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Economic evaluation of the successful biological control of *Azolla filiculoides* in South Africa

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Abstract

Azolla filiculoides (red waterfern) is a floating fern native to South America which has invaded aquatic ecosystems in South Africa. Thick mats of *A. filiculoides* on dams and slow-moving water bodies cause economic losses to water-users. Affected water-users were surveyed using a questionnaire to assess the importance of the weed. Among those most seriously affected were farming (71%), recreational (24%), and municipal (5%) users. The average water area covered by *A. filiculoides* (per water-user) was 2.17 ha, with an expansion rate of 1.33 ha per year. The frond-feeding weevil *Stenopelmus rufinasus* was released as a biological control agent at the end of 1997. Within 3 years, the weevil had reduced the weed population to the point that it was no longer considered a problem in South Africa. Based on year 2000 data, the cost savings (per user per hectare) resulting from the biological control program included a reduction of on-site damages caused by the weed to the value of US$589 per hectare per year. The average cost per hectare per year for the biological control program for the period 1995–2000 amounted to US$278, excluding investment costs of USD$7700 in 1995. These historic costs and benefits were adjusted to constant year 2000 values. The predicted spread of the weed was calculated on the basis of a sigmoid-curve rate of spread model. The net present value (NPV) of the program was calculated from 1995 onwards and discounted at 8%. This resulted in a NPV of US$1093 per hectare and US$206 million for South Africa as a whole. For the year 2000, the benefit–cost ratio was calculated at 2.5:1, increasing rapidly to 13:1 in 2005, and 15:1 in 2010 as the costs of the biological control program are expected to decrease. These indicators reinforce the overall economic viability of biological control, but do not necessarily confirm the viability of biological control on each management unit itself. The results reflect the dynamics of biological control on site-specific survey information, and place higher benefit–cost ratios achieved in other national level studies in a better context. It also raises the important policy question of who is responsible to finance such control programs in future, because on-site benefits of control are enough to justify the program in its own right. The paper concludes with recommendations on a financial mechanism to address biological control of invasive species in a sustainable manner.

Keywords: Red waterfern; *Stenopelmus rufinasus*; Benefit–cost ratio; Net present value

1. Introduction

Azolla filiculoides Lamarck (Azollaceae) (red waterfern) is a small (1–2.5 cm) aquatic fern, which is native to South America (Lumpkin and Plucknett, 1980). The fern has, however, spread to many countries of the world where it is considered a weed (Ashton, 1974; Diatloff and Lee, 1979; Hill, 1999). It was first recorded in South Africa in 1948 in the Oorlogspoort River, Colesberg, Northern Cape Province (Oosthuizen and Walters, 1961), where it was introduced as an ornamental fish-pond plant in 1947 (R. Randall, Cape Nature Conservation, Sedgefield, Eastern Cape, South Africa, personal communication). Initially, the plant was confined to the Colesberg area, but a combination of a lack of natural enemies, dispersal between water bodies by humans and possibly waterfowl, and phosphorus-enriched waters

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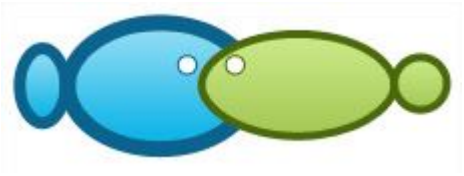

Impacts of using fresh aquatic plants as a total substitute for formulated feed on performance, health and economic efficiency of grass carp, *Ctenopharyngodon idella* (Valenciennes, 1844) fingerlings

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Abstract. The objectives of this study are to determine the effects of total replacement of formulated feed (FF) with four fresh aquatic plants (AP): (1) grass weed, *Echinochloa stagnina*; (2) coontail, *Ceratophyllum demersum*; (3) water hyacinth, *Eichhornia crassipes*; and (4) duck weed, *Spirodela polyrhiza* on growth, feed utilization, health and economic value of grass carp, *Ctenopharyngodon idella*. Fish were fed to satiation for 10 weeks. The best growth was observed in the FF-fed group. Protein, albumin, globulin, and cholesterol levels in blood serum were reduced in the AP-fed groups. Positive changes in biometric indices and midgut histology were detected in AP-fed groups. A selective feeding preference and subsequently a potential positive economic efficiency of utilizing duckweed and water hyacinth as alternative feedstuffs instead of high-priced formulated feed, has been confirmed in the present study. Feeding grass carp AP results in healthier fish, reduces production cost, increases net profit, and is more environment-friendly ecosystem. Besides, using grass carp is considered to be very useful as one of the biological solutions to overcome the over vegetation in fish ponds, waterways, rivers and freshwater lakes. However, more research works are needed to define exactly how many fishes are required to control each case.

Key Words: grass carp, aquatic plants, growth, feed utilization, blood, economic value.

Introduction. In modern aquaculture, aquaculture feed management is certainly vital because it is directly correlated to economic and environmental sustainability (White 2013). Feed is the primary cost of production, which should have balanced nutrients and sufficient energy for fish growth (Choi 2013). Fish feed represents around 60% of production cost, according to Yang et al (2003), Erondu et al (2006), and White (2013) and 30-70% of the overall operating cost according to Webster et al (2001). Bad artificial feed quality and overfeeding fish can also negatively result in considerable impacts on the environment (White 2013). Nutrients, specifically carbon, nitrogen, and phosphorous, released from fish farms into the environment and the ecosystem will definitely lead to the environmental pollution in terms of reducing water quality, eutrophication, an influx of disease-carrying fish, etc. (Amirkolaie 2011).

One of the most important ways to solve this problem is the expansion of the organic aquaculture. So, interest in organic aquaculture has been expanded, and many farmers have shifted from the traditional feeding systems to organic cultivation to produce safe seafood stuff that are environmentally friendly (Majhi et al 2006). Rana et al (2009) reported that since 2005, prices increased 20 to 40% due to the rising cost of raw ingredients for commercially manufactured or on-farm aqua feed in all countries of the world. Consequently, this obliged researchers and fish farmers were seeking

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Integrated aquaculture in Chinese lakes and paddy fields[1]

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Abstract

While pond culturing is still the staple of Chinese freshwater fisheries, its extensive development is handicapped by the increasing shortage of land resource for cereal production in face of China's population growth. Accordingly, people have looked towards the development of aquaculture in lakes (and reservoirs) in the 1970s. This paper reviews the successful integrated measures taken in an experiment for raising fish in Donghu lake (East lake) of Wuhan. By way of (1) stocking the right kinds of fish; (2) producing a large number of sizeable fingerlings; (3) improving fish screens; (4) controlling predatory fish; and (5) applying the 'driving and concentrating' bulk harvesting fishing method, fish production of the lake has increased steadily from 180 t in 1971 to 800 t in 1978, and then to 1840 t in 1995, all in an area of 1500 ha, and all without any supplementary feeding. Integrated aquaculture in paddy fields, known to be beneficial to both rice and fish production, has been regaining momentum in recent years. The paper summarizes its underlying principle, its benefits—economical, social and ecological—and the prospect of its development in China.

Keywords: Integrated aquaculture; Lake fishfarming; Paddy field aquaculture

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Feasibility studies for water reuse projects: an economical approach

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Abstract

Usually the methodologies used to analyse the feasibility of water reuse projects are focused on the internal costs. The aim of this paper is to show a methodology to assess the feasibility of a water reuse project taking into account not just the internal impact, but also the external impact (environmental and social, for example) and the opportunity cost derived from the project. Internal benefit is obtained from the difference between internal income and internal costs. Internal income is obtained by multiplying the selling price of reclaimed water and the volume obtained. Internal costs are made up of the sum of investment costs, operating costs, financial costs and taxes. While some of these factors identified can be calculated directly in terms of money, biophysical and social aspects demand the definition of units of measurement. In order to homogenize results, an annual reference is proposed. A monetary value can be obtained from the calculation of each impact. However, there are a series of externalities for which no explicit market exists. In these cases economic valuation methods are used, based on hypothetical scenarios or patterns observed in related markets.

Keywords: Feasibility studies; Water reuse projects; Externalities; Internal impact

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Methodologies for feasibility studies related to wastewater reclamation and reuse projects

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Abstract

About 20% of the total surface water in Europe is strongly threatened due to pollution problems, and 60% of European cities over-exploit their groundwater resources. The European Framework Water Directive established that by the year 2015 "a good ecological state" of all European water resources and a sustainable use of water must be achieved. Wastewater reuse presents a promising solution to the growing pressure on Europe's water resources. However, wastewater reuse implementation in Europe faces obstacles that include insufficient public acceptance; technical, economic and hygienic risks; and lack of regulations. On the other hand, a very important aspect to implement a water reuse project is the feasibility study that was previously developed. Some of the work carried out in a European project called Integrated Concepts for Reuse of Upgraded Wastewater is described herein. One of the most important tasks of this project is to prepare guidelines on feasibility studies for water reuse systems. The defined structure to carry out feasibility studies and some guidelines to obtain an ecological, social and economical assessment is described.

Keywords: Economical aspects; Feasibility studies; Socio-ecological aspects; Wastewater treatments; Water reuse

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Economic feasibility study for wastewater treatment: A cost–benefit analysis

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ABSTRACT

Water resource management should be made from a multidisciplinary perspective. In this sense, economic research into the design and implementation of policies for the efficient management of water resources has been emphasized by the European Water Framework Directive (WFD). Cost–benefit analysis (CBA) is one of the more widely accepted economic instruments since it is a rational and systematic decision-making support tool. Moreover, the wastewater treatment process has significant associated environmental benefits. However, these benefits are often left uncalculated because they have no market value. In this paper, using the concept of shadow price, a quantification of the environmental benefits derived from wastewater treatment is made. Once the environmental benefits are estimated and the economic costs of the treatment processes are known, a CBA is made for each of the wastewater treatment plants (WWTPs) under study. In this way, a useful economic feasibility indicator is obtained for WWTP operation.

1. Introduction

As environmental quality and sustainable use of natural resources have been recognized as a real social need, authorities have tried to find the most appropriate tools for environmental protection. In most industrialized countries, the so-called direct regulation instruments have been traditionally applied. Yet, this type of instrument has generally failed to achieve a high level of environmental protection and there have been high costs for all of society (Zhang & Wen, 2008).

As a result, a number of authors (Gayer & Horowitz, 2006; Wissel & Watzold, 2010; Song et al., 2010; among others) argue that market principles should be used as decision support tools for the implementation of policies and selection of measures to assist environmental protection.

In the field of water resource management, the EU Water Framework Directive (WFD) has introduced a new approach to water planning for the achievement of the environmental objectives of obtaining a good ecological status for European water bodies. The directive allocates a very important role to economic analysis (Helming & Reinhard, 2009).

For dealing with the requirements demanded by the WFD, especially those related to the cost recovery for water services, economic valuation is presented as a useful tool for implementing efficient and effective policies and strategies for the management of water resources (Moran & Dann, 2008). The WFD requires that cost–benefit analyses (CBA) are made with the aim of identifying cases in which the adoption of measures to achieve a good ecological status for water bodies implies disproportionate costs. In this sense, all of the benefits, including those which have a nature of 'non-market', i.e., those whose value is not determined by the market, but have a high value because they uniquely contribute to improving people welfare, and costs must be integrated into a CBA as a decision support tool.

Historically, the application of CBA in the evaluation of projects has been amended in the function of the objectives of the development policies. There are three stages:

1) Traditional approach: a clear economic approach that aims to increase the level of welfare in monetary terms. This approach was applied until the late 1960s.
2) Socio-economic approach: arises when the concept of social equity is incorporated. The aim is to achieve equitable income distribution.
3) CBA with environmental externality valuation is the third approach and results from the incorporation of environmental criteria are included in the decision-making process. This type of CBA originated in the 1980s (Pearce & Nash, 1981; Pearce & Markandya, 1988; Sugden & Williams, 1988; among others) and became more widespread in the 1990s (Gramlich 1990; Johansson, 1993; Hanley & Spash, 1993; Weiss, 1994; among others).

In the water resource context, it is known that wastewater treatment has important associated environmental benefits, and in economic terms we could define these as positive externalities. However, in most cases these environmental benefits are not quantified because they have no market value. In spite of this, the monetary valuation of these externalities is necessary to justify the economic feasibility of wastewater treatment projects.

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Feasibility of solar technology (photovoltaic) adoption: A case study on Tennessee's poultry industry

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ABSTRACT

The advantages and limitations of solar photovoltaic (PV) systems for energy generation are reviewed under various physical efficiency limits and financial assistance programs. Recent increases in utility and fuel costs in poultry production as well as public awareness of and demand for green power or renewable energy sources have given renewed interest in alternative energy sources. This study seeks to investigate the impact of alternative energy programs, grants and other incentives on the feasibility of solar PV systems in several solar regions within Tennessee's poultry industry. Preliminary results show that incentives exceeding current levels before adoption of solar PV systems would be financially beneficial.

1. Introduction

Rising oil prices and environmental concerns have led to renewed interest in renewable energy sources. In 2004, renewable energy represented 6% of the energy consumed in the United States, from which 47% and 45% were from biomass and hydroelectric sources, respectively [1]. Wind and solar power present potential sources of growth in renewable energy. According to the U.S. Department of Energy (DOE), America could supply its entire energy needs by covering merely 1.6% of its land area with solar cells [2]. The environmental effects of traditional energy sources like coal, natural gas, oil, and nuclear power can be significant. Green power resources such as solar and wind create less waste and pollution than the traditional energy sources.

The search for renewable energy sources has spurred the Tennessee Valley Authority (TVA), one of the United States' largest utility providers, to develop Green Power Switch (GPS) program. The GPS program started in 2000 in order to increase production of electricity from renewable sources and add it to the region's power mix. TVA sold more than 176 billion kilowatt-hour (kW h) of electricity to customers in fiscal year 2006 [3]. Fossil fuel plants produced about 64% of TVA's generation in 2006, followed by nuclear power (29%), hydropower (6%), and green power (less than 1%) [4]. "In fiscal year 2006, 85.1 million kW h of renewable energy was generated by the Green Power Switch program through the use of solar, wind, and methane gas generating sites" [3]. TVA has the capacity to provide as much as 97 million kW h of green power annually [5]. As part of the GPS program, TVA will dual-meter or purchase certain types of renewable energy systems' energy output within the Tennessee Valley region. Dual metering is a financial incentive that originated with electric companies as a way to encourage customers to invest in renewable energy systems such as solar or wind power [4]. The renewable supply from GPS currently includes 78% wind, 21.5% methane, and 0.5% solar [6].

Approximately 800 MW of wind capacity energy is available within 5 miles of the TVA service area [5]. Since the average capacity factor for wind energy systems in the Tennessee Valley is about 25%, the 800 MW of wind capacity is equivalent to only 267 MW of fossil capacity. Wind energy systems depend on the availability of sufficient wind to produce electricity. The lack of control over when and how much wind energy will be available makes this renewable energy non-dispatchable, thus reducing its value to the system [5]. Tennessee does not have a large amount of economical wind energy capacity that has not already been utilized [6].

Methane is a potent greenhouse gas (GHG) that, pound-for-pound, contains 21 times the impact of carbon dioxide on global warming [5]. Because of the environmental issues, TVA has currently capped its capacity of methane production in the region

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An economic and functional tool for assessing the financial feasibility of farm-based anaerobic digesters

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ABSTRACT

Anaerobic digester (AD) technology is a form of renewable energy with significant upside potential and little public resistance. However, previous studies have generally found ADs to be a poor investment for private firms without public assistance. The mixed results on the financial feasibility of ADs could be due to the site of the analysis since results vary with size, geographic location or the type of AD system, which are not standardized but rather customized to the individual situation. Given the public and private interest in AD technology and the need to assess the feasibility by site, a decision-making tool that can be adapted for each location and system would aid assessing the investment. This paper presents a freely available workbook to determine the financial feasibility of a farm-based AD and to demonstrate its use. The decision-making tool identifies the technical and financial parameters affecting the returns to an AD and the sensitivity of the assumption to changes in the value of those parameters. An application of the workbook for the Ontario livestock sector demonstrates its usefulness. Investment in an AD is financially feasible only for the largest dairy farms in Ontario under current electricity prices, which are approximately six times greater than the wholesale price. Shifting to a duel fuel continuous system would improve returns, as would the availability of additional substrate material in the form of solid grease and vegetative waste. Reductions in capital cost and improvements in the efficiency of the technology are probable given the relatively infant status of the biogas sector but these future enhancements would likely only alter the investment decisions for large commercial dairy farms.

1. Introduction

Anaerobic digester (AD) technology is a form of renewable energy with significant upside potential and little public resistance. This interest is mainly due to an AD's ability to turn a waste material, such as livestock manure, into a clean, local energy source. The main source of inputs into a farm-based AD system is manure from a confined feeding operation. The manure is first sent into a storage facility before moving into the AD tank. The AD tank produces two outputs: biogas and digestate. The anaerobic bacteria breakdown the organic material in the absence of oxygen and turn it into biogas, which is approximately 60% methane and 30–40% carbon dioxide. Biogas is typically treated by removing excess moisture and hydrogen sulfide and then sent to a co-generator that produces heat for on-site use and electricity for sale. The digestate that is produced is sent to liquid/solid separator which produces compost or nutrient rich value added products. As the demand for renewable clean local energy increases, so will the need for more accurate and detailed economic information on the financial feasibility of ADs.

Previous studies have generally found ADs to be a poor investment for private firms without public assistance. Bishop and Shumway [3] use two years of physical and financial data from an operational AD located on a dairy farm in Washington State to evaluate the financial feasibility of an AD. They find the net present value of the investment is negative but that revenues (tipping fees and electricity sales), and consequently the financial returns, vary with geographic location. Lazarus and Rudstrom [7]using data monitored over five years from an AD on a dairy farm in Minnesota also found the AD to be financially unfeasible without a significant rise in the electricity price. Similarly, Wang et al. [13] found that the financial feasibility of ADs on Vermont dairy farms is highly dependent on grants from government and non-government

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Green biorefinery (GBR) scenarios for a two-cut silage system: Investigating the impacts of sward botanical composition, N fertilisation rate and biomass availability on GBR profitability and price offered to farmers

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ABSTRACT

In Ireland, grass is a readily available bioresource. It has previously been established that Green biorefinery (GBR) could become a potential use of Irish grasslands, and a blueprint for a sustainable GBR industry in Ireland has been developed. The objective of this paper is to use scenario analysis to investigate the sensitivity of the profitability of the GBR blueprint to variations in grass quantity and quality as a function of botanical composition, fertiliser application, and biomass availability. As an outcome of these scenario analyses, the price the GBR can offer to farmers above their production costs (€ t^{-1} dry matter) was calculated. Results of the scenario analyses determined that GBR systems located in a catchment area of permanent pasture (*Lolium perenne* > 60%) with annual grass yields in the range of 9–12 t dry matter (DM) ha^{-1}, and supplied with grass biomass with a fibre content of 500–555 g kg^{-1} DM and a protein content of 110–130 g kg^{-1} DM, were viable. The most profitable scenarios were generated when nitrogen fertiliser application was greater than 90 kg ha^{-1} a^{-1}. Biomass availability of less than 30% resulted in reduced profitability and for some scenarios resulted in a loss for both the GBR and farmer due to increased transport costs. Within the scenario assumptions of this study, grass feedstock was valued at €4–€56 t^{-1} dry matter above production costs. However, this value depended on the yields and biomass availability of the GBR catchment area.

1. Introduction

1.1. Agricultural systems in Ireland and green biorefinery (GBR)

For the last decade in Europe, there has been increasing interest in using grass biomass for energy and chemicals [1]. Grass is a bioresource that is readily available in Ireland. Approximately 90% of the agricultural area (3.8 million ha) is devoted to grassland farming and animal production systems [2]. Environmental restrictions such as the Nitrates Directive (91/676/EEC) and economic pressure from Common Agricultural Policy reforms have led to declining livestock numbers [3] and a potential for surplus grassland biomass. These issues

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Feasibility of ranching coastal cod (*Gadus morhua*) compared with on-growing, full-cycle farming and fishing

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ABSTRACT

The feasibility of ranching wild cod in 'herds' was compared with three other scenarios: on-growing of wild cod in sea cages, full-cycle cod farming with hatchery produced juveniles, and commercial cod fishery. In the calculations it was assumed that an existing fishing company could either fish, ranch or on-grow 200 tons of cod quota to increase the quota yield or sell it to invest in full-cycle farming. The results indicate ranching to be the most profitable, fishing as the second and on-growing as the third, whereas full-cycle farming appears to be unrewarding. The net present value (NPV) of the four scenarios was €754 000, €532 000, €198 000 and €−95 000, respectively. Ranching based on aggregating and growing wild cod in a reserved coastal area with anthropogenic feeding thus has the potential of decreasing the cost of fishing, improving growth rate and enhancing quota yield without the investments required in conventional farming. As cod ranching is in the initial stages of development the risks are higher than in the well established cod fishery.

1. Introduction

World catches of cod have decreased from about four to one million tons during the last 50 years and thus the market for farmed cod is considered very large. For a few decades there have been ongoing farming trials with cod in several countries. Two main farming methods have been practiced: (1) on-growing of wild cod captured at a mean weight of about 2 kg and reared in sea cages and (2) full-cycle cod farming using juveniles produced in hatcheries [1]. The first method has been hampered by the difficulty in capturing large quantities of viable cod for on-growing and there are still some serious problems associated with the second method: variable quality of hatchery produced juveniles, lack of vaccines to fight bacterial diseases and premature sexual maturation slowing down growth rate [1]. Norway is the leading country in developing cod farming but their production has stagnated at 10–20 thousand tons per year since the year 2007.

Ranching of wild cod using anthropogenic feeding to aggregate and grow free-ranging cod has been carried out in two trials in Iceland [2,3]. The concept of ranching is based on attracting wild predatory fish by feeding trash fish at specific locations in order to make the fish form 'herds'. The word herd is used to emphasize the anthropogenic aspect of the operation. The conditioned cod have shown remarkable fidelity to their herds from spring until autumn [4] and their daily growth rates have increased about three-fold compared with the unconditioned cod [4,5]. Annually, there is a supply of about one million tons of low priced trash fish in Iceland, part of which could be used for cod ranching [6].

Cod ranching based on anthropogenic feeding has the potential of reducing the cost of fishing, decreasing the predation on valuable species, and growing the fish without the expenses associated with using sea cages. The aim of the study is to compare the profitability of cod ranching with farming in sea cages as well as traditional cod fishery. In the calculations it is assumed that a fishing company with 200 tons of cod quota can on-grow this amount of wild cod for about 6 months to approximately double their mean weight and biomass by (1) ranching in herds, (2) farming in sea cages, (3) selling the quota and invest in full-cycle cod farming, or (4) catching the cod at a mean weight of about 2 kg, as is currently practiced.

2. Methods

In all four scenarios it is assumed to use a 30 ton boat (GRT). In Iceland it is common that boats of this size rigged with a Danish seine catch each year about 200 tons of cod equivalents in terms of value. The data used for making a profitability assessment for a ranching program, are based on an experiment conducted in Arnarfjördur, a 40 km long fjord in Northwest Iceland, in the years 2005–2006. These include biological data, such as fish sizes,

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Technical and economic assessment for the production of torrefied ligno-cellulosic biomass pellets in the US

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ABSTRACT

Manufacturing and trade of wood pellets in the United States (US) has seen an exponential growth in the last few years, triggered by its potential utilization in applications typically dominated by fossil fuels, such as heat, power, and combined cycle generation. This combination holds the promise of delivering a high density, high heat value fuel, making it a better substitute for coal and other fossil fuels. This combined process exists only at pilot-plant levels. Scale-up of the technology and feasibility of such projects remain largely unexplored. This research developed a techno-economic model for the production of torrefied wood pellets, considering critical production parameters, and evaluating sensitivity to changes in CAPEX (Capital Expenditure), biomass delivered costs, labor, and energy consumption of a facility, evaluated through a case-study. Results indicated that biomass delivered costs and depreciation are the most significant factors influencing production with CAPEX being the most sensitive variable due to high investments in torrefaction reactors. The selection of different torrefaction technologies, and adequate binders, may represent a major improvement in the feasibility of a project by reducing capital costs drastically. Back-calculated price for torrefied wood pellets is $261/metric ton (100,000 metric tons/year facility), and delivered price may reach $282/metric ton, a similar cost compared to regular pellets. Preliminary analysis of carbon credits as additional income may considerably increase the likeability of the business, and further enhance profitability.

1. Introduction

The resurging interest in biofuels has produced a large amount of research and development in new technologies and reevaluation of old technologies. Among these technologies, torrefaction has been identified as one of the most promising pre-treatments [1] to improve the performance of biomass based fuels.

Traditional biofuels industries such as wood pellets have seen a renewed interest and an exponential market growth [2,3] in recent years. Most of this market growth is due to government mandates. Even with moderate projections (10% demand increase annually), 10–12% of all harvested wood in the world would be destined to end up as wood pellets by 2025 [4], and global markets are expected to double in 2014 (11.3 million metric tons in 2008 vs. 22 million metric tons by 2014 [5]). Part of the industry's success relies on using proven technology [6], making its expansion relatively easy, with only the occasional problems typical of growing industries. [7].

Torrefaction of ligno-cellulosic biomass has been extensively investigated in the literature [8–13]. It is described as a thermo-chemical process that degrades hydrophilic polysaccharides and hydroxyl radicals, producing an increase in the percentage of lignin on a dry weight basis, thereby reducing the hydroscopicity of the material and increasing energy density.

Wood pellets have also been broadly documented in previous literature. During pelletization the biomass is milled, dried and mechanically densified, enhancing its heating value and burning characteristics [3,7,14,15]. Previous research proved the feasibility of producing torrefied pellets from ligno-cellulosic biomass [6,16,17], demonstrating improved properties such as heating value, bulk density, and grindability vs. wood chips, pelletization, or torrefaction on its own.

A large part of the market growth of pelletized woody material has been intended to supplement or replace coal for power generation. Studies indicate that torrefied wood's energy content per kilogram are similar to that of coal, and 12–41% greater than that of wood pellets depending on the degree of torrefaction [18]. The disadvantage of wood vs. coal is its lower bulk density (641–721 kg/m^3 vs. 897–993 kg/m^3 for coal). The addition of pelletization to torrefaction would potentially create a bio-based fuel with similar energy density to coal, prompting the adoption of this product for replacing coal in heat and power facilities. Recent studies aim in the direction of making a combined torrefaction–pelletization process possible in a commercial scale [4,6]. The Energy

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Abalone farming in South Africa: An overview with perspectives on kelp resources, abalone feed, potential for on-farm seaweed production and socio-economic importance

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Abstract

The South African abalone cultivation industry has developed rapidly and is now the largest producer outside Asia. With a rapid decline in wild abalone fisheries, farming now dominates the abalone export market in South Africa. Kelp (*Ecklonia maxima*) constitutes the major feed for farmed abalone in South Africa, but this resource is now approaching limits of sustainable harvesting in kelp Concession Areas where abalone farms are concentrated. This paper gives an overview of the development of the South African abalone industry and analyses how abalone farming, natural kelp beds and seaweed harvesting are interlinked. It discusses options and constraints for expanding the abalone industry, focussing especially on abalone feed development to meet this growing demand.

Kelp will continue to play an important role as feed and kelp areas previously not utilised may become cost-effective to harvest. There are many benefits from on-farm seaweed production and it will probably be a part of future expansion of the abalone industry. Abalone waste discharges are not at present regarded as a major concern and farming brings important employment opportunities to lower income groups in remote coastal communities and has positive spillover effects on the seaweed industry and abalone processing industry.

Keywords: Abalone; Kelp; *Ecklonia*; Integrated aquaculture; *Gracilaria*; *Ulva*

1. Introduction

The global production of abalone reached 22,600 metric tonnes (including poaching of 3700 metric tonnes) in 2002. Of this, over 8600 metric tonnes was farmed and the total value of the production was estimated as approximately US$ 0.8 billion (Gordon and Cook, 2004). Triggered by a decline in yields from wild fisheries, a rapid development of abalone cultivation took place in the 1990s, and cultivation is now widespread in many countries including USA, Mexico, South Africa,

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Energy-neutral dairy chain in the Netherlands: An economic feasibility analysis

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ABSTRACT

The Dutch dairy chain is aiming to achieve energy-neutral production by bringing the whole chain from dairy farm to factory ultimately to be self sufficient in energy in year 2020, through a combination of wind, solar and biogas. This paper investigated the economic feasibility of producing green gas from digestion of dairy manure and other co-substrates. A simulation model of producing 17 PJ of green gas from 2 business models, stand-alone and central upgrading was developed. Probability distributions were chosen to describe the profitability and risks for individual business models and for the aggregate energy production at dairy sector level. Data sources, among others, stem from 23 operating biogas plants in Netherlands. Simulation results showed that the probability of a negative net present value (NPV) is less than 50% for both individual models. The probability that the combined business models producing 17 PJ will result in a negative NPV is 23%. A total of 109 plants are needed to produce the total energy, requiring 8.5% of the total amount of cattle manure produced in the Netherlands to be processed. Sensitivity analysis based on spearman rank correlation coefficient between NPV and each of the sample input distributions showed that biogas yield and investment costs have significant effect in determining the NPV values.

1. Introduction

The Dutch dairy sector is aiming to achieve energy-neutral production by 2020. This initiative is part of its broader Sustainable Dairy Chain initiative which focuses on making the entire chain sustainable in the context of three major themes: Energy and Climate, Animal Welfare, and Biodiversity. The sector aims to achieve this by working together with dairy farmers and chain partners to improve energy efficiency, reduce the emission of greenhouse gases and stimulate the production of sustainable energy on dairy farms. Moreover, the dairy sector worked in cooperation with the Dutch Federation of Agriculture and Horticulture (LTO) and Dutch Dairy Association (NZO) to launch the initiative in 2008 and jointly invested 250 million Euros in sustainability every year. The basis of this initiative stems from the agreements signed by the dairy sector with the Dutch government which aims at 30% increase in energy efficiency, 30% CO_2 reduction compared to 1990 and 20% share of renewable energy in 2020. This is in line with the Dutch government's goals in its white paper on energy which calls for energy savings and efficiency improvement of 30% [1] and a 20% share of renewable energy in 2020 [2].

As part of the energy and climate theme of the sustainable dairy chain initiative, the dairy sector aims to achieve energy-neutral production by bringing the whole chain from dairy farm to factory ultimately to be self-sufficient in energy by 2020, possibly by a combination of wind, solar and biogas. This

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Artikel tersebut dapat memberikan sumbangan terhadap perkembangan ilmu agribisnis dengan kemajuan teknologi di masa yang akan datang, dan dapat menjadi dasar dalam pengajuan draft paten di bidang agribisnis. Publikasi tersebut relevan dengan bidang agribisnis dalam arah pengembangan ilmu agribisnis.

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Effect of duck diet supplemented with fermented seaweed wastes on carcass characteristic and production efficiency of indigeneous Indonesian ducks

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