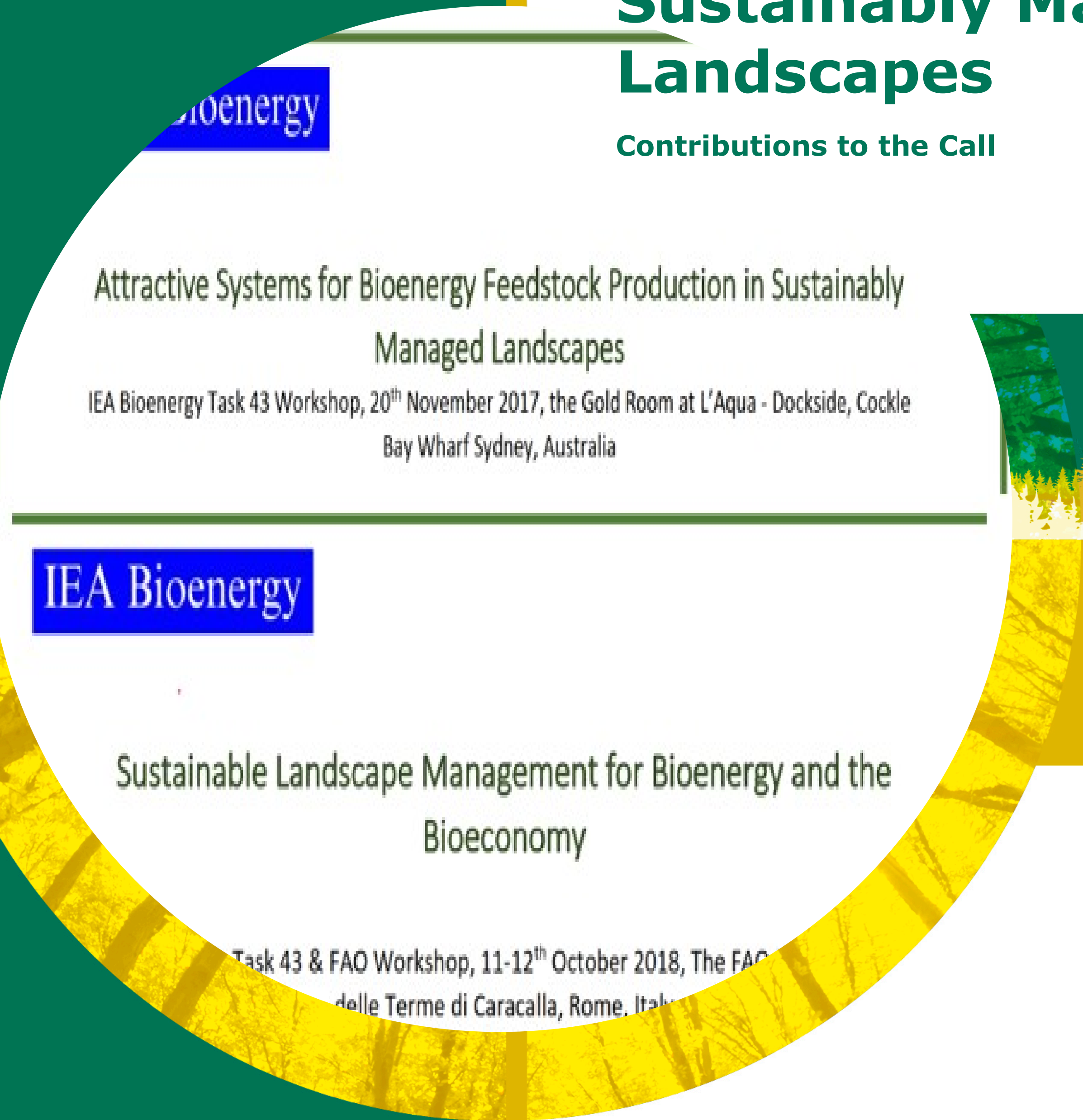
Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes

Contributions to the Call



Front cover information panel

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Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes – Contributions to the Call

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Background

Bioenergy implementation requires strategies for efficient use of biomass from sustainably managed landscapes. Formulating such strategies requires knowledge in how landscape management and land use decisions affect biodiversity and the capacity of ecosystems to provide biomass and other ecosystem services.

Task 43 aims at supporting landscape management and design for bioenergy and the bioeconomy, by expanding the knowledge base required for expansion of biomass production systems that also contribute positively to biodiversity and the generation of other ecosystem services. It combines a landscape level approach to deployment of biomass production for bioenergy and integration of this objective with ownership and societal objectives for existing land use and associated systems. The below overarching questions are addressed, which are relevant for both agricultural and forestry systems and reflect that agriculture and forestry activities often co-exist and shape the landscape together:

- Which are the most suitable areas for production and/or extraction of various biomass feedstocks?
- How can biomass feedstock production systems be located, designed and managed to increase resource use efficiency, avoid/mitigate negative and promote positive environmental, economic, and social effects?
- How can outcomes be optimized to meet the goals of individual stakeholders and society as a whole, including environmental, economic, and social goals?
- How can analysis and assessment inform participatory processes engaging landowners, policy makers, and other stakeholders in further developing and re-defining goals and plans for landscape management and designs?

CALL FOR CONTRIBUTIONS: ATTRACTIVE SYSTEMS FOR BIOENERGY FEEDSTOCK PRODUCTION IN SUSTAINABLY MANAGED LANDSCAPES

Task 43 launched an initiative to identify attractive examples of landscape management and design for bioenergy and the bioeconomy. The aim of this initiative to catalogue and highlight world-wide examples of biomass production systems, throughout all stages of production, that can contribute positively to biodiversity and the generation of other ecosystem services. Information about biomass production systems and their impacts, as well as information about governance and policy initiatives that encourage adoptions of solutions leading to positive outcomes are welcomed.

The goal of this initiative is to compile innovative examples as a means of showcasing how the production of biomass for bioenergy can generate positive impacts in agriculture and forestry landscapes. These examples are also meant to serve as sources of inspiration that other biomass producers can use to enhance the sustainability of their own activities.

All contributions that are within scope and meet the set quality requirement are included in this Report. Selected contributions will be invited to submit a manuscript for a Special Collection in the peer review journal WIREs Energy and Environment, published by Wiley.

Contributions were promoted at two IEA Bioenergy Task 43 workshops:

1. **Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed**

Landscapes; 20th November 2017, the Gold Room at L'Aqua - Dockside, Cockle Bay Wharf Sydney, Australia.

Presentations downloadable from http://task43.ieabioenergy.com/publications/5090/ .

2. **Sustainable Landscape Management for Bioenergy and the Bioeconomy**, 11-12th October 2018, The FAO Headquarters, Viale delle Terme di Caracalla, Rome, Italy.

Presentations downloadable from http://task43.ieabioenergy.com/publications/sustainable-landscape-management-for-bioenergy-and-the-bioeconomy/.

By June 2017, there were 17 contributions received. Geographical outreach of case studies/projects/approaches is dominantly from Europe (5), Australia (4) and North America (the United States) (5), whereas there were single contributions from South America (Brazil) and Africa (Zambia). Thematically, the contributions could be clustered as energy plantations (5), interaction of bioenergy and agriculture (9) and interaction of bioenergy with forestry (3).

Figure 1: Geographical outreach of contributions

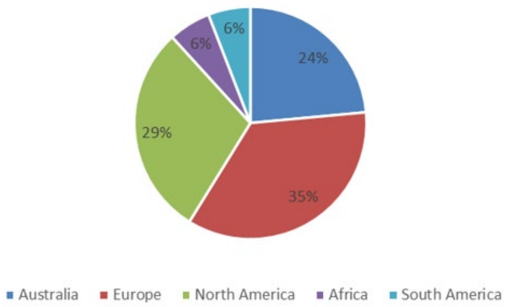
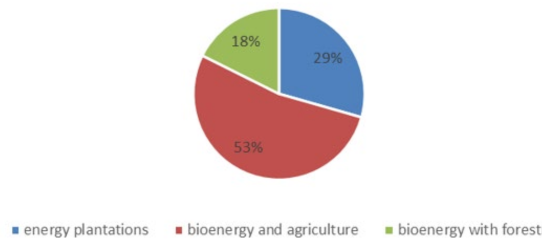


Figure 2: Contributions to Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes



The first round of revision was made by three T43 bioenergy experts where each had a lead in one section: J. Dimitriou (energy plantations), B. Kulisic (bioenergy within agriculture) and M. Brown (bioenergy within forestry plus Oceania case studies).

The outcome was:

- 8 acceptations + 5 conditional acceptations (all accepted upon improvements)
- 4 recommendations to other IEA Bioenergy Tasks

Contributions

1. AFRICA

1.1. A set of integrated practices: a multi-faceted market-led approach to improving food and energy security and adaptation to climate change, which incorporates alley cropping of Gliricidia sepium into small-scale maize farming systems in Zambia

Contact Name: Chris Armitage (coordinating this study for IRENA & ICRAF), Jeffrey Skeer

Location of the practice: The Luangwa Valley in Eastern, Central and Northern Provinces of Zambia

Publications: Currently under development jointly by the International Renewable Energy Agency (IRENA) and the World Agroforestry Centre (ICRAF)

Link: www.itswild.org

Type of Contribution

This example relates to a specific approach or set of integrated practices: a multi-faceted market-led approach to improving food and energy security and adaptation to climate change, which incorporates alley cropping of *Gliricidia sepium* into small-scale maize farming systems in Zambia.

Status

The approach was first implemented by COMACO in 2003, and has been refined continually in the years since, as the scale and impact has grown

Positive Impact

COMACO's integrated food-energy model simultaneously addresses the most common root causes of rural poverty and food insecurity in Zambia: inadequate extension support and training on improved and sustainable farming practices; lack of access to biomass for energy; lack of access to affordable farming inputs; lack of access to equitable and reliable markets; and inadequate systems to prevent wastage - and its success and scalability has led to rapid expansion and growing support from the Zambian Government and major multilateral agencies.

COMACO's programme targets some of Zambia's poorest and most vulnerable small-scale farming communities, who have limited or no access to expensive chemical fertilizers, extension support or markets. By 'alley' cropping with *Gliricidia*, COMACO's 167,400 members are achieving comparable maize yields to farmers in similar areas who use organic fertilizer, effectively doubling their profit. At the same time, they sustainably harvest more than enough high-quality fuel-wood to meet their annual cooking and heating requirements.

COMACO's market-driven approach is bringing rural communities out of poverty, and has changed the lives of participating small-scale farmers in real ways: ensuring they have enough food to sustain their families until the next harvest; have reliable 'on-farm' access to biomass for cooking and heating; earn enough money to send their children to school, buy medicine when a family member becomes ill, install a metal roof for the family home, or simply buy a mattress to sleep on.

As the lives of a growing number of farmers in a community improve, so too does the community itself begin to transform. People who are not so desperate, regarding where their next meal will come from, can plan for tomorrow. With this change comes improved community leadership: willing and better able to make the right decisions to ensure sustainable practices and safeguard natural resources.

COMACO monitors this transformation to assess its progress and encourages the process by supporting communities with skills and incentives to demonstrate their capacity and commitment for making the right decisions. These incentives are sustained from the sale of 'It's Wild!' products and awarded on the basis of an annual conservation compliance audit, which COMACO undertakes for each of the 67 chiefdoms where COMACO operates.

COMACO's approach is recognised as an effective model to sustainably address rural poverty, food insecurity and vulnerability to the impacts of climate change - and it will likely play a significant role in the achievement of Zambia's climate change mitigation and adaptation targets under its Nationally Determined Contribution, and its socio-economic targets under the Sustainable Development Goals.

The use of *Gliricidia* biomass for dendro power production has been well documented, and is practiced widely in countries such as Sri Lanka. In Zambia, while the power plants are yet to be established, large-scale supply chains for biomass and timber are already operating through COMACO's farmer cooperatives. This represents a significant opportunity for supply-driven power generation.

Reasons or main drivers for implementing the practice/project

Farming for most small-scale farmers in Luangwa Valley in the Eastern, Central and Northern Provinces of Zambia is a life of hard labour, often borne by women, using farming practices that typically limit productivity, crop diversity and incomes. Common agricultural practices in the region include mono-cropping, burning crop residues, inadequate soil and water management, overgrazing of livestock, and subsistence farming. These practices are resulting in the further decline of soil fertility and extensive land degradation. The general factors contributing to this outcome are a lack of effective extension services that promote improved and sustainable production technologies, poor or unsustainable access to sources of energy, poor access to affordable farm inputs, and markets that fail to support the adoption of these technologies or build effective synergies between forests, wildlife and agriculture.

In addition, climate models predict increasing rates of transpiration, rising temperatures, and greater precipitation variability in Zambia over the next 40 years. If effective mitigating solutions are not adopted, small-scale farmers will experience growing risks of crop loss and uncertain livelihood security. Under such scenarios, Zambia could witness massive losses of biodiversity in the future as small farmers seek coping strategies to satisfy household food and income security needs from such off-farm sources as charcoal-making, wildlife poaching, fish-netting, and timber-cutting.

Such outcomes will not only limit future economic opportunities and endanger ecosystem services, but will perpetuate rural poverty and hunger, leading toward a new equilibrium of human impoverishment and depleted biodiversity.

Key enabling factors

Maize is Zambia's staple food crop, and *Gliricidia* intercropping has a proven positive impact on maize yields within three years of planting, due to its rapid fixation of soil and atmospheric nitrogen. *Gliricidia* is a fast-growing multi-purpose tree that tolerates aggressive annual coppicing, repels various pests, and produces excellent fodder and green manure/mulch. It is also an extremely good fuelwood, producing 19.8MJ/Kg with specific gravity of 0.5-0.6, and burning slowly with little smoke or sparks. Key enabling factors inherent in the implementation model include:

a) financial incentives to farmers who become members of the programme;

b) high-quality extension services, coupled with complementary practices to enhance the benefits of the agroforestry system, and increase and diversify household income;

c) training of local members to become lead farmers. Currently, over 1700 lead farmers provide year-round support and training to members;

d) farmer cooperatives which represent the interests of their members and manage lead farmers, produce bulking and logistics, and provide strategic leadership on a range of farming and conservation issues;

e) Regional Farmer Support Centers which help coordinate logistics with local cooperatives through their local depots and bulking points;

f) farmer schools and demonstration farms which allow farmers to share experiences, showcase best practices, and reinforce community understanding of the 'approach' and its benefits. A training manual, called the Better Life Book, supports these schools; and

g) training and information services via 'Farm Talk' radio broadcasts, which air 3 times a week to over 1.2 million listeners in local languages.

Achieved outcomes

Since COMACO's programme began in 2003, it has grown rapidly, delivering market-led transformational development outcomes to a growing number of Zambia's most vulnerable small-scale subsistence farming families.

Significant outcomes of COMACO's approach include:

1) the establishment of 36 chiefdom-level small-scale farmer cooperatives, which overlap with 9 districts and are organized into 15 producer groups;

2) the establishment of 11 Regional Farmer Support Centers, which assist with the logistics of produce bulking, storage, handling and transport;

3) the establishment of 58 community warehouses and depots, with a combined produce storage capacity of 7000 tones, and surge capacity of an additional 2000 tones;

4) the registration and continued active participation of more than 167,400 small-scale farmer members;

5) the active participation and empowerment of women, including in decision-making and teaching aspects of the programme. Women comprise approximately 52% of registered members;

6) the increase in food security of member households from an estimated 34% in 2001 to over 80% in 2016;

7) the planting of more than 6 million *Gliricidia* trees annually, with an estimated cumulative 26 million trees currently under management. The high-quality fuel-wood which is

sustainably harvested each year has the potential to produce an estimated 1.24PJ of thermal energy. Further, members practicing *Gliricidia* alley cropping use no chemical fertilizers, and produce comparable annual maize yields to farmers from the same regions who use expensive fertilizers;

8) the distribution of more than 70,000 fuel-efficient cookstoves to member households. Each member sustainably harvests more than 2 tonnes of *Gliricidia* prunings per year, capable of producing an estimated 39.6GJ of thermal energy, which is sufficient to meet all their cooking and heating requirements;

9) the training of members in apiary, and the establishment and continued use of approximately 10,000 beehives;

10) average monthly sales of US$250,000-300,000 from members' produce;

11) the average annual income of member households has increased from US$79 in 2003, to US$348 in 2016, with COMACO paying over US$2.1 million annually for members' produce, and providing continuous extension support;

12) through capacity-building and high-quality extension services, the average annual cost of support provided to member farmers has reduces from US$25 in 2003 to US$16 in 2016, while maintaining increased yields, food security and incomes; and

13) improved and sustainable farming practices, and diversified livelihoods have improved the resilience of member households to extreme weather events and climate change.

It is also estimated that, as a direct result of the programme, 1,500 former poachers in the Luangwa Valley have been rehabilitated and now participate in sustainable farming practices. Demand for COMACO's products is high and key market channels, including regional export and mass consumer markets, remain untapped.

Main challenges encountered

COMACO farmers are often geographically isolated, because many are located in areas considered to be amongst the harshest and most difficult to reach in Zambia. COMACO's approach to establishing farmer cooperatives, extension support, and logistics has evolved to respond to the specific circumstances of its members, and helps to connect them to markets.

The short-term needs of participating communities presented a challenge, particularly in the first 2-3 years of joining the programme, when improved farming practices and market access hasn't yet provide significant returns to farmers. Incentives were provided to overcome these needs and ensure early participation, including provision of complementary technologies and livelihood opportunities.

In many instances, participating farmers were detrimentally impacted by inadequate knowledge of nutrition, health and family planning. Capacity-building and advocacy in these areas was introduced in 2010 to COMACO's approach, in partnership with the Ministry of Health and the BALANCED project. While the results have been overwhelmingly positive, initial challenges included issues associated with young lead farmers engaging with older community members on sensitive social issues, and the inclusion of men on topics usually reserved for women.

Overall, limited working capital and human resources have constrained the rate at which the programme could be scaled-out. COMACO's approach is intensive and multi-faceted, and infrastructure has needed to be continually extended to support the expansion of the programme. In addition, the expansion of *Gliricidia* alley cropping has been constrained by limited resources to purchase plastic sleeves for the seedlings.

Potential for scaling-up and replication

COMACO's approach effectively addresses root causes of poverty and food insecurity that are common to vulnerable rural communities across Africa and much of the developing world.

The current programme is expanding rapidly across what were previously neighboring districts of Zambia and, with increasing support from the Zambian Government and other stakeholders, it is expected that it will be adopted across much of the country in the coming years.

Gliricidia is easily propagated and grows prolifically in a wide range of conditions: acidic soils, ranging from sand to dark loam with a pH range of 4.5-6.2, and annual rainfall of between 600-3500mm.

It is already being used successfully as a multi-purpose 'fertilizer' tree in many East and Southern African countries, South-East and Central Asia, South and Central America, and the Pacific Rim. Accordingly, with minor adjustments to reflect the constraints and opportunities posed by varying biophysical and cultural contexts, and sufficient seed investment, COMACO's approach could be easily and rapidly replicated across much of the developing world.

2. AUSTRALIA AND OCEANIA

2.1. "The Emerald Plan" - Concepts of fitting production landscapes with modern energy production possibilities via merging better biodiversity outcomes in agricultural landscapes at large scale

Affiliation / Organisation: Gasification Australia Pty Ltd

Contact name: Mark Feltrin, on behalf of Gasification Australia

Project name: Development of a Multi Role Indigenous Integrated Landscape Design (MRIILD) for Australia: The Emerald Plan

Location of project: Victoria, Australia

Publications:

- Gasification Australia March 2008, The Emerald Plan: Integrated solutions for energy, biodiversity and climate change, Mark Feltrin, Ben North & Dr John Sanderson
- Gasification Australia March 2010, Environmental and economic benefits of multiple use tree plantings for landscape restoration, wood products & bio-energy production, Mark Feltrin & Dr Barrie May

Link: http://www.gasificationaustralia.com/; http://www.emeraldplanfoundation.org/

Type of contribution: A specific project/activity

Description

As a conceptual tool, The Emerald Plan informs policy based on a foreseeable future, scoping remedy for heavily degraded land through holistic approaches to landscape conservation and bioenergy production with consideration given on a state by state basis. Three years later in 2010, a second paper entitled 'Environmental and economic benefits of multiple use tree plantings for landscape restoration, wood products and bioenergy production' continued these themes, modelling practical examples compatible with the growth rate of trees in low rainfall terrains characteristic of Australia, applicable to agricultural production at a private landowner / farm-forester scale; comparing results for biodiversity, biomass production and profitability of alternative native plantings in three contrasting theoretical forest systems.

Status

Initially developed in 2007 with subsequent additions in 2010, the Emerald Plan has been formally presented at the 2rd World Agroforestry Congress ICRAF/UNEP in 2009, three Bioenergy Australia conferences and various educational institutions in South Australia and Victoria. Arousing curiosity internationally from Australian Federal and State governments as well as NRM academics, papers were distributed to as many quarters as possible. Despite this, it has not yet been given the attention it deserves.

The necessity to develop a bioenergy vision of a green future is currently gaining impetus as landscape degradation continues, with surmounting pressure for policy makers to contain. Once seen as idealism, a decade later has become a probable pathway for bioenergy sustainability credentials to be realised, with a potential for a large biomass resource to be further developed. In the decade since, the demand for a MRIILD mindset has become a reality at national and international levels, with Integrated Landscape Management (ILM) being recognised as a policy priority, actively pushed at upper tier levels such as the United Nations (UN) and Food & Agriculture Organisation (FAO).

Positive impact

While FAO approximations for marginal land currently stand around 2,700 Mha, Gibbs and Salmon (2015) estimate current levels for marginal and degraded land to range from 1,000 to 6,000 Mha (Fritsche, 2017). Other calculations indicate that 25 percent of global land area is impacted by degradation at a rate of 12 Mha per year, costing up to 10.6 trillion annually; the rural poor being most affected (FAO, 2011).

Until now, most biomass resources snapshot what already exists rather than taking account of future alterations, including actions to mitigate threats tied to degradation.

Landscape modifications proposed in The Emerald Plan show clear amelioration strategies, resolving negative environmental impacts of large 1st generation bioenergy plantation endeavours such as the Asian palm oil crop expansion. Fundamental to The Emerald Plan was recognition that responses to climate alone could not solve fundamental landscape issues. Devised in response to growing landscape and consumer tensions, The Emerald Plan highlighted Gasification Australia's belief that:

- Landscape planning could achieve multiple outcomes, and not be driven by a singular focus.
- Reversal of negative ecological spatial attributes need not forsake output. In other words, reintegration of fragmented indigenous ecologies is possible while still deriving an economic capacity.
- Synergies exist across government departments so that a singular activity [e.g. revegetation] can achieve multiple benefits.
- Overall cost effectiveness should be viewed over larger time spans and across multiple outcomes.

- The capacity of biomass energy to service national demands will always be challenged by scale and cannot be justified by energy outcomes alone.

In improving land quality and ecosystem resilience, a holistic yet pragmatic approach can be taken to degraded landscapes by applying conservation theories to agricultural production. An image of a restored South East Australian landscape was generated (illustrated below as Figure 1), where biomass would be derived from sustainably harvested native revegetation placed in the landscape; addressing biodiversity loss and creating habitat corridors with improved vegetation connectivity and providing a pathway for biomass production for bioenergy.

Serving as an example of such an approach, aggressive planning zones for revegetation are indicated in red; selected against a broad criteria and cost-benefit analysis while taking account of the predominant environmental issues in each state. These bio-rich, core agricultural areas would eventually be groomed for biomass harvesting, having modifiable and multi-role traits and agricultural outcomes; providing more appropriate land use alternatives for areas becoming sub-economic for existing agricultural uses.

Integrated Landscape Management (ILM) is perceived to counter traditional measures where "conventional policy approaches that assume land can have one priority objective while 'trading-off' other objectives" is a desired approach to addressing global UN development goals (Shames, Heiner & Scherr, 2017). Bioenergy has the promise to not just be an attached option, but to stimulate further forest and landscape restoration (FLR) efforts; bridging developing & developed nations with technical expertise and enabling broader contexts.

By pragmatically matching modern society's need for energy and the wider ecological need for landscape restoration and ecological spatial connectivity, The Emerald Plan outlines numerous methodologies to counter any shortcoming, with respect to 1st generation simplistic crop-dependent bioenergy sources. Modelling undertaken in the document Environmental and economic benefits of multiple use tree plantings for landscape restoration, wood products and bioenergy production compared increases in landscape capacity among three differing tree systems:

- Production focused - short rotation industrial pulpwood monocultures

- Environmentally focused - revegetation for biodiversity and other environmental needs (but not harvested)

- Mixture of both – Mixed native species harvested for multiple products (including bioenergy) over longer rotations.

The theoretical scenario involved a typical cleared farm (60 ha) with some remnant vegetation currently used for firewood and shelter (6 ha /10%, resulting in a cropland of 54 ha). Other attributes assigned were: medium to low rainfall, moderate productivity and a biodiversity score of 24/100. Here, the area was assessed as having low biodiversity, but because of the remnant vegetation still possessed some value.

We assumed the same site productivity and growth curves for the 3 scenarios, with the main differences being species mixture, rotation length and harvest regime. Using the National Carbon Accounting Toolbox (2005), growth and carbon sequestration was modelled over 100 years. While estimated profitability was based on values derived from the instrument 'Regional Opportunities for Agroforestry Systems in Australia' (Polglase et al., 2008), biodiversity benefit was approximated from the Plantation Biodiversity Scorecard (Cawsey and Freudenburger, 2005).

Environmental performance may be applicable to a wide range of local scenarios, with spatial and functional modifications able to improve potentials and be constructive components to specific environmental activities such as biodiversity connectivity linkages. The creative modelling did not attempt to measure food potential but had obvious utility for integration with existing agricultural practice, such as grazing animal usage; indicating that managing outcomes can broaden possibilities of outputs, including food production. This highlights that ILM and Natural Resource Management (NRM) approaches do not necessarily limit agricultural activities, even if intensive. In fact, scenarios provided scope for new income streams through diversified agricultural enterprises and new regional business, offering improved employment and value chains.

Reasons or main driver for the project

1. *Consumption demands*

Access to cheap energy and high per-capita energy consumption are modern traits of the Australian society. This document pondered the possibility of applying financial mechanisms and environmental actions to justify mass environmental plantings. Lowering carbon emissions and enhancing energy security depend heavily on domestically produced low-carbon fuels instead of fossil fuels.

2. *Remediation of the environment*

Compared to other renewable energy sources bioenergy has a larger land footprint (McDonald et al. 2009), yet under the IEA 2DS scenario will deliver up to 17% of global energy demanded by 2060 (IEA, 2017). Bioenergy's application becomes important when scoping for solutions to landscape tensions (e.g. food vs fuel issues), compounded by current and projected population and consumption patterns, but must be produced and used sustainably.

Of the 25 percent of the world's lands subject to high rates of degradation aforementioned, Minnemeyer, Laestadius & Sizer (2011) believe 1500Mha suited to mosaic restoration including agroforestry, 1000Mha in croplands and elsewhere the strategic placement of trees to protect and enhance agricultural or ecosystem functions. FAO 2018 targets to rehabilitate 350Mha by 2030 through their Forest and Landscape Restoration Mechanism (FLRM) have bio-energy potential, recognised within the publication 'Global Land Outlook: energy and land use' (Fritsche, 2017); stating that "production of bioenergy feedstock on marginal land combined with biodiversity and social safeguards is a possibility".

Key enabling factors

1. Mitigation opportunities available through conservation science, NRM principles and applications

The emergence of climate change and recognition of tree crops as providing both carbon sequestration and renewable energy opportunities have added impetus to solving land issues. Consideration of total landscape function, agricultural production and rural communities have been well understood in the Australian context, beginning with soil conservation efforts as early as 1930-40's, evolving into the community based LandCare movement formed in 1986 (Campbell, 1994).

Guided by these theories, our vision was achieved by creatively applying the multiple challenges faced (e.g. climate change, energy, biodiversity loss), and matching them to societal needs, while envisioning a possible landscape through methods already utilised in this country; principally derived through revegetation schemes.

2. Emerging policy

In Australia, national and state government resolve to address NRM problems arising from agriculture is given. Efforts to counter degradation run parallel to FAO and UN measures like Integrated Landscape Management (ILM), the Forest and Landscape Restoration Mechanism (FLRM), and agroforestry (long promoted by ICRAF & UNEP), seen to assist developing nations.

The Emerald Plan holds that a bioenergy pathway exists via global land remediation. Biodiversity-focused agricultural production systems implemented with ILM processes and community/farmer based NRM activities can achieve multiple Sustainable Development Goals.

Achieved outcomes

Results of the three alternative planting scenarios abovementioned showed:

- The Emerald Plan's focus on wider production tree systems rather than particular species indicate the breadth of outcomes possibly derived.
- Spatial considerations such as waterway planting and connectivity; native/indigenous production tree species mixes; and indigenous understory and ground habitat presence are all important environmental elements.
- Production tree systems can have performance capabilities nearing purely environmental plantings but with advantages in profit.
- Inclusion of biomass utilised for bioenergy over 100 years of usage compared favourably to locked carbon in environmental plantings.
- Not modelled was the cost value of these systems acting on the whole landscape.

Biodiversity was maximized by the environmental plantings, but the pulpwood monoculture had higher biodiversity outcomes than the cleared paddock. Importantly, biodiversity score of the mixed plantation was nearly as high as the environmental plantings.

Biomass production was maximized under the pulpwood monoculture as a result of the shorter rotation. Because trees grow slowly as they mature, biomass production is lowest in environmental plantings. The growth rate of mixed plantations fits between the two other examples.

There was an inverse relationship between the ranking of carbon sequestration and biomass production. The environmental planting sequestered the most and pulpwood monoculture the least, while the mixed planting assumed the middle position again.

Products: Only one product was harvested from the pulpwood plantation at the end of its 10-year rotation. The mixed planting created a range of products supporting on and off farm industries; the result of thinning and final harvest through a 30-year rotation.

Without a carbon price, the pulpwood monoculture and mixed plantings were profitable, however not as lucrative as the original cropping system. On the other hand, biodiversity and carbon sequestration was maximized by the environmental plantings. The mixed planting combined a relatively high biodiversity score and profitability with intermediate carbon sequestration and no bio-energy production, to high levels with bioenergy production (indicated in grey).

With the introduction of a \$20/t CO_2e carbon price, the profitability of all three forest systems is increased, including the environmental planting. The pulpwood and mixed plantings systems become nearly as profitable as the current cropping system, however the mixed plantation offers a combination of higher profitability with higher biodiversity and carbon mitigation benefits. Further research could investigate the influence of bio-char technology upon these systems.

Main challenges (encountered)

Of issue is the role of the tree in the Australian landscape. Forestry and production of bioenergy from forests are often portrayed negatively due to unsustainable harvesting of existing native forests. Traditional agricultural industries of grazing and cropping also consider forestry a threat to competition for land and water. These perceptions, combined with lack of ongoing support for private farm forestry, failures of the Australian carbon trading system, lack of positive forestry examples in Australian media, and bushfires have eroded the ideal of productive and sustainable tree harvesting on private land.

In contrast to this, the importance of environmental planting has increased in social consciousness over time, be it at a farm level through to grand ambitions of large landscape environmental connectivity projects. By 2011, 12 large (700–3000km) initiatives and approximately 20 smaller scale initiatives (50-200km) were underway within Australia (Wyborn, 2011). The fate or extent of these endeavours in 2018 remains unclear.

Bioenergy projects are typically driven from a business case perspective, assessing feedstock resources and applicable technologies rather than landscape implications. Hindering its broader global appeal, expressed concern (Giovannucci et al., 2012) that "biofuels are likely to contribute to more food-related crises due to their inefficient use of food-related resources" are justifiable, demanding substantive changes of approach. Current international policy to stop global environmental degradation, while conflicted with the role of bioenergy in the landscape, may better guide the Bioenergy industry to refocus.

Potential for scaling-up and replicability

Scalability is hinged on the plan's wide application, with permutations to all parts of Australia and the world. In addressing landscape issues, national scales are a logical progression, having policy implications at all tiers of government.

The Emerald Plan initially focused on a national bioenergy system along the Eastern seaboard in proximity to the main Australian population, although consideration and application is given to all mainland areas. Acknowledgement is also given to the diversification of renewable energy production and the potential for solar, wind and ocean energy to be incorporated in diversified (and possibly decentralised) national energy systems.

In terms of replicability, modelling undertaken in the documents can inform strategic planning in land-use change. Assessment of the environmental and economic benefits of multiple-use tree plantings for landscape restoration, wood products and bio-energy production afford evidential insight into maximised local and global outcomes.

Focusing on Australia, a continent of environmentally harsh and diverse conditions and life forms, The Emerald Plan provides a global microcosm to the challenges and possible directions for adaption by the Bioenergy industry into the Anthropocene age. As a model for integrating indigenous landscapes which provide a basis for energy production, there are transferrable concepts and strategies lending to international application.

2.2. A 30 MW power plant from 16.000 ha eucalyptus, PNG Biomass Markham Valley Power Project

Submission type: Organisation

Affiliation / Organisation: Markham Valley Biomass Limited (aka PNG Biomass)

Contact name: Michael Henson

Project name: PNG Biomass Markham Valley Power Project

Location of project: Markham Valley, Lae, Morobe Province, Papua New Guinea

Other details: The project is fully owned by Oil Search Limited. Oil Search is an oil and gas exploration and development company that has been operating in Papua New Guinea (PNG) since 1929. The Company is the country's largest oil and gas producer and has interests in all of the nation's producing oil and gas fields. While biomass-to-energy is a new business sector for Oil Search, it has a long history of developing large-scale greenfield projects in PNG, with extensive in-country experience. In 2016, the Company made an estimated US$284 million contribution to PNG's socio-economic development.

Publications:

- PNG Biomass - Driving Sustainable Growth in PNG (2015)
- Profile Magazine - Oil Search's Renewable and Sustainable Energy Initiative (2017)

Link: www.pngbiomass.com

Type of contribution: A specific project/activity

Description

Front End Engineering and Design (FEED) is currently underway on the PNG Biomass Markham Valley Power Project (the Project). The Project is a long-term (25+ years) energy initiative that presents one of the most exciting renewable and sustainable energy initiatives in PNG's history.

The Project in the Markham Valley is a long-term renewable energy initiative in Morobe Province, PNG. It will use wood chips from trees sustainably grown and harvested in surrounding plantations to fuel a biomass power plant to provide up to 30 megawatts (MW) into Lae and the Ramu grid. Subject to the successful completion of FEED and a Final Investment Decision, first deliveries of power are targeted to commence in 2019, in line with PNG Power Limited's (PPL) requirements.

The Project consists of two distinct components:

1) the establishment of up to 16,000 ha of sustainably managed eucalypt plantations; and

2) the construction of a biomass-fuelled power plant consisting of two 15 MW units, with the preferred power plant site being located in the southeast of the Project area.

The Project's overarching goal is to enhance energy security in PNG by increasing power generation capacity and providing energy independence for PNG, without compromising the country's pristine and unique environment.

A key objective of the Project is to improve the wellbeing of Papua New Guineans by developing biomass plantations, with the active involvement of local landholders. The Project will create a long-term sustainable source of safe and reliable power which meets the needs of communities and the environment.

A secondary objective is to sell timber products when biomass supply exceeds power plant requirements.

Status

Initial development of the PNG Biomass Markham Valley Power Project commenced in 2010 and its progress has followed four stages.

In the Project's first two-year phase, more than 2,500 kilometres of field traverses, soil sampling and studies were conducted across the whole of PNG, to identify areas suitable for biomass plantations and to understand the land use and regional community and business requirements.

Between 2011 and 2014, the Project entered its second stage. Over 500,000 trees were planted at more than 50 test sites across PNG, to evaluate growth and survival rates and, from this data, select the best species of tree to support large-scale plantations. Studies were conducted in cooperation with the PNG Forestry Department and Forest Research Institute to enhance the knowledge and use of PNG's species.

The Project's third stage from 2014 to 2017 has already seen the establishment of three nurseries capable of generating the seedlings required to support the project and plantation. In 2014 an exhaustive, transparent and competitive tender process commenced, which resulted in the signing of a PPA with PPL to underwrite the initial 15 MW in 2016 and an option to expand to 30 MW. Agreements are now being negotiated with landowners to convert existing MOUs for land use into rental and leasehold agreements covering 16,000 ha of land, which will be planted under sustainable forestry practices. Only 9,000 ha is initially required to produce 15 MW. However, planting 16,000 ha allows for rapid expansion to meet the expected demand and provides additional fuel certainty. The 15 MW power plant modules will be constructed within the plantation area and the power will be tied into the 132 kV Ramu electricity grid commencing in 2017.

The fourth and final stage of the Project will provide power into the Ramu grid. By the end of 2019, it is expected that the biomass power plant will be feeding 30MW of reliable and competitive power into the Ramu grid, supplying additional energy for major industries, households and rural communities. With the Project, Oil Search is helping the PNG Government achieve its goal of making electricity available to an additional million people near the Ramu power grid by 2030.

Project progress

- Initial PNG-wide Feasibility Study for biomass power conducted between May 2010 and February 2011.
- Markham Valley determined to be the preferred site; first trees planted in August 2011.
- Initial landowner agreements, trial plantations and services agreement with PNG Forestry Research Institute in Lae signed in January 2012.
- MOU signed with PNG Power Limited (PPL) to conduct a Feasibility Study in May 2012.
- PPL competitive tender process commenced in December 2012.

- A 25-year Power Purchase Agreement (PPA) was signed with PNG Power Limited (PPL) in December 2015.

- The FEED phase commenced in September 2016 and is targeted to be completed in the second half of 17.

- FEED phase activities focus on refining technical and commercial aspects of the Biomass Project as well as completing a full Environmental and Social Impact Study.

- Oil Search acquired full ownership of the Project in mid-2016.

- 584 hectares of eucalypt are planted by December 2016, with another 1,000 hectares to be planted in 2017, of the total 16,000 hectares of plantations.

- Submitted the Environmental Assessment (EA) report and Environmental Management Plan (EMP) to CEPA in March 2017.

- Receive Environment permit from CEPA by 3Q 2017.

- Establishment of initial 3,000 hectares of plantation by 4Q 2017.

- Commissioning of the power plant (first 15 MW unit) by 3Q 2019.

Positive impact

The potential impacts and benefits as a result of the implementation of the Project have been considered in the three assessments: Social Impact Assessment, Environmental Assessment and Economic Impact Assessment.

The PNG Biomass project is expected to generate considerable benefits and opportunities for PNG and its citizens during the Project life. By providing reliable power that is sustainable and in harmony with the environment and the community, the Project is a key driver for the growth and the well-being of the people of PNG. PNG Biomass will have large and long-lasting positive benefits in an area which is not presently benefitting from a resource project.

The main benefits include providing competitively priced, sustainable and reliable power capable of supporting everyday needs and creating employment and local business opportunities for PNG citizens. In particular, the Project's emission of carbon dioxide (CO2) to the atmosphere is significantly lower than if the same amount of power was generated by heavy fuel oil (HFO) or other fossil fuels.

Employment opportunities

PNG Biomass will create major local employment opportunities for PNG citizens in the Markham Valley. An independent economic study estimates that the 16,000 ha plantation, the power plant and associated plantations will provide over 500 direct jobs for Papua New Guineans and many more additional indirect jobs in a region that has traditionally faced significant unemployment for youth and women. There is no other power project in the country which can sustain this number of jobs for Papua New Guineans in local communities.

Landholder engagement

An important element of the Project is that landowners obtain a range of economic and social benefits. Landowners receive land rental payments for the land leased to the Project, receive local business development support and get crop share payments.

Food security

Intercropping, where food and cash crops are planted between the rows of plantation trees, is proving to be a significant activity to improve local food security and generate economic value. Landowners are increasing their income materially by co-planting (intercropping) between trees in the Project area. The Project is also looking at the most effective way to integrate the grazing of cattle between mature plantation trees.

Reasons or main driver for the project

The PNG Biomass project aligns with the development priorities of the PNG Government. Access to electricity remains one of the country's most significant development challenges. With only 13% of PNG's population connected to a power grid, many people do not have access to reliable power capable of supporting their everyday needs. Those who are connected to one of the three main PNG power grids pay some of the highest electricity prices in the world. The PNG Government is therefore seeking solutions that will substantially improve the population's access to electricity and that will result in a reduction in its cost.

PNG is an ideal candidate for distributed generation and small-scale (domestic or village level) power, as reflected in various PNG Government development goals and planning strategies. The PNG Power Sector Development Plan has a long-term objective of increasing the availability of reliable and sustainable power supply in PNG at a reasonable cost. Focusing on existing technology for providing local level electricity, the use of biomass is considered to be highly feasible.

The PNG Government has set a goal of connecting 70% of the population to the power grid by 2030, using multiple power solutions. Our power strategy will help the PNG Government to meet this goal and its renewable energy target and commitments under the Paris Agreement. PNG has committed to transitioning to 100% renewable energy by 2030, if funding is available. Scalable renewable energy solutions will need to be rapidly introduced, with gas as a transition fuel.

Key enabling factors

Power Purchase Agreement

The Project is a response to a call from PNG Power Ltd (PPL) for an Independent Power Producer (IPP) to generate 30 to 40 MW of power near Lae, and reflects the requirements of a 25-year Power Purchase Agreement (PPA) that was executed with PPL on 15 December 2015. The Project will address, at least partially, the current inability of the Ramu grid to provide reliable power, and the PNG Government's long-term objective of increasing the availability of reliable and sustainable power supply at a competitive cost.

Plantation site

The Markham Valley is an area which is highly suitable for biomass power generation due to its rainfall and proximity to existing infrastructure. There are sealed roads from Lae and PNG Power Limited (PPL) has 132 kV transmission lines passing overhead to a nearby switching station as well as 22 kV lines for construction power and a new Lae port expansion underway for the import of materials. The land is predominantly flat Kunai grasslands with suitable climate, rainfall, alluvial plain soil conditions, a nearby water supply from the Markham River, generally flat topography and low local population density.

These conditions enable a guaranteed fibre (woody-biomass fuel) supply provided by large scale, specially planted and sustainably managed plantations, located in close proximity to the power plant. By establishing the plantations only on degraded and underutilised Kunai grasslands and grasslands invaded by exotic invasive woody-weed species (such as rain tree), the Project is ensuring it will not contribute to deforestation in PNG. The plantations convert Kunai grasslands into a multiple-use agricultural system that allows for intercropping on the same site in the first year and grazing cattle after 18 to 24 months.

Achieved outcomes

- Co-planting trials in which local landowners grow cash crops in rows between the plantation seedlings have been highly successful in increased food production and cash crop revenue for local families.
- The application of silvopastoral techniques (cattle grazing under planation trees) to foster the continuation of cattle raising in the area.
- Extensive trials and pilots have been conducted to find the best growing trees.
- Two community nurseries and a local business nursery have been established, and these operations derive material revenue by providing seedlings for the Project.
- The Project is providing employment for people from local communities, with hundreds of positions with active work.
- A landowner management committee has been formed to manage community business development opportunities.
- Social, Environmental, Economic impacts assessments have been completed and indicate that the project will meet or exceed all relevant metrics, principles and codes (Equator Principles, FSC, Carbon Gold Standard).
- An independent report on project benefits has confirmed that the Project will make a long term, positive and material impact on reducing carbon emissions, creating local employment and training opportunities and raising the local socioeconomic conditions as a consequence of wages, land rental and wood royalty payments and local business development.

Main challenges (encountered)

- A lack of familiarity of government and utility decision-makers with biomass production and power generation technology.
- A "business as usual" legacy attachment to hydrocarbon-based generation at senior decision making levels.
- Scepticism from local landowners that (a) electricity can be produced from biomass and (b) that a project would eventuate, as they have been provided many assurances in the past by other projects which have failed to materialise.
- A long engagement with PNG Power to establish the most appropriate technology size (15 MW) which would allow scalability and additions but would minimise the potential for unused generation capacity in the Project

- A low level of formal documentation of individuals and land ownership, which means that ownership confirmation is a long and detailed process, requiring appropriate records to be kept from initial contacts and on an ongoing basis with all landowners and claimant landowners.

Potential for scaling-up and replicability

The project has been designed so that 15 MW units can be added at the central plantation location to provide a generation capacity of 30 MW – with the potential for up to 45 MW, if required.

Scaling up above 45-50 MW often becomes problematic with biomass, as there is a limit to the amount of underutilised land which is available, and this Project's philosophy does not support using land which may have an existing use for food or agriculture. In addition, transportation of biomass over long distances is usually not economically viable.

Replication of the Project requires a combination of parameters:

- Over 20,000 ha of underutilised and lightly populated land which lacks alternative uses, and which is not already covered by native forest.
- Proximity to a large waterway for cooling water.
- Proximity to a transmission line or dedicated customer who requires base load power.
- A remote location where the alternative for shoulder / baseload power in the 15 MW range are liquid hydrocarbon based with the associated environmental negatives (NOx, SOx, fumes).

2.3. The Benefits of Biomass Harvest with Crop Rotation in the Australian Agricultural Landscape

Contact name: Gordon Williamson, solvestuff@gmail.com

Organisation: Individual

Location of practice: Western Victoria, Northern Victoria, Southern New South Wales (NSW), Central NSW, Northern NSW, Southern Queensland, Eyre Peninsula South Australia (SA), South Eastern SA, Midlands Western Australia (WA), Central WA and Southern WA.

Other details: The practice requires no additional investment or expense compared to current agricultural operations. The practice is applicable to both large and small land holders.

Publications:

- Harvest weed seed control - Grains Research & Development ...; https://grdc.com.au/.../2012/04/**Harvest-weed-seed-control**
- Harvest Weed Seed Control - AHRI; ahri.uwa.edu.au/.../10/1100-AHRI-**Harvest-Weed-Seed-Control-**Booklet...
- Crop Weeds: Weed management at harvest | Department of ...; www.agric.wa.gov.au › ... › Crop Weeds: **Weed** management **at harvest**
- Intercropping Winter Cereal Grains and Red Clover; https://store.extension.ia**state**.edu/Product/pm2025-pdf · PDF file

- [Pastures in cropping rotations – North West NSW;]() www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/162936/Pastures-in... · PDF file

- [Legumes: Their potential role in agricultural production;]() eap.mcgill.ca/MagRack/AJAA/AJAA_9.htm

Type of contribution: The example is a practice or approach

Status: Requires trial / Pilot project

Positive impact

- Retaining crop residue at an optimum height in Canadian 5 yr trials reduced soil evaporation by 27% and increased grain yield by 13.8%

- Collect crop residue above optimum height as Biomass harvest - including small grain, weed seeds, crop stubble, disease spores and weed biomass that across 14 trials in Australia improved herbicide resistant annual ryegrass control by 32 – 75%

- Moving to crop rotation including pasture legumes that lodge Nitrogen to the soil recorded in 8 yr US trials as reducing synthetic Nitrogen usage by up to 86%

- Moving to crop rotation including pasture legumes and a full crop harvest each 3rd year at minimum, removing crop stubble with disease spores and herbicide resistant weeds that in 8 yr US trial reduced Herbicide usage by 89%

- As a result of reduced Herbicide and Synthetic fertiliser usage Water toxicity reduced 100 times from 10,000 CTUe to 100 CTUe from 2003 to 2005 in the US trial

- Employing crop rotation reduced fossil energy use by up to 51% in the 8 yr US trial

- Profitability was consistent and crop biomass remained at up to 8.6 Mg ha in the 8 yr US trial

- Employing crop rotation required a 94% increase in labour creating Jobs in the 8 yr US trial

- A Canadian study between 2006 and 2009 confirmed that seeding barley on barley residue increased the risk of plant disease spore carryover than seeding on canola or field pea (crop rotation) as a disease management approach

- An Australian study in 2002 confirmed that narrower row seeding and applying a higher density of seed can generate a higher wheat yield and minimise rye grass seed yield.

Reasons or main drivers for implementing the practice

- Reduce herbicide resistant weeds, their seeds and crop volunteers to ensure crop yield and food security

- Reduce disease spore carryover on crop residue and crop volunteers to ensure crop yield and food security

- Reduce water toxicity to ensure sustainability and food security

- Create Jobs

- Maintain crop biomass volume and farm profitability
- Reduce on farm fossil fuel use

Key enabling factors

A change in Governmental policy so farmers must maintain water toxicity units (CTUe) in ground water, recycled water and run off at nominated levels

Achieved outcomes: Requires trial / Pilot project

Main challenges encountered

A Biomass plant easily meets the temperature and time requirements for weed seed and small grain destruction, but there are none for this purpose in Australia.

Potential for scaling-up and replicability

The practice can be replicated in Temperate climates throughout the world in Semi Arid to Sub Humid environments.

3. EUROPE

3.1. Biogas done right

Submission type: Organisation

Affiliation / Organisation: CIB – Consorzio Italiano Biogas e Gassificazione

Contact name:

Guido Bezzi (agronomia@consorziobiogas.it); Lorella Rossi (agroricerca@consorziobiogas.it)

Project name: Biogasdoneright®

Location of project: Italy

Other details: CIB - Consorzio Italiano Biogas e Gassificazione is the first voluntary group that brings together manufacturers of biogas and syngas from renewable sources (mainly agricultural biomass), business or industrial companies which supply equipment and technology, bodies and institutions that contribute in various ways to achieve social purposes in Italy. CIB was established in 2009, has national coverage and aims to be the reference point for the supply of data and information in the biogas and gasification sector. CIB aggregates 582 ordinary members (plants), 43 company members (manufacturers of biogas plants), 10 institutions and 65 partners (companies operating biogas chain)

Publications:

- D. Peters et al., 2016. ECOFYS report - Assessing the case for sequential cropping to produce low ILUC risk biomethane.
- AA.VV., 2016. Biogasdoneright – Anaerobic digestion and soil carbon sequestration.
- Bezzi et al., 2016 - BiogasDoneRight® model: soil carbon sequestration and efficiency in agriculture. Proceedings of BiogasDoneRight® model: soil carbon sequestration and efficiency

in agriculture, pp. 1387-1389.

- CIB working group - Considerations on the Italian agricultural Biogasdoneright potential (https://www.consorziobiogas.it/wpcontent/uploads/2017/05/Potenzialit%C3%A0_biometano_Italia_FI NALE-ENG.pdf)

- Lo sviluppo del biometano e la strategia di decarbonizzazione in Italia – Position Paper CIB, SNAM, Confagricoltura per COP21 Parigi

Link: www.consorziobiogas.it

Type of contribution: A practice or approach

Description

Production of advanced biofuels with Biogasdoneright® model: the application of sustainable sequential cropping to produce biomass, food and feed with high soil use efficiency and low environmental impact.

Status

Since its foundation (2007) CIB - Italian Biogas Consortium is analyzing some member's questions about the role of anaerobic digestion in farm. For these reasons, it was set a strategic plan with the main objective to produce agricultural biogas and advanced biofuels while continuing production of quality food and feed. Today this objective is achieved with the Biogasdoneright® application, that means the complete integration of the anaerobic digestion in farm with a change of agricultural approach in order to improve soil use efficiency and rotations. In this way, it is allowed the production of biomass for the biogas without lowering the food or feed production for the market. Moreover, it is possible to contribute positively to improve agro-biodiversity thanks the introduction of new crops rotations without changing of landscape or soil destination and, in some cases, recover marginal soils.

Positive impact

Agriculture can become a key sector for safe environment when is able to make a sustainable increase of production with an efficient use of natural resources.

Biogasdoneright® is a real efficient agronomic approach which can create a positive relation between food production and bioenergy in a real circular, sustainable and productive system because: - Farms with biogas are recycling agricultural by-products and are closing the soil carbon cycle with the continuous return organic matter to soil via digestate. - Is possible to improve soil fertility and rotations with conservative and efficient cultivation systems. - Farms can support profitability of quality production thanks to differentiation and integration of different activities and productions. - Farms can produce more bioenergy and agricultural products with a very low carbon foot print.

Biogasdoneright® model has begun from some Italian farms directly on field. It requires a change of agriculture management related to the improve of soil use efficiency. With this approach farmers are already obtaining an improve of sustainability and resilience of their farms, are introducing new efficient rotations and are maintaining original agroecosystem with an improve of biodiversity and without significant changes in original landscape.

One of farms that is starting to apply Biogasdoneright® model from some years ago is analysed as a case study in order to measure in real positive effects obtained applying the new purpose of agricultural management based on: - Valorisation of agricultural by-products (manure, sewage, crop residues etc.). - Soil covered almost all year long with the beginning of sequential cropping cultivation that allowing the improve of forage unit production potential in the same hectare. - Improve of soil fertility and soil carbon sequestration, thanks to efficient use of digestate as fertilizer. That allows a reduction of chemical supplies, reduction of aquifer and atmospheric pollution risk and general reduction of environmental impacts of farms productions.

The benefits achieved by the advanced agricultural management done with Biogasdoneright® will be described by measuring some parameters: - Added carbon production per hectare by introduction sequential cropping (second harvest crop after/before food or feed first crop). - Soil organic matter increase - Carbon foot print reduction - Production costs save by increase of investment capacity and food security improve.

Reasons or main driver for the project

The example proposed is real and already applied with good results and good perspectives of diffusion. It can have a huge positive impact to demonstrate in practice the feasibility of new agricultural management approach for efficient food/feed and energy production. The main drivers for implementing the practice are the improve of resilience of farms in order to develop sustainable and really applicable circular economy model in agriculture, the sector which have one of the bigger potential to contribute on world environmental safety.

Key enabling factors

The challenges of the purpose are in line with the EU concept of "circular economy" i.e. spanning the value chain and ensuring the use of secondary resources in other industries or value chains (COM(2011) 571 final). Moreover, the example is in accord also with the objectives of reduction of anthropic environmental impact purposed on COP22 and it is a real demonstration of the high potential that agriculture can give to contribute on sustainability and safety on food production (e.c.: programme 4pour1000). Finally Biogasdoneright® model allow the production of advanced biofuels with a lowest ILUC risk without significant changes in landscapes and agroecosystems.

Achieved outcomes

Some studies focused on Biogasdoneright® are done. First of all was the Ecofys study (2016) focused on the environmental performance of the model when sequential cropping (two different crops in the same field) is adopted in an Italian farm. Main results obtained demonstrate a significant increase of production of additional biomasses a low ILUC risk with sequential cropping compared to historical production of farm (in average +30-35 t/ha of triticale silage in winter in addition of summer food/feed production). Those results demonstrate how new agricultural model is able to produce additional biomasses without changes of soil use. Moreover, in the same study has been observed a significant increase of carbon and nutrients in soil thanks to conservative techniques and soil organic matter recycling done by applying Biogasdoneright® model. Another positive aspect observed by the Ecofys study was the significant reduction of costs and CO2 emissions when farm can produce biogas with sequential cropping. Compared traditional mays cultivation, double crop can generate a reduction costs for both (21% of reduction costs for feed silage and 43% of reduction costs for biogas silage). Moreover, when biogas is produced with sequential cropping and manure, biofuel can safe 86% of GHG emissions compared to fossil fuel emission. Other results achieved are published in a study on long agronomic effects of Biogasdoneright® model in another Italian farm (Bezzi et al., 2016). In particular, this 6-year study demonstrates how the new model can restore carbon cycle and improve soil fertility. With the efficient use of digestate as fertilizer and applying sequential cropping, was possible to obtain an average increase of 0,5% of organic matter in soils with related increase of cationic exchange capacity and increase of C/N ratio that means increase of nitrogen stability. That means sustainable increase of potential production of soil with a significant potential of carbon sequestration and reduction of chemical fertilizers use. Moreover, high nitrogen stability means a significant reduction on nitrogen leaching risk with a significant safety for aquifer. Results achieved demonstrates how BiogasDoneRight® model is a real example of agricultural management which can improve efficient use of natural resources. In particular, the increase of soil organic matter can enhance soil fertility and stability maintain soil nitrogen. Moreover, the introduction of sequential cropping can reduce costs of cultivation and makes really sustainable the production of bioenergy with additional biomass production. For these reasons, the BiogasDoneRight® model can be considered a true BECCS technology (BioEnergy with Carbon Capture and Storage) since it contributes to the closure of the soil carbon cycle thus creating efficient and sustainable "carbon negative" agriculture with a positive effect on increase of biodiversity and without changes in soil use and landscapes.

Main challenges (encountered)

To allow the correct application of the described model, the demonstration of feasibility of change in agronomy management is one of the main challenges. It means a big change in crop management and efficiency by farms. For these reasons Biogasdoneright® diffusion requires fundamental share from technicians to farmers in order to obtain a diffusion of new efficient agronomy techniques and solutions. The public participation for social acceptance is also important. The better understanding of the characteristics of Biogasdoneright® and how it can contribute from social, environmental and economic point of view are fundamental challenges in order to overcome local opposition and demonstrate the feasibility of feed/food/bioenergy system without limitation at the introduction of connected innovative technologies. There are also challenges from the political and normative aspects (e.c.: different digestate rules, biomethane rules ecc.) that requires a continuous development of studies in order to give a technical support at political stage.

Potential for scaling-up and replicability

Biogasdoneright® model validation and his diffusion are now at the beginning not only in Italy but also in all Europe. It has the potential to be replicated everywhere: in fertile soils, it could improve rates of cultivation; in marginal areas, it could rescue the fertility of soils avoiding desertification. The model has demonstrated to be completely suitable to scale-up or scale-down in order to be applied both in large farms or in small farms. Biogasdoneright® approach can be replicable in different agricultural contest in order to reduce emissions, improve sustainability and safe production and improve conservative systems. This is a really opportunity to develop an efficient and integrated circular model of agriculture that can produce more maintaining environment, biodiversity and landscapes.

3.2. Contribution of SRC to long term ragweed eradication in the City of Osijek

Contact name:

Biljana Kulišić[1] (submitting on behalf of an organisation and research team)

Željka Fištrek[1], Ranko Gantner[2], Vladimir Ivezić[2], Hrvoje Glavaš[3], Domagoj Dvoržak[4], Ines Pohajda[5]

Affiliation / Organisation:

[1]Energy Institute Hrvoje Požar, Department for RES, EE & environmental protection, Zagreb,

Croatia; [2]JJ Strossmayer University of Osijek, Agronomic Faculty Osijek, Croatia; [3]JJ Strossmayer University of Osijek, Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, Croatia; [4]City of Osijek, Department for EU programmes and projects & economy, Section for preparation and implementation of programmes and projects, Osijek, Croatia; [5]Croatian Extention Service, Zagreb, Croatia;

Location of project: Croatia, the City of Osijek

Other details:

As a follow up activity of an IEE project SRCplus (2014-2017) focused on SRC for local heat supply chains, the City of Osijek has engaged an interdisciplinary team of experts to investigate the option of planting SRC for bioenergy as a long term measure for control and eradication of strong allergen and invasive plant: common ragweed (Ambrosia artemisiifolia, ambrosia eliatior) with an ultimate goal to improve life standard of its citizens. At this point, the City utilises public funds for short term interventions against ragweed, resulting in temporary ease but still leading to high environmental, social and economic consequences and costs. Therefore, long term solutions for eradication of ragweed are proposed that would reduce prevalence of allergies and associated costs.

Publications:

- Kulišić B; Fištrek Ž; Gantner R; Ivezić V; Glavaš, H; Dvoržak D; Pohajda I: Reaching Economic Feasibility of Short Rotation Coppice (SRC) Plantations by Monetizing Ecosystem Services: Showcasing the Contribution of SRCs to Long Term Ragweed Control in the City of Osijek, Croatia // Forests 2018, 9, 693:Conference Report The 2018 Woody Crops International Conference / Gardiner ES; Ghezehei SB; Ghezehei WL; Richardson J; Soolanayakanahally RY; Stanton BJ; Zalesny Jr RS. (eds.). Basel, Switzerland: MDPI, 2018. 4-5 doi:10.3390/f9110693

- Pohajda I; Balabanić M; Fištrek Ž; Kulišić B: Management of *Ambrosia artemisifolia* in Croatian agricultural practice // 8th International Symposium on Environmental and Material Flow Management - Book of proceendings / Goletić, Šefket ; Imamović, Nusret (eds.).Zenica, BiH: Faculty of Mechanical Engineering in Zenica, University of Zenica, 2018: 221-226

Link:

www.SRCplus.eu

http://www.osijek.hr/index.php/cro/Socijalna-skrb-i-zdravstvo/Zdravstvo/Aktivnosti-na-suzbijanju-alergenih-korova-a-posebno-ambrozije-na-podrucju-Grada-Osijeka/Ambrozija

Type of contribution: A practice or approach

Status

The example has been selected for financing under the two-stage Rural Development Program: Measure 16 – EIP for Agriculture Productivity and Sustainability in 2018. The 2nd stage is pending in 2019. The plan is, if cost-benefit ratio proves to be better than the alternative, to implement the action under Urban Innovation Call 2020. Biomass for bioenergy is already in demand for local 2MWe/10MWth biomass CHP and ecosystem services approach against ragweed would be an additional gain.

Positive impact

The City of Osijek, North-East Croatia, is one of the many urban areas in Europe affected by ragweed (*Ambrosia L. species*). Namely, ragweed is the most proliferating invasive alien species in Europe with pollen of highly allergenic impact. The City has already invested much efforts in eradicating ragweed and dedicates significant assets on annual basis to reduce the allergenic effects on population.

Previous research has come to the conclusion that the most efficient method of eradicating ragweed is manual uprooting at the early stage of its growth. Yet, this method is labour intensive and slow. Thus, a combination of manual, chemical, biological and mechanical methods are implemented while a long term solution is yet to be found.

Ragweed has superior features that makes it difficult to control, let alone eradicate. It is wind-pollinated and it has been reported that each plant produces as many as 6,000 seeds per year with germination capacity up to 30 years from resting on the soil. It has ability to gain resistance to herbicides but it is sensitive to competition from other plants and disappears in dense vegetation. Ragweed grows along transport infrastructure, gardens, fallow land and pastures and, in particular, on abandoned agricultural land. However, due to its high capacity to spread, ragweed can often be found also on arable land under cultivation (wheat, buck weed, sunflower…) and in gardens and orchards causing reduced yields. For its growth ragweed demands high amounts of nutrients and water, and results in impoverishment of soil. The climate change effects in the area favour the spreading of ragweed and extents its pollination period as it requires warm climate, dry soil and sufficient humidity in summertime.

The assumption of this research is that planned planting of SRC on ragweed growing areas would eventually choke ragweed and provide wind-barriers that would reduce both spreading of pollen and seed. As SRC plantations have a life span beyond 20 years, it is reasonable to assume that this could be a measure for long-term eradication of ragweed.

The aim of this research is to contrast the current net costs for society of ragweed eradication measures to those of planting SRC plantations and risk of implementing this measure before getting proven results from pilot plantations.

Reasons or main drivers for implementing the project/practice/policy

The City of Osijek has recognized the problem of ragweed as a significant public health problem and has incorporated ragweed spread prevention among its priorities. Yet, a long-term solution is still missing. On the other hand, the City pursues its green agenda: it has established an eco-industrial zone Nemetin that would lean on low carbon economy, starting with utilising energy from renewable sources; founded a PPP "Centre of Renewable Sources" together with the University with a biogas plant using locally available substrates. In 2017, a solid biomass CHP of 2 MWe/10MWth for district heating will become operational.

SRC plantations would fit in the green agenda as local biomass supply while serving also as ragweed eradication measure.

Key enabling factors

Previous research has come to the conclusion that the most efficient method of eradicating ragweed is manual uprooting at the early stage of its growth. Yet, this method is labour intensive and slow. Currently, a combination of manual, chemical, biological and mechanical methods are being implemented while a long-term solution is yet to be found.

Project IEE SRCplus (2013-2017) and activities of IEA Bioenergy Task 43 have brought to the attention to the City stakeholders SRC as a plausible eradication measure, for the City of Osijek and beyond.

Achieved outcomes

It is expected that the current costs of the society assigned to ragweed, including both eradication measures and sensitivity of population to the pollen, would be more than net costs needed for planned establishment and maintenance of SRC plantations for local supply of biomass for the existing CHP plant.

SRC plantations would be a part of mixed measures with significant cost reduction in all other measures and increasing the effect of manual eradication as less areas would be left for uprooting. In that sense, less chemical agents would be used and soil/water quality would not be affected.

Overall, it is expected to demonstrate a pilot example with local biomass production from SRC plantations together with ecosystem services of a long-term sustainable ragweed eradication measure.

Main challenges encountered

To the best of our knowledge, SRC plantations have not been considered as a ragweed eradication method so far and the assumptions upon which this research is based are to be proven in the real life. Obtaining statistically significant and measurable proof that SRC plantations are long term ragweed eradication method would take several years.

This research is a turning point for the decision-makers to contrast the risk against the potential gains from SRC plantations and ecosystem services provided.

The first challenge is to achieve successful ragweed eradication by SRC on the proposed sites. The weeding of the SRC plantations in the first years is a crucial component for success, and the plantation weeding should be carefully planned in order to assure predominance of SRC over ragweed in competition over available nutrients.

The second challenge expected is legal. At this point, the Law on SRC plantations for bioenergy is in the process of adoption and, if enforced in the existing form, would reduce possibility to plant SRC on abandoned agricultural land of high quality.

The third challenge is administrative. Successful management of invasive species often requires an integrative approach, which combines monitoring, research, control tools, preventive regulations and interagency coordination. It is expected to have some resistance to the novel approach and thus, this preliminary research should detect how wide is the cost-benefit range of SRC plantations as ragweed eradication method.

Potential for scaling-up and replicability

This concept has a high scaling-up and replicability potential as sustainable bioenergy supply fits to the global plans for mitigating climate change and transition to low carbon economy. On the other hand, the sensitization rate of subjects allergic to ragweed pollen in the European population (Italy, France, Czech Republic, Austria, Croatia) is increasing and reached as high as 80% (Hungary). It is expected that sensitization to ragweed will increase from 33 to 77 M of people in Europe by 2016 (Lake et al., 2017). Allergies are estimated to cost the European Union at least €55 billion a year (Zuberbier et al., 2014) due to absenteeism and presenteeism. Current ragweed eradication methods are still short term and costs of the society are increasing as well as geographical area suitable for ragweed proliferation.

3.3. Combining different management regimes of fast-growing plantations on a landscape can result in the production of different and compatible ecosystem services, in addition to widen the economic options for the owners

Contact name: Blas Mola-Yudego, [1,2]; Ioannis Dimitriou [1]

Affiliation / Organisation:

[1] Swedish University of Agricultural Sciences; [2] University of Eastern Finland

Location of project/policy/practice: Sweden (different locations from commercial energy plantations on agricultural land)

Publications:

- Dimitriou, I., Mola-Yudego, B. 2017. Poplar and willow plantations on agricultural land in Sweden: Area, yield, groundwater quality and soil organic carbon. Forest Ecology and Management 383, 99–107.
- Mola-Yudego, B., Dimitriou, I., Gonzalez Garcia, S., Gritten, D., Aronsson P., 2014. A conceptual framework for the introduction of energy crops. Renewable Energy 72: 29–38.

Type of contribution: A specific project/activity (*)

Status: Currently being implemented

Positive impact

We are exploring the benefits of combining poplar and willow plantations at landscape level, with current agricultural crops. The main positive impacts refer to

- Diversification of economic incomes at different scales (social/economic)
- Positive synergies in ecosystem benefits created (environmental)
- Water & soil quality improvements (environmental)

Reasons or main drivers for implementing the project/practice/policy

Combining different management regimes of fast growing plantations on a landscape can result in the production of different and compatible ecosystem services, in addition to widen the economic options for the owners

Key enabling factors

- combine data concerning agronomy, energy efficiency, economy and soil/water/biodiversity effects.
- establish and quantify at the regional scale the functional characteristics of the lignocellulosic crop systems with regard to economy, agronomy, as well as water quality, soil quality and biodiversity effects - compare the lignocellulosic crop systems with each

other and with other relevant conventional agricultural crops.

Achieved outcomes

Better decision tools for the planning alternatives related to soil and/or water quality, food security

Main challenges encountered

The introduction of large-scale cultivation of poplar and willow plantations in Europe may have both positive and negative effects depending on the exact implementation, therefore decisions by farmers introducing these crops in the landscape should take the positive effects into consideration. This can only be achieved if there are available incentives implemented by decision-makers depending on their priorities that might be political decisions that do not take into consideration the priorities of farmers and other practitioners. Therefore priorities of several stakeholder groups need to be considered to achieve maximum benefits for all parts involved (not in all cases easy to achieve).

Potential for scaling-up and replicability: Being currently explored in the project.

4. NORTH AMERICA

4.1. Quebec, Canada - Unloved trees as sustainable feedstock for bioenergy, Evelyne Thiffault, Research Centre on Renewable Materials, Université Laval

Affiliation / Organisation: Research Centre on Renewable Materials, Université Laval

Contact name: Evelyne Thiffault, Evelyne.thiffault@sbf.ulaval.ca

Project name: Unloved trees as sustainable feedstock for bioenergy

Location of project: Quebec, Canada

Type of contribution

Research projects and results related to a forest management approach for procurement of forest biomass

Description

Surplus forest growth can be a particularly abundant but yet untapped and poorly accounted for source of forest biomass. A special case of this category is low-quality, degraded, damaged, or dead trees, together referred here as "unloved woods" (Figure 1). Unloved woods are particularly abundant in Quebec (Canada) due to the high levels of naturalness across forest landscapes. A substantial volume of unloved woods goes unutilized despite being part of the forest annual allowable cut (the government-dictated maximum sustainable forest harvesting volume).

Forest operators leave them on site because they do not meet quality requirements for conventional wood products such as lumber, pulp and panel: they are either too dry or too rotten (Figure 2), affected by fungi, cankers, cambial necrosis or trunk fissures, or are of a species that do not fit with current standards of wood-processing industries. Although they are unfit for conventional wood products, these unloved woods represent an attractive source of biomass for the production of renewable bioenergy because they do not compete with fibre supply of other forest industries.

Using undervalued trees and stands as bioenergy feedstock could greatly stimulate silviculture and management activities and improve wood value chain profitability by providing an outlet for underutilized fibre. Also, research into the emerging properties of fibre from unloved woods suggests that their characteristics might make them suitable feedstocks either for thermochemical and biochemical conversion, depending on species and level of wood degradation. In terms of economics, bioenergy offers the forest sector an opportunity to adapt to changing markets and build upon current sawmill and pulp and paper mill infrastructure. Using unloved wood for biomass production can help offset fixed costs and serve to redistribute timber harvest and forest management costs amongst multiple products. In doing so, the competitiveness of the forest sector as a whole can be increased.

Reasons for the project

- The high variability in terms of species and fibre quality across Quebec forest landscapes, due to the influence of natural disturbances and the forest management regime that promotes naturalness and biodiversity, is a challenge for the industries producing conventional forest products (sawtimber, pulp, panels) because of their strict fibre requirements.

- Current harvest levels in Quebec, which mainly feed an industrial network dominated by the production of lumber, panels and pulp, average only 55% of annual allowable cut, which may cause a gradual depletion of the overall quality of the forest resource if stands that have the highest value are preferably selected, and if landscapes are undermanaged due to lack of market for low-quality fibre (Durocher et al. 2019).

Achieved outcomes

Over the past years, the carbon neutrality assumption of forest bioenergy, especially of whole trees, has been the subject of much debate. This debate has brought some policymakers to consider abandoning forest biomass entirely as a renewable energy source, or to ban whole categories of feedstocks, such as roundwood. Careful prediction of the timing of the greenhouse gas (GHG) mitigation benefits of forest bioenergy systems relative to reference fossil fuel systems can be performed, therefore allowing the identification of optimal solutions in terms of feedstock choices and procurement strategies.

As an example of such calculations applied to bioenergy systems based on unloved woods, it is estimated that the procurement of biomass from degraded hardwood stands (Figure 3) as a substitution to petroleum coke could provide GHG mitigation benefits after 12 years or less after implementation of the bioenergy system, with cumulative GHG savings of 5.6-8.5 tonnes of CO2 eq per gigajoule of bioenergy produced over a 100-year period (translating into theoretical average total savings of about 100 000 to 152 000 tonnes of CO2 eq per year). Current common practice for those unloved stands, with the help of financial incentives from the government to reduce the amount of stagnant unproductive forest areas, is to cut down and bulldoze the trees (which have no market for their fibre) into large windrows and replant the cleared block. Another alternative reference scenario for those hardwood stands is to leave them standing and untouched, which happens when the governmental financial incentives for clearing and replanting run low. In this case, a bioenergy scenario in which those stands would be cut and replanted and the trees used as biomass feedstock would provide GHG mitigation benefits within 23 years. Harvesting these unloved stands for bioenergy therefore provides an incentive to replant areas that are otherwise stagnant and prevents the creation of heaps of slowly-decomposing discarded trees, which also eat on productive forest areas.

Another example is that of fire-affected boreal stands in Côte-Nord (northeastern Quebec): a study showed that sites with low density of standing dead trees also generally have low levels of natural regeneration: although not prime candidates for bioenergy production in terms of energy content, these sites could nevertheless benefit from harvesting operations triggered by a bioenergy market, which could facilitate their regeneration, and enhance forest productivity and carbon sequestration potential (Barrette, Thiffault, and Paré 2013). Further analyses will make it possible to estimate GHG savings associated with bioenergy but also the positive effects of procurement of unloved woods on forest productivity, management activities and consequent flow of forest products (sawtimber, pulp, etc.).

Bioenergy offers the forest sector an opportunity to adapt to changing markets and build upon current sawmill and pulp&paper mill infrastructure and activities. Using unloved woods for biomass production can help offset fixed costs and serve to redistribute timber harvest and forest management costs amongst multiple products. In doing so, the competitiveness of the forest sector as a whole can be increased. It is also a means of adaptation to a changing climate under which natural disturbances, such as insect epidemics and wildfires, are predicted to increase, creating large amounts of unloved woods. For example, a study in boreal forests of northeastern Quebec suggests that in stands that contain an increasing number of dead trees due to the progress of the spruce budworm epidemic (Figure 4) the productivity of the harvester (in harvested cubic meter per hour) is highly dependent of the stand degradation level: its productivity in a highly-degraded stand could be decreased by 50% relative to a healthy (non-budworm affected) stand. With such higher costs, there is a need to optimize the value of the harvested wood. However, dead trees are often seen as "contaminants" in the wood supply chain, for example for pulpmills that struggle with their high proportion of wood rot and low moisture content, both of which complicate the pulping process (Barrette et al. 2015).

A financial analysis has assessed the potential profitability for different uses of dead trees from boreal forests (Barrette et al. 2017). The analysis was performed from the standpoint of an eastern Canadian, independent sawmill, the most prominent lumber processing facility in this region. Results suggested that using dead trees for lumber and wood pellets for overseas markets is almost as profitable as using them for lumber and pulp, with a difference of about 1 to 12% depending on tree size. Dead trees from all classes of wood degradation could serve as an interesting feedstock for pellets because wood density is only slightly affected by wood rot. However, the presence of large trees able to generate value through lumber remains key to the profitability of the sawmilling industry. Nevertheless, for a sawmill to have several alternative pathways for its fibre and residues increases the resilience of the value chain, making it possible to adapt to temporary or permanent market changes and take full advantage on the emerging bioeconomy. However, these results also highlight the need to focus on higher value-added products: dead trees could be used as an interesting feedstock to make other types of products such as liquid biofuels. Further research will therefore explore financial scenarios of using dead trees as feedstock for the production of a full suite of biofuels and bioproducts.

Potential for scaling-up and replicability

The Quebec forest sector resembles an industrial ecosystem, in which different tree parts, trees and stands are used as feedstocks by the various industries within the sector, and in which by-products flow from one industry to the other. The profitability of each industry is highly reliant on the vitality of other stakeholders. Empirical evidence from Quebec has shown that takers of low-quality fibre and residues are particularly important within that ecosystem. Unloved woods can help to unlock stands or landscapes with a proportion of sound trees for sawnwood. Their procurement can also serve as a silvicultural practice to improve establishment and growth of the new stand. The best opportunities for unloved wood are therefore likely to be found in integrated forest product chains, where conventional forest products, such as lumber and pulp, and bioenergy streams are integrated to optimize the fibre flows and values. These opportunities will only materialize if both the forest and biofuel sectors develop innovative forest management and procurement solutions, which make it possible to extract maximum value from the resource while respecting sustainability principles. Proper training of forest workers for improved tree sorting during joint procurement of wood for lumber and bioenergy and of forest managers for improved planning of silviculture, will be required. Unloved woods offer the Quebec forest sector a unique opportunity to diversify its production, to innovate and to increase its competitiveness at the global scale. This nimbleness will become even more essential in the context of climate change, which may increase the occurrence of existing or new pests and disturbances, all the while making the need for sustainable and renewable bioenergy and biomaterials all the more important.

4.2. Cellulosic-based biofuels are expected to contribute to renewable energy goals while strengthening rural investment and development in the United States

Contact name: Virginia Dale, Keith Kline, Esther Parish

Affiliation / Organisation: Oak Ridge National Laboratory and other collaborators from the US Department of Agriculture, Pennsylvania State University, and the University of Tennessee

Location of project: The project focuses on cellulosic in the US by considering the states of Iowa in the Midwest and Tennessee in the Southeast.

Other details: This work is supported by the Bioenergy Technologies Office of the US Department of Energy.

Publications:

- Dale & Beyeler. 2001. Challenges in the development and use of ecological indicators. Ecological Indicators 1: 3-10.

- Dale VH, RA Efroymson, KL Kline, MH Langholtz, PN Leiby, GA Oladosu, MR Davis, ME Downing, MR Hilliard. 2013. Indicators for assessing socioeconomic sustainability of bioenergy systems: A short list of practical measures. Ecological Indicators 26: 87-102. http://dx.doi.org/10.1016/j.ecolind.2012.10.014

- Dale VH, KL Kline, D Perla, A Lucier. 2013. Communicating about bioenergy sustainability. Environmental Management 51(2): 279-290. DOI: 10.1007/s00267-012-0014-4.

- Dale VH, Kline KL, Richard TL, Karlen DL, Belden WW (In review) Selecting indicators of changes in ecosystem services due to cellulosic-based biofuel in the midwestern United States. Biomass and Bioenergy

- Efroymson RA et al. 2013. Environmental indicators of biofuel sustainability: What about context? Environ Mgmt 51(2): 291-306. http://web.ornl.gov/sci/ees/cbes/Publications/Efroymsonetal2012biofuelindicatorcontextEMfinal10%201007_s00267-012-9907-5.pdf

- McBride A et al. (2011) Indicators to support environmental sustainability of bioenergy systems. Ecological Indicators 11(5) 1277-1289.

- Parish, ES, M Hilliard, LM Baskaran, VH Dale, NA Griffiths, PJ Mulholland, A Sorokine, NA Thomas, ME Downing, R Middleton. 2012. Multimetric spatial optimization of switchgrass plantings across a watershed. Biofuels, Bioprod. Bioref. 6(1):58-72. DOI: 10.1002/bbb.342

- Parish ES, VH Dale, BC English, SW Jackson, DD Tyler. 2016. Assessing multimetric aspects of sustainability: Application to a bioenergy crop production system in East Tennessee. Ecosphere 7(2):e01206. 10.1002/ecs2.1206.

Link: http://web.ornl.gov/sci/ees/cbes/

Type of contribution: We are providing examples that are specific projects/activities

Status: Start 2014, end 2020.

Positive impact

- Stakeholders identify soil and water quality as key issues in Iowa
- Bioenergy feedstock sustainability in Iowa can be quantified using eleven indicator groups
- Provisioning, cultural, regulating, and supporting ecosystem services are affected by production of biomass for energy

Reasons or main drivers for implementing the project/practice/policy

Cellulosic-based biofuels are expected to contribute to renewable energy goals while strengthening rural investment and development in the United States (US). Stakeholder input is necessary to identify indicators that can be used to determine how ecosystem services are being influenced by emerging biofuel industries. Sustainability assessment is an iterative process. By engaging stakeholders in the process, more effective and efficient practices, and more useful indicators, can be developed over time

Key enabling factors

Biofuel production can provide positive ecological, social and economic opportunities for agricultural regions including most rural communities in the United States (US) that have suffered from declining populations, incomes, and jobs.

Achieved outcomes

Relevant indicator categories for potential biomass supply areas in the US state of Iowa have been determined using scientific literature, response information from a targeted survey, and input from two stakeholder meetings. Eleven indicator categories were identified that collectively can measure progress toward sustainability during production, harvest, storage, and transport of cellulosic feedstocks. Five categories focus on environmental concerns (soil quality, water quality and quantity, greenhouse gas emissions, biodiversity, and productivity) and six on socioeconomic concerns (social well-being, energy security, external trade, profitability, resource conservation, and social acceptability).

The relative contributions of the social, economic and environmental information were determined for East Tennessee switchgrass production and show that switchgrass production is an attractive option for improving environmental and social sustainability trajectories without adverse economic impacts, which can lead to overall enhanced sustainability. Although external trade does not yet exist for this switchgrass commodity, our economic modelling indicates that switchgrass production can still be beneficial to the counties surrounding the biorefinery in terms of dollars earned and jobs created. The opportunity to use inactive equipment and laborers is a potential benefit captured indirectly by the sustainability evaluation framework. This case study demonstrates that integration of qualitative sustainability indicator ratings may increase holistic understanding of a bioenergy system in the absence of complete information.

Main challenges encountered

Wide recognition of the opportunities and constraints for the bioeconomy is a challenge. Ongoing monitoring and stakeholder engagement are necessary to support continual improvement and to determine how effectively the indicators reflect changes in ecosystem services related to provisioning (e.g., energy, nutrition and materials), cultural, regulating, and supporting (i.e., optimum soil water and nutrient balances, remediation of wastes, toxins, or other nuisance compounds, and maintenance of desirable physical, biological and chemical properties) benefits.

Sustainability assessments benefit from indicator measurements repeated over time, and we recommend the periodic incorporation of newly acquired data into sustainability evaluation frameworks such as the one presented here as well as the into management processes. Through the process of adaptive management, i.e., the viewing of policies and system interventions as experiments that need to be continuously monitored, updated and adjusted, more complete understanding of bioenergy production systems will be gained over time, and it will become possible to assign meaningful targets and weightings to the proposed set of environmental and socioeconomic sustainability indicators. Ultimately, sustainability assessments of a variety of bioenergy feedstocks in diverse settings will be necessary for the development of sound best management practices that sufficiently address the multiple and sometimes competing demands of stakeholders.

Potential for scaling-up and replicability

Items that can be scaled up and replicated elsewhere include a common understanding of sustainability, means to quantify effects of bioenergy, and the relationship between ecosystem services and indicators of progress toward sustainability.

4.3. Living snow fences (LSF) from willow stop blowing and drifting snow from reaching roadways

Contact name: Justin Heavey and Timothy Volk

Affiliation / Organisation: State University of New York College of Environmental Science and Forestry (SUNY-ESF)

Location of project: New York State

Publications:

Heavey, J.P. & Volk, T.A. Agroforest Syst (2014) 88: 803. doi:10.1007/s10457-014-9726-1

Link: www.esf.edu/willow/lsf/

Type of contribution

- A practice or approach and a specific project/activity

Status

Multi-year research and demonstration project in cooperation with New York State Department of Transportation (NYSDOT), completed in 2013. Practice continues to be implemented by NYSDOT and other transportation agencies in the U.S.

Positive impact

Living snow fences (LSF) stop blowing and drifting snow from reaching roadways. This saves money in avoided snow and ice control and improves road safety. Selected shrub willow cultivars developed for bioenergy are an ideal plant choice for living snow fences due to their rapid growth rate, ground-level branching pattern, upright stem form, multiple stems per plant, coppice ability, ability to be planted at relatively low cost from unrooted stem cuttings, and other characteristics. Willow LSF can achieve the same snow trapping function as structural (wooden/plastic/metal) snow fences or LSF of other species at a lower cost. This research project studied LSF of willow and other species and discovered critical patterns of how the snow trapping function of LSF changes over time as plants grow, the impact on downwind drift length, and the implications for design of LSF, especially in regards to the setback or distance between the fence and the road. In addition to preventing blowing and drifting snow, LSF can have other benefits such as renewable biomass production, wildlife habitat, carbon sequestration, erosion control, nutrient buffering, etc.

Reasons or main drivers for implementing the project/practice/policy

Extensive research has been conducted on structural snow fences, but little has been done on LSF or willow LSF. Design guidelines in extension and transportation publications have loosely adapted design protocols for LSF from structural snow fence standards without making adjustments for the dynamics of plant growth. Research was undertaken to address these issues and understand the structure and function of living snow fences across a variety of species and range of ages. Transportation agencies are interested in implementing LSF as a low-tech, "green" alternative for controlling blowing and drifting snow.

Achieved outcomes

This research project identified and studied 18 living snow fences of various species including willow at various locations across New York State and produced new research results stated above. The project also engaged dozens of NYSDOT staff in classroom and field trainings and planted four willow LSF. Best practices for successful LSF plantings were developed and communicated in presentations and a fact sheet series (www.esf.edu/willow/lsf/) and NYSDOT protocol documents developed as part of the project. A benefit-cost model was also developed to assess the economics of installing and maintaining LSF versus traditional mechanical and chemical snow and ice control methods.

Main challenges encountered

The project identified numerous areas of future research that would be beneficial, but funding has not been readily available. The implementation of recommended best practices is not always followed and some LSF do not achieve optimal growth rates, fail to produce the intended snow trapping function, or die as a result. Work to install LSF is often contracted out to engineering or construction firms and state transportation agencies are required to go through a bidding process which can hinder the implementation of critical best practices.

Potential for scaling-up and replicability

There is a large potential for scale up and replicability. There are thousands of miles of roadways with blowing/drifting snow problems in cold weather climates around the world. Millions of dollars are spent maintaining these roads in winter and repairing the damage caused by snow and ice and the required snow control practices. LSF can help mitigate public costs of maintaining and repairing roads impacted by blowing and drifting snow, while also enhancing safety for drivers and providing a potential source of woody biomass energy and environmental benefits.

4.4. Modelling: converting agricultural marginal land in the test watershed from the typical rotation to perennial bioenergy crops, Illinois, USA

Contact name: M. Cristina Negri, negri@anl.gov

Affiliation: Argonne National Laboratory

Location of project: Illinois, USA

Other details This is a research project involving Argonne National Laboratory and the University of Michigan and Southern Illinois University

Publications:

- Graham, J.B., J.I. Nassauer, M. C. Negri and H. Ssegane. Landscape boundary objects in socioecological research: engaging stakeholders to investigate production alternatives for perennial Energy crops. Ecology and Society. In review

- Zumpf, C., H. Ssegane, P. Campbell, M.C. Negri and J. Cacho (2017). Yield and Water Quality Impacts of Field-scale Integration of Willow into a Continuous Corn Rotation System. J. Environ. Qual., in press.

- Graham, J. B., J. I. Nassauer, W. Currie, H. Ssegane and M.C. Negri (2017) Assessing wild bee abundance in perennial bioenergy landscapes: Effects of bioenergy crop composition, landscape configuration, and bioenergy crop area. Landscape Ecol. DOI 10.1007/s10980-017-0506-y.

- Ssegane, C. Zumpf, M. C. Negri, P. Campbell, J. Heavey, and T.A. Volk (2016) -The Economics of Growing Shrub Willow as a Bioenergy Buffer on Agricultural Fields. A case study in the Midwest Corn Belt. Biofuels, Bioproducts and Biorefining. DOI: 10:1002/bbb.1679.

- Ssegane H. and M C. Negri (2016) An Integrated Landscape designed for Commodity and Bioenergy Crops in a Tile-drained Agricultural Watershed. J. Environ. Qual., published May 31, 2016, DOI:10.2134/jeq2015.10.0518.

- Negri, M. C. and H. Ssegane (2016) Bioenergy crops: delivering more than energy. In "Commercializing Biobased Products". S. Snyder Editor, Royal Society of Chemistry, Cambridge, UK.

- Hamada, Y., H. Ssegane, and M. C. Negri (2015) Mapping Intra-Field Yield Variation Using High Resolution Satellite Imagery to Integrate Bioenergy and Environmental Stewardship in an Agricultural Watershed. Remote Sensing, 2015, 7, 9753-9768; doi:10.3390/rs70809753.

- Ssegane, H., M.C. Negri, J. Quinn, M. Urgun Demirtas (2015) Field scale Design of multifunctional landscapes for food, bioenergy and ecosystem services. Biomass and Bioenergy 80, 179-190.

Type of contribution

This contribution provides and models an example approach to improve sustainable resource production incorporating bioenergy at the landscape and watershed level.

Status

This modeling and design effort is ongoing. It includes physical/environmental, economic and lifecycle analysis aspects.

Positive impact

Designing novel bioenergy future landscapes acknowledges that bioenergy development is per se not good or bad, but rather its final environmental, social and economic outcome depends on the way bioenergy is deployed on the land. Capitalizing on traits that are specific to perennial bioenergy crops allows stakeholders to design landscapes that produce biomass integrated with food and feed production, and also delivers conservation benefits such as removing nutrients and sediment from water, improve pollinator habitat, improve soil health and carbon sequestration, and, under the right practices, also improve biodiversity. Perennial crops such as grasses and short rotation woody crops can deliver important ecosystem services with their deep and extensive root system, their year-round ground cover, reduced need for fertilizer and ability to tolerate sub-optimal soil conditions such as flooding or drought (Negri and Ssegane, 2016. Depending on the final desired outcome, location, socioeconomic interests and final markets, different landscape designs (or plans for resource allocation) can be proposed, that balance productivity with positive environmental outcomes, and respond to specific policy drivers and cultural preferences. Targeted stakeholder meetings can help refine future landscape options, suggest preferred strategies, highlight practical issues and bring together communities. Land management design at an implementable scale relies on physical models that allow for the examination of "what if" scenarios, to address productivity and water quality improvements (Ssegane and Negri, 2016), pollinator habitat (Graham et al., 2017), and other physical outcomes. Precision agriculture and remote sensing techniques are also available to identify underproductive land that would be better used for bioenergy cropping (Hamada et al., 2015; Ssegane et al., 2016, Zumpf et al., 2017). Using a series of selection criteria on existing soil survey (SSURGO database, USDA-NRCS) and other approaches (Keefer, 1995) land can be classified and selected for specific uses based on its environmental vulnerability to nitrate leaching, drainage characteristics, crop productivity, frequency of flooding and surface water ponding, and surface runoff and erosion (Ssegane and Negri, 2016). Our project used the Soil and Water Assessment tool (SWAT) model to assess the productivity and water quality impacts of planting perennial bioenergy crops on environmentally and economically marginal land at the subfield scale, selected using the criteria above, in the Indian Creek watershed in Central Illinois. This watershed, encompassing approximately 21,000 hectares in the heart of the US Corn and soybean production belt, was used as a case study to incorporate perennial bioenergy crops on approximately 22% of land identified as having high risk for nitrate leaching and/or other marginalities. This design, which aimed at addressing yields and water quality, the main priorities, was then used to further assess co-benefits of this new landscape in terms of potential improvements in pollinator habitat (using the InVEST-Lonsdorf model (Kareiva et al., 2011), and is currently been examined for other potential co-benefits in soil health and carbon sequestration. Further, a techno-economic analysis was conducted that examined the potential cost implications of a distributed bioenergy supply based on the new design (Ssegane et al., 2016), and a lifecycle analysis of emissions and energy balances is ongoing.

Reasons or main drivers for implementing the project

The need to provide food, feed, energy, fiber and conservation for a growing world population under changing climatic patterns requires new strategies to ensure that finite land, water and material resources are used efficiently to achieve best outcomes and balance the production of goods with the needed environmental impacts derived from them. At the same time, agricultural intensification may bring increased environmental externalities, and while important and critical to achieve environmental improvements, traditional agricultural conservation practices struggle to be adopted because of their cost, the opportunity costs in land use, and other limitations. This project wanted to develop approaches that use biomass for both energy production and conservation and test if these approaches could deliver the economic and environmental outcomes that are important to farmers and society. For example, if nutrient management improvements could be sold, nutrient trading initiatives that match point source discharges from municipal wastewater treatment plants with non-point nutrient loss reductions from farming (by adopting perennial bioenergy crops, among other practices) could provide better outcomes to communities in terms of water quality at a fraction of the cost of installing expensive nutrient control technology at the plants. By proactively designing alternative future integrated, bioenergy/food land management examples, we aimed at proposing a different economic model that incorporates the valuation of the biomass produced and also of the deliberate positive environmental effects of bioenergy cropping in landscape positions to the economic bottom line of farmers and other stakeholders.

Key enabling factors

Current advances in precision agriculture and remote sensing (Hamada et al., 2015), and the availability of detailed soil surveys and computational tools enable the identification of specific land types and match them with crops that are the best fit for that specific condition and desired function. Further, another enabling factor is the presence of rural communities interested in diversifying their business model to absorb fluctuations in market prices for current agricultural crops. These communities are important stakeholders that provide key input in envisioning how their future landscapes will look like. Additionally, societal needs for a clean environment, affordable and plentiful domestic energy, food and bioproducts will need to guide the translation of the results from research into sensible policy tools. Last but not least, the presence of markets for the biomass is an indispensable factor to ensure that farmers will grow the bioenergy crops and therefore drive the landscape change in the desirable direction.

Achieved outcomes

Our case study showed that converting agricultural marginal land in the test watershed (approximately 20% of the watershed land focused on areas that presented one or more marginalities) from the typical rotation of corn-soybean to perennial bioenergy crops provided a reduction of 18-26% in nitrate and approximately 10% of sediment leaving the watershed compared to business as usual (BAU). Water yields were found to decrease 1-11% compared to BAU depending on the crop selected (willow, switchgrass or big bluestem) (Ssegane and Negri, 2016). The improvements in water quality engendered by the crop change came with a deficit of 49K tons of corn and 14K tons of soybean, compensated by alternatively 34K tons of switchgrass, 40K tons of willow or 30K tons of big bluestem biomass. The same landscape design was also found to provide co-benefits in terms of increased abundance of wild bee nesting, with crop composition and area under perennial bioenergy cropping being the most relevant factors (Graham et al., 2017).

An economic analysis examined the differences in production and logistic costs of growing bioenergy shrub willows in the same landscape design. This analysis showed that growing willows may not be economically profitable for farmers under the current economic framework, however it also highlighted some positive aspects of this rotation change: first, in underproductive, marginally fertile subfield areas, willow could represent a better opportunity cost compared to corn, with margins depending on corn yields at that particular location. Second, the landscape design scenario would provide better economic results over BAU (willow grown conventionally in dedicated fields) depending on the distance travelled and number of fields, as a result of more efficient land use and reliance on passive use of the nitrate lost buy the adjacent corn instead of newly purchased fertilizer. Finally, when normalized for the relative efficiency in removing nitrate, the annual costs of a bioenergy willow buffer was found to be overall more cost competitive compared to mainstream conservation practices such as cover crops and, crop rotations. The cost of bioenergy buffers resulted however slightly higher than others, wetlands and bioreactors, and higher than the most cost effective practice of deferring nitrogen fertilization to the spring. Future work will assess the lifecycle outcomes of the bioenergy future landscape, and a comparative assessment of all conservation practices will be conducted to include a comprehensive analysis of all ecosystem effects resulting from the landscape design, including carbon sequestration, water use, biodiversity and social implications. Finally, as these bioenergy crops are cultivated in the watershed to provide both market (the biomass) and non market ecosystem services (water quality, pollinator habitat, etc.), a value will need to be established for both, to develop a new economic framework that will boost the profitability of biomass and compensate farmers for the additional effort and costs incurred in growing multi-purpose perennial crops. Preliminary research has shown that the value to society of water quality ecosystem services could more than compensate for the losses from crop production.

Main challenges encountered

The main challenge of this approach is the lack of a clear market to absorb the biomass production, which is the cause of the reluctance of farmers to grow bioenergy crops. From our stakeholder meetings in the watershed this was rightly identified as the critical element in the producer decision process. Additionally, challenges related to the lack of a suitable form of crop insurance covering bioenergy crops was also identified as an obstacle, particularly as these crops are often new to the farming community and agronomic practices for their cultivation are not nearly as well known as those of conventional crops. Finally, another challenge is in the annual nature of land rental agreements, which may create conflicts with the perennial growth habit of dedicated bioenergy crops.

From the modeling perspective, more field studies need to be conducted to understand the true benefits of perennial cropping as a function of landscape position, soil, climate and specific practice, and provide models with realistic data for calibration and validation. Also, lack of available data on field aggregation into farms increases the uncertainty of economic evaluations and requires the use of more conservative assumptions in calculating transport distances.

Potential for scaling up and replicability

This study provides a template for the comprehensive analysis of multiple provisioning and regulating ecosystem services provided by alternative landscape designs that incorporate bioenergy into existing agricultural rotations. It also provides a framework to identify and select priority areas where perennial bioenergy crops could provide intentional positive environmental benefits, and the economic implications derived from the implementation of the selected design. Future work will link each of these modeling components in a comprehensive framework that will be made available for replication in other watersheds. While our effort deliberately focused on the implementation scale, it will eventually connect with other efforts that work at the large, regional scale and contribute to nested modeling methodologies. Scaling up will however benefit from additional field experimentation to provide performance data more representative of larger and more diverse regions.

Annex

CONTRIBUTIONS' TEMPLATE

The intention of the call was *not* to collect information about incremental improvements in mainstream practices, intended to mitigate impacts of existing biomass production systems. The ambition was to seek information about novel biomass production systems and approaches to integrate biomass production systems into landscapes, to improve resource management and promote more sustainable land use.

Case Studies / examples could aim at improving resilience and food security, be relevant to soil stabilisation and productivity, improved water productivity, flood control, water filtration, fire control, reduction in nutrient and sediment export, pest and plant disease control, climate change adaptation, and other issues. Possible case studies might include (but are not limited to):

I. Integration of specific crops in specific regions or landscapes and/or siting of cropping systems, examples including:
   a. Developing upstream degraded lands in rainfed watersheds to enhance green water use efficiency and minimize erosive runoff;
   b. Establishing biomass plantations alongside roads and highways to reduce runoff and siltation load;
   c. Planting trees and shrubs in windbreaks and shelterbelts to reduce wind velocity and soil erosion, and to provide shade and shelter to livestock and grazing land.

II. Specific practices – cultivation and harvest:
   a. Mixed crop and livestock (agriculture-based);
   b. Alley cropping, crop rotations and buffer plantations providing soil and water protection along with the biomass harvest;
   c. Harvesting in streamside management zones;
   d. Specific biomass harvesting in forests, e.g., harvest of trees killed by natural disturbances.

III. Using organic 'waste' resources as feedstock where such materials would otherwise present challenges, e.g., pose a fire risk or water quality risk.

IV. Introducing policies and other instruments that have been shown to encourage the adoption of best management practices for improving soil and water resource utilization through biomass production systems.

The submission should clearly identify how the example described can improve the state of conditions while also supporting the production of biomass for bioenergy and - where relevant - other products.

TEMPLATE FOR SUBMISSIONS **TITLE:** **AUTHORS:**	
GENERAL	
Contact name	Specify whether you are submitting as an individual or on behalf of an organisation
Affiliation / Organisation	
Location of project/policy/practice	Specify the country and specific location within the country
Other details	Provide any further relevant details e.g., organization description, size and type of investment (i.e., public, private or public/private), etc.
Publications	Provide a list of publications (if any) on the specific project/policy/practice described

Link	Provide the link to the project web-site (if any)
DETAILS	
Type of contribution	*Specify whether you are providing an example that is:* *A policy or other enabling instrument* *A practice or approach* *A specific project/activity*
Status	*Specify whether the example is currently being implemented and indicate start and end dates as appropriate*
Positive impact	*Provide a description of how the example you are contributing has produced or is expected to produce positive impacts* **[max. 500 words]**
Reasons or main drivers for implementing the project/practice/policy	***[max. 250 words]***
Key enabling factors	*Describe the main environmental, social, economic and/or policy-related factors (if any) that enabled the implementation of the example and contributed to its success* ***[max. 250 words]***
Achieved outcomes	*Provide information about the outcomes achieved, e.g., relative to soil and/or water quality, food security* ***[max. 500 words]***
Main challenges encountered	*Describe some of the main challenges e.g., policy, legal, technical, financial, verification of outcome, other* ***[max. 250 words]***
Potential for scaling-up and replicability	*Discuss whether and under which conditions the example could be scaled-up and replicated elsewhere* ***[max. 250 words]***

JOINT IEA BIOENERGY TASK 43 & FAO WORKSHOP: "SUSTAINABLE LANDSCAPE MANAGEMENT FOR BIOENERGY AND THE BIOECONOMY"

Joint IEA Bioenergy Task 43 & FAO Workshop, 11-12th October 2018, The FAO Headquarters, Viale delle Terme di Caracalla, Rome, Italy

IEA Bioenergy Task 43 has launched an initiative to identify attractive examples of landscape management and design for bioenergy and the bioeconomy. The goal of this initiative is to compile world-wide innovative examples as a means of showcasing how the production of biomass for bioenergy can generate positive impacts in agriculture and forestry landscapes. These examples are also meant to serve as sources of inspiration that other biomass producers can use to enhance the sustainability of their own activities.

A year ago, a warm-up event for the current workshop was organized as part of the Bioenergy Australia Conference 2017 where contributions were handpicked to demonstrate good examples and stimulate a discussion on how these can be relevant for developing attractive systems in the Australian context.

This event takes us a step forward towards by placing the discussion of biomass feedstock systems within the broader bioeconomy. The attractive examples selected for this workshop show how biomass can be produced together with food and other products in sustainably managed landscapes. This is a highlight topic of the workshop host, the Food and Agriculture Organization of the United Nations, as described at the Energy-Smart Food for People and Climate Programme (ESF Programme).

The aim of the workshop is to provide a platform for a dialogue between stakeholders along biomass supply chains where invited representatives from important organizations will share their perspectives on the showcase examples and landscape management and design for bioenergy and the bioeconomy.

Agenda

13:00 – 13:20	**Registration and introduction**
	- FAO: welcome - Dimitriou: Welcome to IEA Bioenergy Task 43 workshop
13:20 – 13:40	- Dubois: The Energy-Smart Food for People and Climate Programme (ESF Programme) - Berndes: WP1 Landscape management and design for bioenergy and the bioeconomy - Kulisic: Sustainable Landscape Management for Bioenergy and the Bioeconomy workshop format
13:40 - 14:30	- Introduction of stakeholders
	Coffee/tea break
14:45 – 16:30	**Section 1**
	- FAO (Maltsoglou I.): Bioenergy Potential from Crop and Livestock Residues in Egypt and Turkey – through the BEFS RA methodology - Bentsen N.S.: Grass based biorefinery systems producing biofuels/biomaterials/feed - Kline K.& Negri C.: Implementing bioenergy at the landscape level to reduce land use impacts and improve resource use efficiency? - Moderated discussion
	Coffee/tea break
16:45 – 18:30	**Section 2**
	- Skeer J & Armitage Ch. (IRENA&ICRAF): A set of integrated practices: a multi-faceted market-led approach to improving food and energy security and adaptation to climate change, which incorporates alley cropping of *Gliricidia sepium* into small-scale maize farming systems in Zambia - FAO (Dubois O.): Water-energy-food nexus in bioenergy-landscapes - Bezzi G. et al: Biogas done right - Moderated discussion as in Section 1
DAY 2: 12 Oct 2018	
09:00 – 10:00	Reporting back of the Sections 1&2 and introduction to the Day 2
	Coffee/tea break
10:15 – 12:00	**Sectio1n 3**
	- Dale V. et al: Cellulosic-based biofuels are strengthening rural investment and development in the United States - FAO (Colangeli M.): Web-based sustainability assessment tools for Bioenergy projects on underutilized lands in Europe - Thiffault E. et al: Opportunities for making use of unloved wood - Moderated discussion as before in Section 1 and 2
	Lunch break
13:00 – 15:00	Section 4 Where to move from here?
	- Reporting back of the Section 3 - Plans forward – FAO (O. Dubois) - Plans forward – new triennium of IEA Bioenergy (M. Brown & G. Berndes) - Stakeholders' ideas on collaboration opportunities - Wrap up (I. Dimitriou & O. Dubois)

IEA BIOENERGY TASK 43 WORKSHOP: "ATTRACTIVE SYSTEMS FOR BIOENERGY FEEDSTOCK PRODUCTION IN SUSTAINABLY MANAGED LANDSCAPES"

IEA Bioenergy Task 43 Workshop, 20th November 2017, the Gold Room at L'Aqua - Dockside, Cockle Bay Wharf Sydney, Australia

IEA Bioenergy Task 43 has launched an initiative to identify attractive examples of landscape management and design for bioenergy and the bio-economy. The goal of this initiative is to compile world-wide innovative examples as a means of showcasing how the production of biomass for bioenergy can generate positive impacts in agriculture and forestry landscapes. These examples are also meant to serve as sources of inspiration that other biomass producers can use to enhance the sustainability of their own activities.

The workshop is a warm up event for **Bioenergy Australia Conference 2017** where contributions were handpicked to demonstrate good examples and stimulate a discussion on how these can be relevant for developing attractive systems in the Australian context. An additional event is planned for September 2018, to be hosted by the Food and Agriculture Organisation of the United Nations, Rome (Italy). This event will include variety of examples both in terms of bioenergy systems and geographical distribution with details coming soon.

Agenda

11:30 – 12:30	Registration with welcome lunch and introduction
	- Dimitriou: Welcome to IEA Bioenergy Task 43 workshop - Brown: welcome from the host and house rules
12:30 – 12:40	- Berndes: WP1 Landscape management and design for bioenergy and the bio-economy
12:40 – 13:50	Australian Section (20' each)
	- Feltrin, Gasification Australia: "The Emerald Plan" - Concepts of fitting production landscapes with modern energy production possibilities via merging better biodiversity outcomes in agricultural landscapes at large scale - Henson, PNG Biomass Markham Valley Power Project: "A 30 MW power plant from 16.000 ha eucalyptus Markham Valley, Lae, Morobe Province, Papua New Guinea" - Williamson: "The Benefits of Biomass Harvest with Crop Rotation in the Australian Agricultural Landscape" - Highlights by a rapporteur
	Coffee/tea break
14:10 – 15:20	International Section (20' each)
	- Mola-Yudego & Dimitriou: "Combining different management regimes of fast growing plantations on a landscape can result in the production of different and compatible ecosystem services, in addition to widen the economic options for the owners" - Heavey & Volk: "Living snow fences (LSF) from willow stop blowing and drifting snow from reaching roadways, New York State" - Kulisic et al.: "Contribution of SRC to long term ragweed eradication in the City of Osijek, Pannonian Basin" - Highlights by a rapporteur
	Coffee/tea break
15:40 – 17:00	Interactive Conclusions with Göran Berndes & Biljana Kulišić: Australian perspectives on Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes

Further Information

IEA Bioenergy Website
www.ieabioenergy.com

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www.ieabioenergy.com/contact-us/