SUSTAINABLE AGRICULTURAL PRODUCTION BY BIOMASS UTILIZATION TECHNOLOGY

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ABSTRACT

Biomass is an organic material of biological origin that is devoid of any fossil material and is continuously renewed as long as there is life and solar energy. Biomass is carbon neutral, which means that it does not contribute to the increase of carbon dioxide (CO_2) in the atmosphere. Substituting fossil fuel-based energy and manufactured products with biomass-derived fuel and products will markedly reduce greenhouse gas (GHG) emissions, the primary cause of global warming.

First-generation bio-based energy and materials, such as sugar cane or cone, could contribute to reduced CO_2 emissions and improvements in energy security [1]. However, sourcing first-generation feedstocks may have negative impacts on biodiversity, land use, and competition with food crops. The main disadvantage of first-generation feedstocks is thus closely linked to food-versus-fuel and chemicals debate [1]. Thus, in order to reduce GHG emissions, it is considered necessary to shift our attention to the utilization of more efficient alternatives based on renewable and conventional technologies. Second-generation feedstocks, such as agricultural wastes and forest and marine residues are mainly composed of polysaccharides and do not compete with the production of human food and animal feed [2]. Second-generation feedstocks are primarily composed of cellulose, a linear polysaccharide polymer consisting of 1,4-linked glucose units. Cellulose is a major constituent of plant cell walls and is thus considered to be the world's most abundant biopolymer [3, 4]. Glucose is particularly well suited for use as a carbon source for feeding the bio-based economy, particularly since it can easily be converted into biofuels and chemical compounds by microbes and enzymes.

The biomass that remains after conversion and fermentation could subsequently be processed into biogas by anaerobic digestion, and any residual waste fractions could be converted into bio-oil or biochar by pyrolysis [2, 5]. The biogas, bio-oil and fermentation residues produced in this way could then all be used as an energy source, and the biochar produced at the end of the process is both carbon and nutrient rich. Using the biochar to amend agricultural soil would also close the nutrient cycle and sequester atmospheric carbon. This recycling of energy and nutrients could create a sustainable economy and society [2], which could be attained by focusing on the fundamental biological processes of photosynthesis (biomass production), conversion and fermentation (sugar platform), and waste management (agronomic benefit), all of which should be considered technological cornerstones.

In this presentation, we would like to discuss the importance of biomass utilization technologies within the context of agricultural sustainability. The JIRCAS biomass project focuses on the economical production of fuels and chemicals from biomass through biological processes [6, 7]. Although the technical and economic aspects of production still require considerable research, the outcomes of the project will promote the development of sustainable social systems and improvements to rural livelihoods through biomass utilization technologies.

KEYWORDS

Biomass, Sustainability, Biomass utilization technology, Biofuels, Biochemicals, Cellulose

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Akihiko Kosugi
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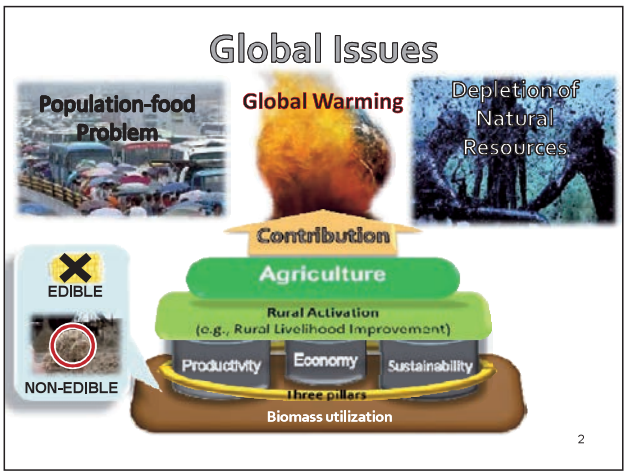
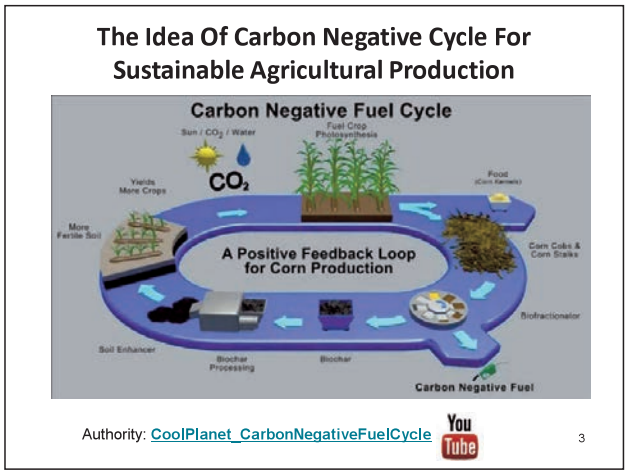

Global Issues
Population-food Problem
Global Warming
Depletion of Natural Resources
Contribution
EDIBLE
NON-EDIBLE
Agriculture
Rural Activation
(e.g., Rural Livelihood Improvement)
Productivity
Economy
Sustainability
Three pillars
Biomass utilization
2

2


The Idea Of Carbon Negative Cycle For Sustainable Agricultural Production
Carbon Negative Fuel Cycle
CO2
A Positive Feedback Loop for Corn Production
Carbon Negative Fuel
Authority: CoolPlanet_CarbonNegativeFuelCycle
YouTube
3

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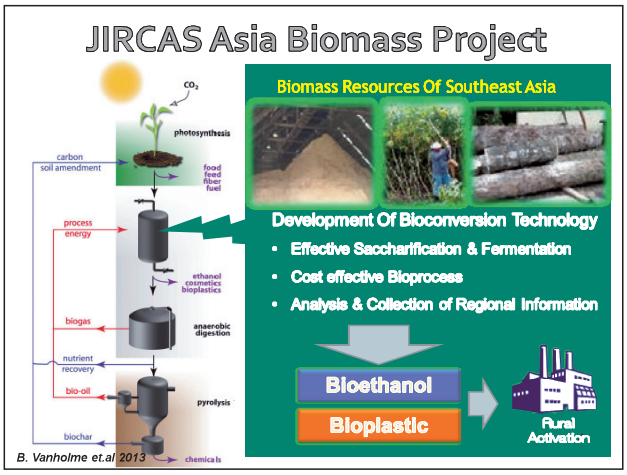
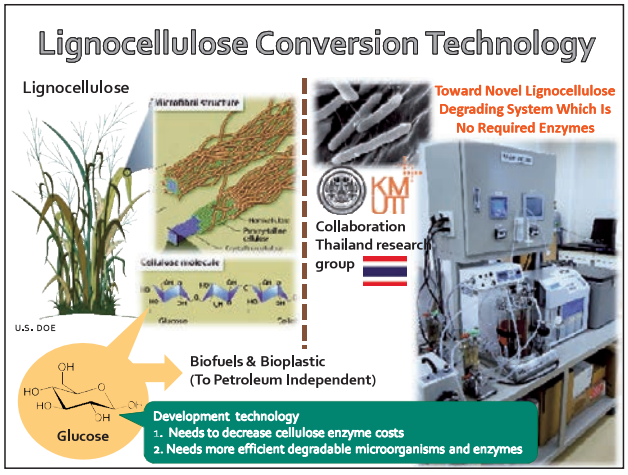
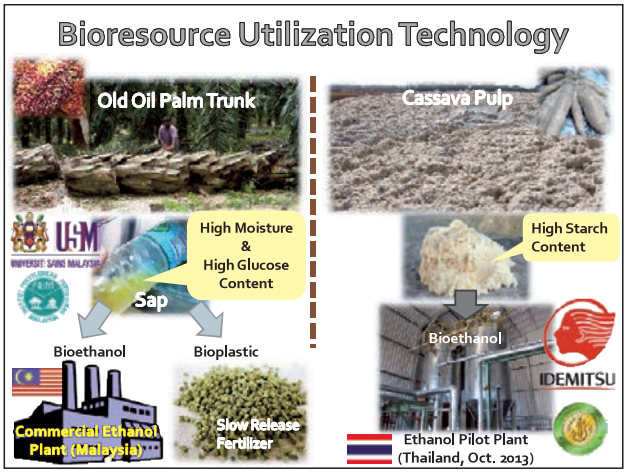

JIRCAS Asia Biomass Project
Biomass Resources Of Southeast Asia
Development Of Bioconversion Technology
Effective Saccharification & Fermentation
Cost effective Bioprocess
Analysis & Collection of Regional Information
Bioethanol
Bioplastic
Rural Activation
B. Vanholme et.al 2013

4


Lignocellulose Conversion Technology
Lignocellulose
U.S. DOE
Toward Novel Lignocellulose Degrading System Which Is No Required Enzymes
Collaboration Thailand research group
Biofuels & Bioplastic
(To Petroleum Independent)
Glucose
Development technology
1. Needs to decrease cellulose enzyme costs
2. Needs more efficient degradable microorganisms and enzymes

5


Bioresource Utilization Technology
Old Oil Palm Trunk
Cassava Pulp
High Moisture & High Glucose Content
Sap
High Starch Content
Bioethanol
Bioplastic
Bioethanol
IDEMITSU
Commercial Ethanol Plant (Malaysia)
Slow Release Fertilizer
Ethanol Pilot Plant
(Thailand, Oct. 2013)

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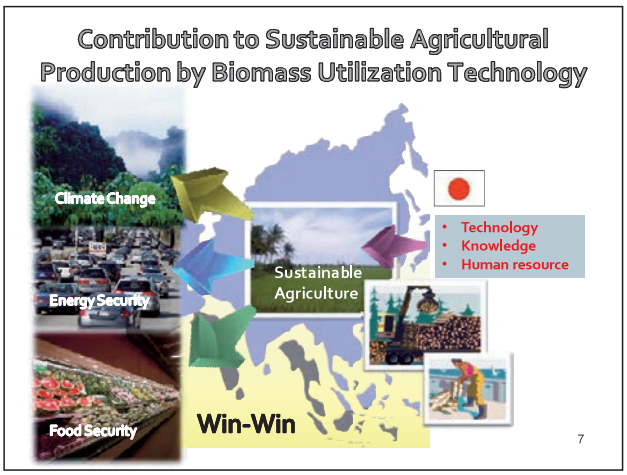
Contribution to Sustainable Agricultural Production by Biomass Utilization Technology
Climate Change
Energy Security
Food Security
Sustainable Agriculture
Win-Win
• Technology
• Knowledge
• Human resource
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Chair Saito: So now I'd like to invite Dr. Akihiko Kosugi. He is the project leader of the JIRCAS project titled the Asia Biomass Project. He is a professor at the University of Tsukuba as well. His expertise is in the area of biomass utilization using microbial technology. Dr. Kosugi, please.

Dr. Akihiko Kosugi: Thank you, Chairman. Today I'd like to talk just briefly, talk about how to contribute to sustainable agricultural production by biomass utilization technologies.

So this is the background. As you know, we face these global issues, so to resolve the global issues, agriculture has become two important things. To contribute to these issues by agriculture, we need rural activation such as rural livelihood improvement. So to establish rural activation, we need three pillars, such as productivity, economy, and sustainability. I think the biomass utilization is contributing to these pillars. Once we use the biomass we should use non-edible materials actually.

So this is one idea for sustainable agricultural production. So we agree with these ideas. So I'd like to show you these ideas in a small animation.

So as you know, plants absorb carbon dioxide, then so grown, then we harvest the crops, then so we use. Then remaining is the agricultural waste, and so this is agricultural waste converted to biochemicals, such as fuel, then also remain residues. This is converted to fertilizer, such as soil enhancers, so then back to soil. Then regenerate the soil to keep this cycle. This cycle is called the carbon negative cycle. So I think this idea can use not only agriculture but also forests and fisheries.

Then this is an outline of our overview of the JIRCAS Asia Biomass Project. We are focused on the bioconversion process, especially here. So we try to develop this biomass technology, such as effective saccharification and fermentation and we try to do a cost-effective bioprocess. Then we try to process the bioethanol, bioplastic. Then this technology, we believe this technology will contribute to rural activation.

This is for example our topic. We tried to develop the lignocellulose conversion technology. As you know, the lignocellulose is the most abundant biomass in nature. Lignocellulose is composed of cellulose. Cellulose can be converted to fermentable sugar such as glucose, so of course glucose can convert to biofuel, bioplastic easily. If so, we can establish these technologies, so we change the society to independent petroleum. But there are so many related-technologies. We need to decrease the enzyme cost and we need more efficient degradable microorganisms and enzymes.

So recently we developed the novel lignocellulose degradation system which is no-required enzyme, so we collaborated with a Thailand research group, King Mongkut's University.

Another thing we focused on also, bioresources in Southeast Asia, especially we are very interested in oil palm and cassava. So Dr. Othman already told us about oil palm. We found the sap from the oil palm trunk. This sap has high moisture, a high glucose content. Then we developed the bioethanol, bioplastic from the sap. So this research collaborates with the University Sains Malaysia and FRIM. Then now a Japanese company and Malaysian companies are trying to build a commercial ethanol plant in Malaysia.

Also, we tried to develop the bioplastic from this sap, especially a slow-release fertilizer.

Another thing, we also are interested in the cassava pulp. Cassava pulp is produced from starch factories. Cassava pulp has a high starch content, so that's why we can easily convert cassava pulp to bioethanol.

We also collaborated with a Japanese company and Kasetsart University. Then Japanese companies, recently Japanese companies built an ethanol pilot plant in Thailand, so they tried to analyze the data and tried to expand

this technology to expand in Southeast Asian countries.

So we believe these technologies contribute to sustainability, also contribute to expand to these Southeast Asian countries.

So in Japan, there is much technology, much knowledge, and human resources. Therefore, we can contribute to build, establish sustainable agriculture in Asian countries. Sustainable agriculture can contribute to this: climate change, energy security, food security, these issues.

So through these things we believe we can make a win-win situation between South Asian countries and Japan. Thank you for your attention.

Chair Saito: Thank you very much, Dr. Kosugi.