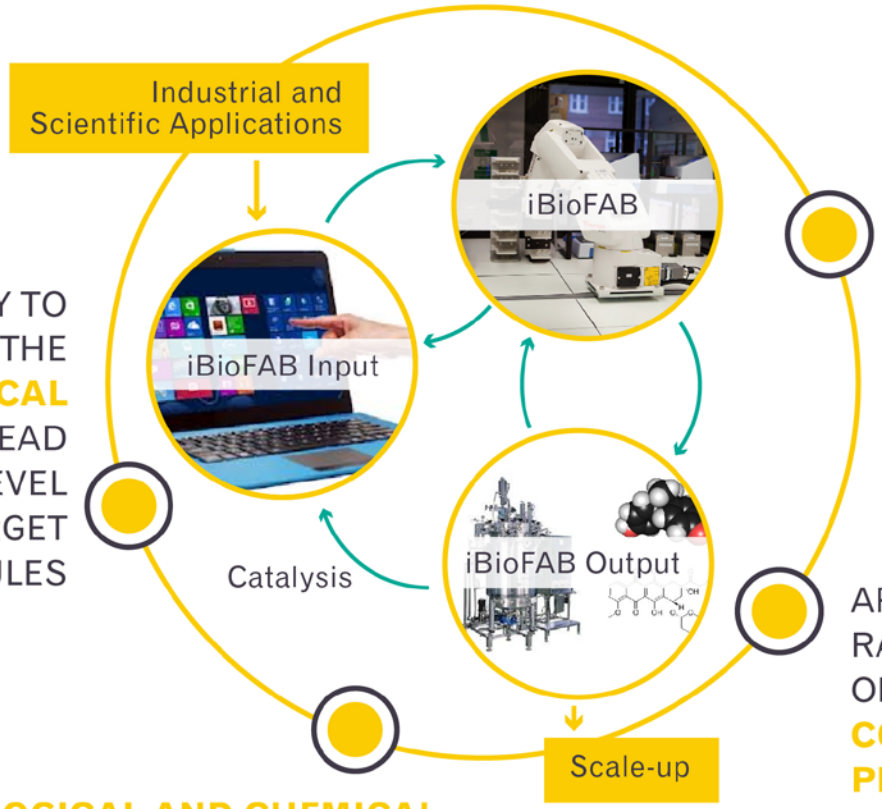
POOR UNDERSTANDING OF HOW NATIVE **METABOLISM AND PHYSIOLOGY CONSTRAINS** THE PRODUCTION OF NON-NATURAL COMPOUNDS



TIME-CONSUMING AND EXPENSIVE DESIGN-BUILD-TEST-LEARN CYCLE FOR METABOLIC ENGINEERING

DIFFICULTY IDENTIFYING COMPOUNDS THAT CAN BE EFFICIENTLY PRODUCED IN LIVING ORGANISMS

THE CABBI SOLUTION



DEVELOP A BIOFOUNDRY FOR EFFICIENT **AUTOMATED DESIGN OF ORGANISMS** — PLANTS AND MICROBES — FOR SYNTHESIS OF BIOFUELS AND BIOPRODUCTS

APPLY THIS FOUNDRY TO INVESTIGATE THE **UNDERLYING BIOLOGICAL MECHANISMS** THAT LEAD TO HIGH-LEVEL PRODUCTION OF TARGET MOLECULES

APPLY THIS FOUNDRY TO RAPIDLY ENGINEER ORGANISMS FOR **COST-EFFECTIVE PRODUCTION** OF INDUSTRIALLY IMPORTANT MOLECULES

INTEGRATE **BIOLOGICAL AND CHEMICAL CATALYTIC APPROACHES** TO PRODUCE A DIVERSE PORTFOLIO OF ADVANCED FUELS AND BIOPRODUCTS

THE SCIENTIFIC CHALLENGE...

LIMITED UNDERSTANDING OF ECOSYSTEM PROCESSES RELATED TO C, N, AND WATER CYCLING TO ENABLE PREDICTIONS OF ECOSYSTEM SERVICES AND YIELD

POOR UNDERSTANDING OF LAND AVAILABLE TO OPTIMIZE FEEDSTOCK PRODUCTIVITY

POOR UNDERSTANDING OF THE ECONOMIC VIABILITY AND RESILIENCE OF BIOMASS PRODUCTION

LIMITED REFINERY-SCALE TECHNO-ECONOMIC UNDERSTANDING OF THE FEEDSTOCK CONVERSION PROCESS

THE CABBI SOLUTION

DEVELOP NEW TEA AND LCA APPROACHES TO EXAMINE ECONOMIC AND ECOLOGICAL TRADEFFS

'BIG DATA' APPROACH TO QUANTIFYING LAND AVAILABILITY

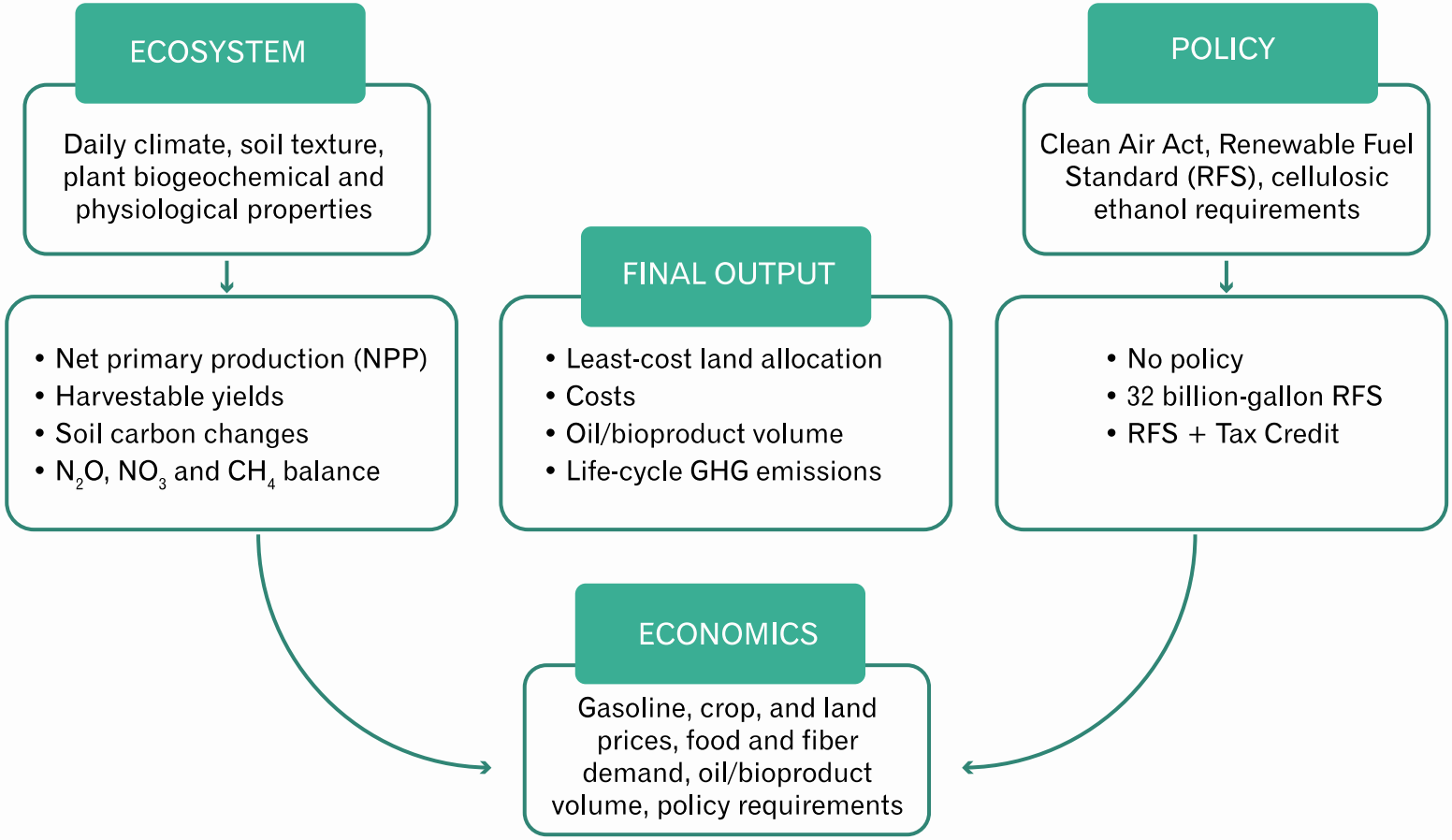
HUB-AND-SPOKE MODEL OF **EXPERIMENTAL SITES COMBINED WITH DATA-MODEL SYNTHESIS** TO EXAMINE G x E x M

INTEGRATED MEASUREMENT-MODELING APPROACHES TO UNDERSTAND COORDINATION OF ABOVE- AND BELOW-GROUND PHYSIOLOGY (ROOT-SOIL-MICROBIOME)

IMPROVE MODEL PREDICTIONS REPRESENTING A RANGE OF BIOMASS CROP SPECIES AND VARYING PHENOTYPES

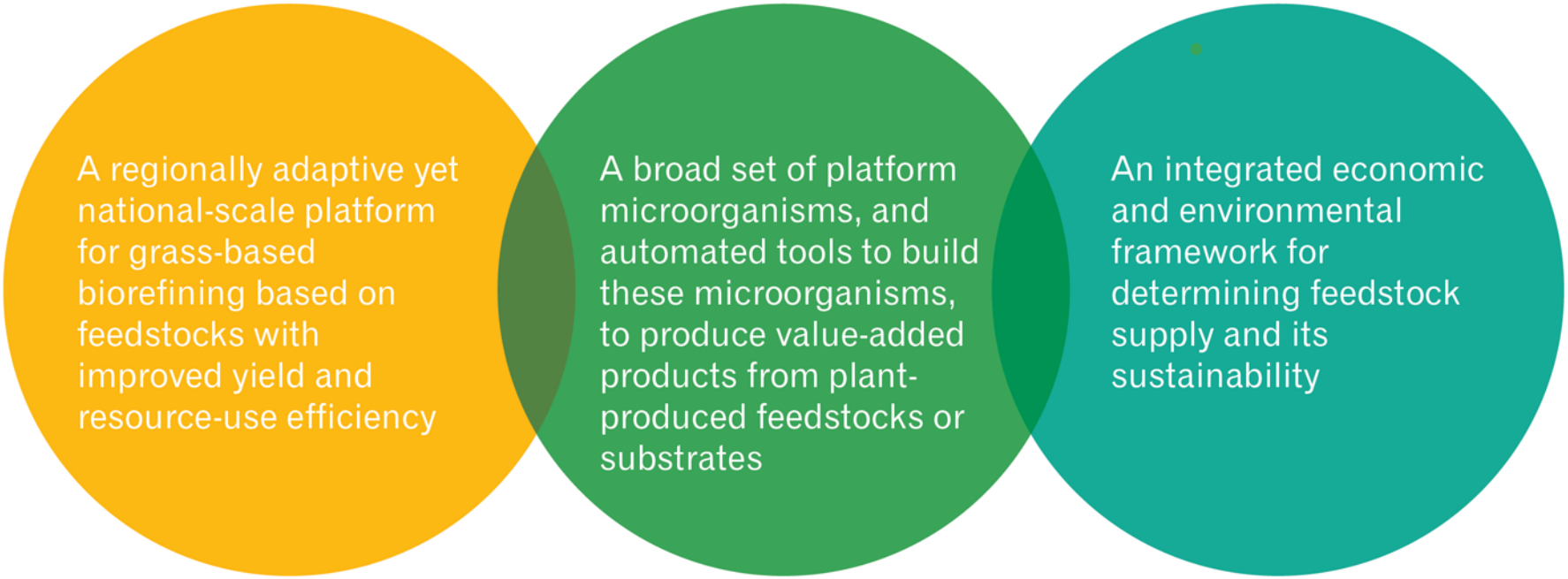
LINKING BIOGEOCHEMICAL AND ECONOMIC MODELS

REVEALS THAT WE CAN MEET BIOFUEL MANDATES AND REDUCE GHGS WITHOUT REDUCING FOOD



Hudiburg et al. 2016. Nature Energy

THE CABBI LEGACY



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[DISCUSSION AND QUESTIONS]

https://www.cabbi.bio