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Process Development and Techno-Economic Analysis (TEA) of Ethanol Production from Switchgrass Using Superpro Designer Software

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ABSTRACT

In this paper switchgrass biomass has been investigated as an energy crop for ethanol production, and the techno-economic analysis is conducted using SuperPro Designer software. Switchgrass is a perennial herbaceous plant, and in US, there are five variety of switchgrass varied like Alamo and Kanlow across different lowlands, and the upland plants included the varieties of Trailblazer, Cave in Rock, Blackwell. Ethanol can be produced from cellulose and hemicellulose, and lignin can be separated as co-product and lignin is not used for conversion to ethanol. The maximum cellulose content belongs to Blackwell and Alamo cultivars which are 33.65% and 33.48 % respectively.; the highest hemicellulose and lignin contents with cave-in-rock cultivar like 26.32% and 18.36%. In addition, the compositions of polysaccharide sugars in the different switchgrass cultivars the maximum glucan (36.60%) and mannan (0.80%) are in Kanlow cultivar, Xylan (21.17%) in Trailblazer, Galactan (1.16%) in cave-in-rock, arabinan (3.01%) in Blackwell. For 1000MT/day ethanol production from switchgrass, a process flow diagram, block diagram and table about process descriptions are developed using SuperPro designer software, and all the process parameters are assumed and used based on the literature. The selling price of produced ethanol is $ 0.9/kg and $ 3.4/gallon based on economic evaluation by SuperPro Designer. Total amount of ethanol produced 90 million gallons per year and total lignin produced 2,20,440 MT/yr and the lignin selling price is assumed $ 0.5/kg. Based on the economic and profitability analysis the developed design process for ethanol production from switchgrass is profitable one with payback time around 10 years.

Key Words: Switchgrass, TEA, Ethanol, SuperPro Designer, Cost Analysis.

INTRODUCTION

Ethanol production from switchgrass is viable process and it can be a potential resource of biomass, which can reduce the greenhouse gas emissions in comparison with the gasoline. Switchgrass is attractive feedstock for biorefinery in United states due to it has several features to be considered as valuable energy crop. On the other hand, ethanol production from switchgrass can face several challenges than from starch-based feedstocks due to the physical and chemical boundaries to access to the sugars within the biomass. Pretreatment requires to open the surfaces for enzymatic hydrolysis followed by fermentation methods for ethanol production from glucose and xylose. Additionally, there are several aspects which inhibits the ethanol fermentation process during pretreatment [1–4].

Switchgrass is a C_4 grass native to the US and a ideal plant for cellulosic ethanol production because of it has really high productivity and cellulose contents, effective pretreatment methods, conversion efficiency, and high ethanol yields based on different reactor types and reaction conditions. Switchgrass is a warm-season perennial grass that has the characteristic C4 physiology and anatomy. To increase the ethanol yield, carbon fixation can be a major option, and photosynthesis can be the primary option to increase the carbon; switchgrass a following C_4 photosynthesis provides competitive advantages with high photosynthetic efficiencies which can evolved C_4 pathway with biochemical. There have been numerous studies to make more effective for the photosynthetic capacity of switchgrass following the modification original structure with genes from other plants. Switchgrass can be separated into two types – upland and lowland – based on phenotype and habitat, habitant [5–7].

The importance of growing switchgrass as a perennial energy crop is the type and land required for sufficient feedstock for ethanol production. Switchgrass can grow in the marginal lands can be more productive for biorefinery replacing the others crops in the fringe lands. By using the marginally productive sites it can ensure long-term sustainable ethanol production in comparison with the maze and soybeans crops. The yields of ethanol from switchgrass can be equal or more than traditional annual crops by reducing required raw materials, and soil erosion of these marginal lands can be reduced and enhanced wildlife habitat. Admittedly, there are some concerns about loss of grassland and the reduction of grassland nesting habitants [6–9].

The aim of this report is to represent switchgrass as an energy crop through available methods. In addition, the plant description, cultivation and harvesting in different part of USA, and the research and potentiality of ethanol production from switchgrass. Several strategies have been reviewed for this purpose, including plant anatomy, morphology, composition analysis, product processing methods, yield, Techno-economic analysis (TEA). Consequently, the industrial applications, profitability, and feasible methods of switchgrass valuable bio-energy resource will be studied as well.

Material Description, Process Conditions and Methods

Description of switchgrass plant and location in USA

Due to high yields switchgrass can be considered a potential resource as an ideal energy crop. The production start from the first year of cultivation (Figure 1) in lowland and can yielded 17.6 tons per acre and the yield will increase for the third and fourth years. In different location of US five variety (Table 1) of switchgrass varied (Alamo and Kanlow) across different lowlands, and the upland plants included the varieties of Trailblazer, Cave in Rock, Blackwell. The cultivated switchgrass can be harvested in November, when the crop entered winter and the harvesting process can be hampered due to wet soils [7].

Switchgrass biomass feedstock production distributed among different states in USA, the goal of distributed biomass energy production to developing much more economic friendly technologies by: (i) increasing product yield and decreasing the manufacturing costs, (ii) higher ethanol conversion, and (iii) genetical modifications can be implemented to increase ethanol production (USDA-ARS 2006). To develop improved cultivars, hybrids, pre-treatment, fermentation conversion technologies and product processing systems for ethanol production and the cultivation, harvesting and research locations are shown in Figure 2 [7,10–12]. Switchgrass can be categorized in different region-based biomass based on the temperature during the year. There are different varieties of these ecotypes, but it can be called as lowland and upland varieties. The low land cultivars contain tall and thick stems and can grow in heavy and wetted soils as well. The upland varieties prefer dried soil and can grow and survive with warm temperature [13]. The summary of the different varieties of switchgrass is presented in Table 1.

The taxonomic descriptions of switchgrass are given in figure 3, the culm (center) of switchgrass can have leaves about 0.5 to 3 m tall and 3- 5-mm wide and 10 to 60 cm long; Panicle inflorescence (left) can be 15 to 55cm long; Collar grows (lower right) up to 1.5 to 3.5 mm long fringed membranous; Spikelet (middle right) that is about 3 to 5mm long; and seed (upper right) [10]. The general properties and the functions of switchgrass are shown in figure 4: switchgrass is a C_4 perennial herbaceous plant; decreases windblow and water evaporation; contribute for less erosion from surface flow; deep rooting system benefits soils; show excellent nesting, invertebrate habit and carbon sink as well.

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Figure 1: Switchgrass on fields [7]

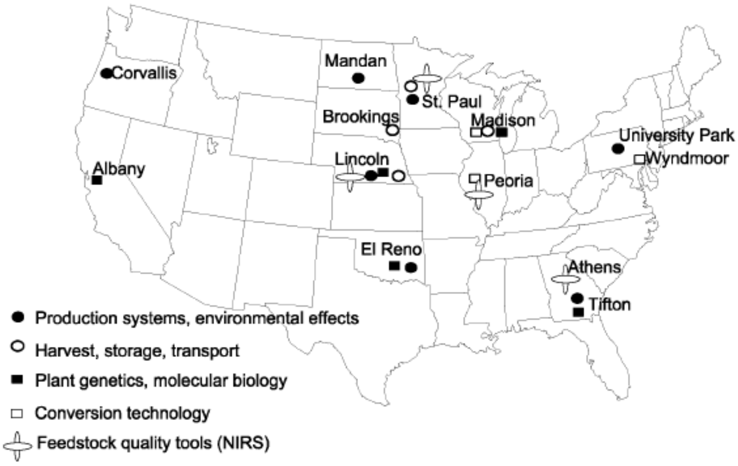

Figure 2: Location of USDA-Agricultural Research Service switchgrass biomass research locations [11].

Table 1: Switchgrass cultivars and characteristics in USA [7,10,13]

Variety	characteristics
Cave-in-Rock	More adapted to the flooded regions and the release date was 1973
Blackwell	Adapted to the areas where there will have more precipitation, released date was 1944
Trailblazer	Mainly cultivated in mid-west cities and released date was 1984
Alamo	Grow with high yield in south regions, and released date was 1978
Kanlow	More suitable for the flooded regions, and released date was 1963

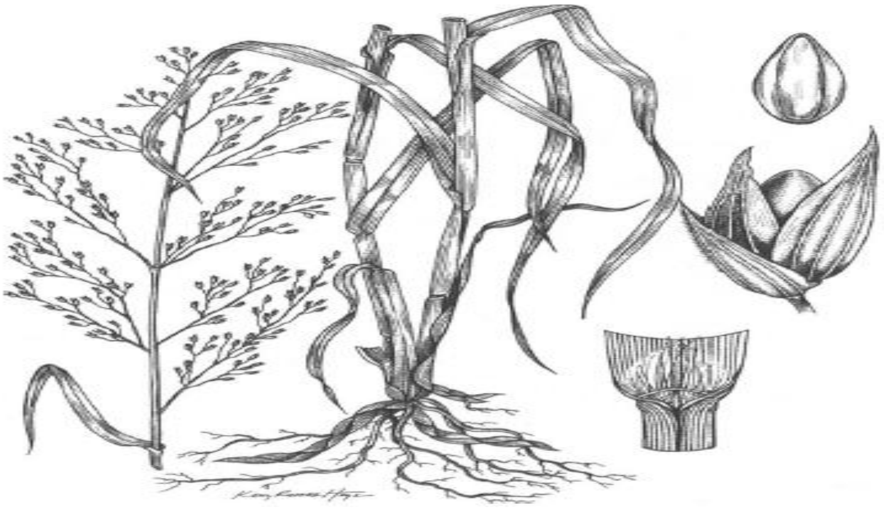

Figure 3: Switchgrass plant description [10]

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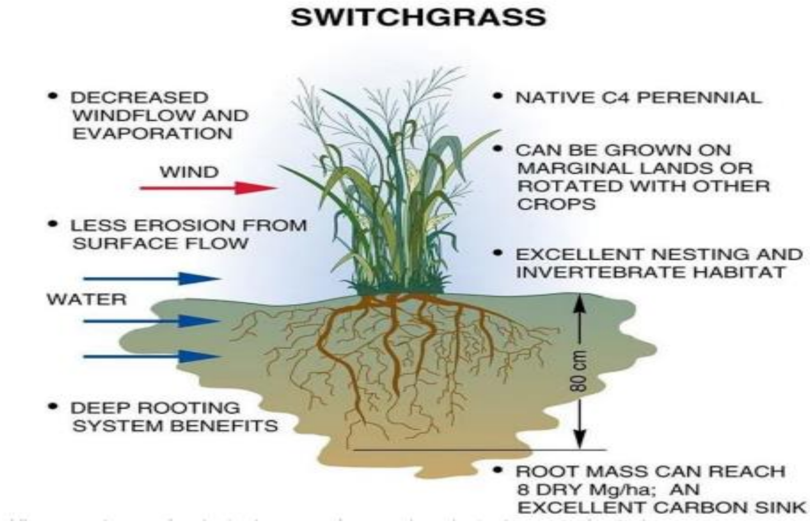

Figure 4: General functions of Switchgrass

Composition analysis of Switchgrass

The elemental composition of switchgrass as C, H, N and O values are given in table 2, and the switchgrass cultivars can be compared with the standard woody biomass, and other potential biomass feedstock. From the table 2, it can be seen that the maximum carbon content belongs to Kanlow cultivars (48%), maxim hydrogen content carry by the cave-in-rock (6.81%), Nitrogen content is in Blackwell cultivar (1.08%) followed by the cave-in-rock cultivar with maximum oxygen content (42.54%). The main components of switchgrass biomass are cellulose, hemicellulose, and lignin. Ethanol can be produced from cellulose and hemicellulose, and lignin can be separated as co-product and lignin is not used for conversion to ethanol. The amount of cellulose, hemicellulose and lignin in different switchgrass cultivars are shown in Table 3. The given table shows that the maximum cellulose content belongs to Blackwell and Alamo cultivars which are 33.65% and 33.48 % respectively.; the highest hemicellulose and lignin contents with cave-in-rock cultivar like 26.32% and 18.36% followed by the maximum ash content with Trailblazer cultivars (6.4%). In addition, the compositions of polysaccharide sugars in the different switchgrass cultivars are summarized in Table 4. This table illustrate the information that the maximum glucan (36.60%) and mannan (0.80%) are in Kanlow cultivar, Xylan (21.17%) in Trailblazer, Galactan (1.16%) in cave-in-rock, arabinan (3.01%) in Blackwell [13–16].

Table 2: Elemental (C,H,N,O) composition of switchgrass species [13,16]

Variety	C (% mass)	H(% mass)	N(% mass)	O(% mass)
Cave-in-Rock	47.53	6.81	0.51	42.54
Blackwell	46.29	6.01	1.08	-
Trailblazer	45.86	6.00	0.96	-
Alamo	47.27	5.31	0.51	41.59
Kanlow	48.00	5.40	0.41	41.40

Table 3: Cellulose, hemicellulose, lignin and Ash in switchgrass cultivars (% dry basis) [13–16]

Variety	Cellulose	Hemicellulose	Lignin	Ash
Cave-in-Rock	32.85	26.32	18.36	6.0

Blackwell	33.65	26.29	17.77	6.2
Trailblazer	32.06	26.24	18.14	6.4
Alamo	33.48	26.10	17.35	5.2
Kanlow	31.66	25.04	17.29	5.4

Table 4: Polysaccharide sugar content in switchgrass biomass (% mass) [13,16]

Variety	Glucan	Xylan	Galactan	Arabinan	Mannan
Cave-in-Rock	32.81	21.15	1.16	2.99	0.30
Blackwell	33.08	20.93	1.04	3.01	0.27
Trailblazer	34.44	21.17	0.98	2.93	0.39
Alamo	30.97	20.42	0.92	2.75	0.29
Kanlow	36.60	21.00	1.00	2.80	0.80

Anatomy and Morphology of Switchgrass

Switchgrass mainly harvested from above part of internode I_6 (right) in the figure 5. From the figure 5 (right) shows that the internode I_1 to I_5 mainly used for harvesting and product manufacturing. The harvested tillers (internode I_1 to I_5) can be kept at indoors room temperature, then the tillers dried at 45°C at oven then the tiller separated to leaf, leaf sheaths and stems and pinnacle are discarded; and the certain size was reached by a shredding machine. For the alkaline pretreatment the loading was maintained at 10% (g NaOH/g dry biomass) loading at 10% (g biomass/g solution) loading, giving a 0.25 M NaOH concentration. However, the morphology of the before pretreatment is shown in Figure 5 (left); from the figure, switchgrass stem, sheath, and leaf exhibit clear morphological and structural difference before and after pretreatment with alkali.

The stems have much higher ticker cells and the ratio of lignified cells higher than other parenchyma cells. The figure 6 shows the cross-sections of cell wall with NaOH-pretreated switchgrass and their fractions for different internodes I_2 to I_4. The scanning micrography conducted at wavelengths of 405 and 543 nm. From the figure 6, it can be seen that the impact of NaOH pretreatment on different internodes to gauge both organ and internode and decomposition of cell walls in response to pretreatment. In the cross sections of stems and leaf, the red emission spectrum indicates the secondary cell wall tissue and fibre bundles, on the other hand the blue emission spectrum indicates mainly parenchyma cells. The light micrography of different internodes are shown in figure 7. The figure 7A shows the internodes (I_1) starting from the top, the predominantly fiber cells (DF) and fiber sheaths (F) which are surrounded by the Parenchyma cells (PC) show limited deposition of secondary cells. The figure 7B shows the third internode(I_3) and indicates more lignified content surrounded by the vascular bundles. Figure 7C shows the lowest internode (I_5) exhibited formation and structure of cortical fibers and dominant areas for fiber sheaths and the lignification of the cortex [17,18].

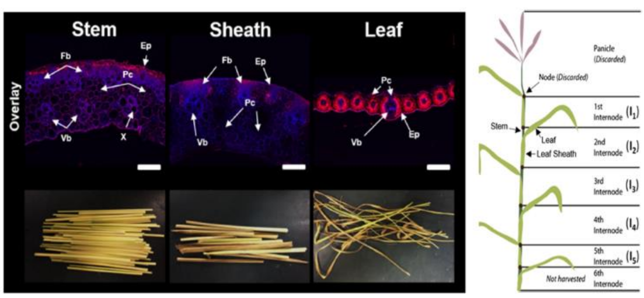

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Figure 5: Morphology, cell wall deposition among different internodes of switchgrass anatomical fractions [17,18].

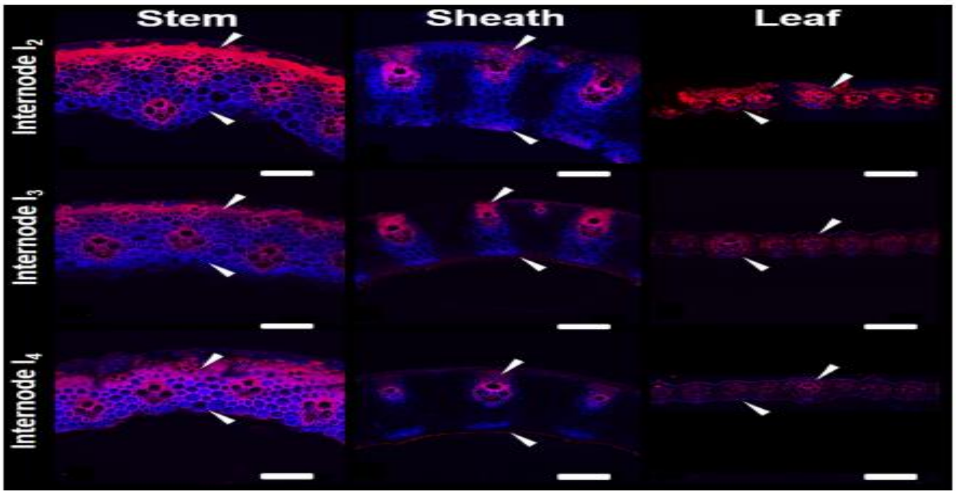

Figure 6: The effect of NaOH-pretreated on switchgrass and anatomical fractions for the internodes I_2, I_3, and I_4 [17,18]

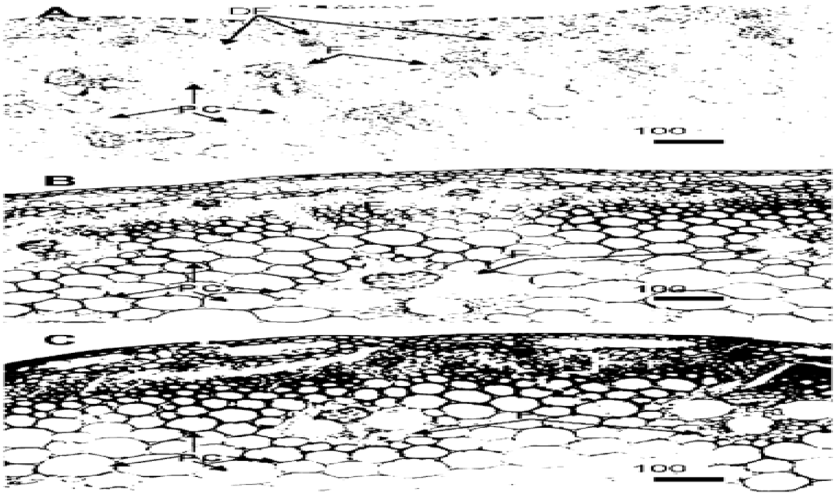

Figure 7: Micrography of different internodes I_1, I_3, and I_5 in between different strains of switchgrass [18].

Pretreatment conditions, pyrolysis methods, and yields of Switchgrass.

Different pretreatment methods, used chemicals, conditions and yields of switchgrass for hydrolysis and fermentation are shown in table 5. From the table 5, it can be noted that the ammonia water pretreatment (25-28%) for 20 min produce yield 93% of glucan conversion to glucose and 70% Xylan conversion to xylose. The dilute acid pretreatment process at 140°C for 1 h can yield 70% of cellulose conversion of resulting biomass. For the lime pretreatment at 120°C for 2h can yield 85% of switchgrass to reducing sugars. The favourable conditions for pyrolysis reactors to convert switchgrass to biofuels including yields are shown in table 6. From the table 6, it can be noted that fluidized bed pyrolytic reactor at 480°C can yield 43%, using flash Pyrolyzer at 600 to 1050°C for 20 seconds can produce yield 58.6%, followed by the fluidized bed reactor at 500°C for 4-5 seconds can produce maximum yield 62.4% [13,14,16].

Table 5: Summary of pretreatment methods and conditions for switchgrass [13,14,16].

Pretreatment	Conditions	Yield
Ammonia water	120 °C, 20min, 25–28% ammonia	93% cellulose conversion to glucose, 70% hemicellulose conversion to Xylose

Dilute acid	140 °C, 1h, 0.45–0.50% v/v dilute sulfuric acid	70% cellulose conversion to glucose
Lime	120 °C, 2h, 0.1g $(CaOH)_2$/g dry biomass, 9 ml H_2O/g dry biomass	85% cellulose conversion to glucose

Table 6: Summary of pyrolysis methods, yields and conditions for switchgrass [13,16].

Reactor types	Conditions	Bio-oil composition %				Yield %
		C	H	N	O	
Fluidized bed	480 °C, 0.1s residence time	52.97	6.43	0.38	39.13	43
Flash Pyrolyzer	600 °C to 1050 oC, 20 s					58.6
Fluidized Bed	480 °C, 30 min					60.7
Fluidized Bed	500 °C, 4-5 s	55.85	6.90	0.79	36.3	62.4

RESULTS AND DISCUSSION

The product processing, and operating conditions

Based on the available information and reactions conditions and yield of ethanol production from switchgrass, a process flow diagram, block diagram and table about process descriptions are developed using SuperPro designer software. The block diagram of ethanol production from switchgrass is presented in figure 8. From the figure 8, it can be depicted that the after harvesting the switchgrass the internodes are shredded for 4-5 mesh size and then washed by water, then mixed with pure water and proceeded for thermal hydrolysis where the cellulose and hemicellulose will hydrolysed by the temperature at 180 °C for 2 h; after cooling the enzymatic hydrolysis step have completed by supplying enzyme at 50°C for 72 h; then the produced glucose and xylose sent for fermentation at 35°C for 72 h with yeast to produce ethanol; and ethanol and lignin are separated by the distillation process. All the reactions and reaction conditions, yields, catalyst loading and extend of reaction are presented in table 7 and table 8. The table 8 represents that 3% of the available glucose and xylose used for Yeast formation and 95% and 70% to ethanol production. The process flow diagram has been designed and developed by using superpro designer software for 1000MT/day ethanol production from switchgrass and presented in figure 9. Figure 9 represents the process modelling, required equipment's, and their design and connection for ethanol production from switchgrass. The required raw materials, enzyme and yeast loading have been presented in table 7. The amount pf lignin produced as co-product after ethanol production is 668 MT/day.

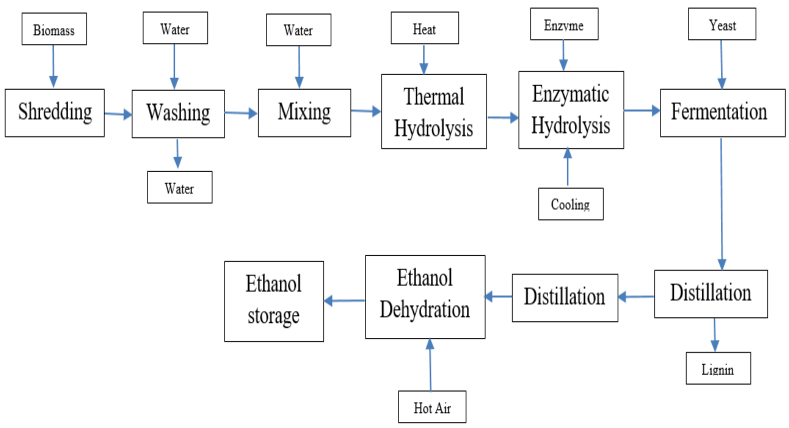

Figure 8: Block diagram for ethanol production from switchgrass.

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Table 7: Block description for ethanol production from switchgrass.

Production capacity: 1000 MT/Day ethanol, Operation Day: 330, 24 h		
Total Biomass: 3850 MT/Day		
Name of Operation	Description	Ref.
Shredding	4-5 mash size	[19]
Washing	Cleaning of biomass	[20]
Mixing	Mixing of water with Shredded biomass	[20,21]
Heating	Exit temperature 180 ^{o}C,	[22,23]
Thermal Hydrolysis	180 ^{o}C, 2h, Extent of Reaction: Cellulose 70%, Xylose 80%	[20,23]
Cooling-I	Exit temperature 50 ^{o}C,	[22,23]
Enzymatic Hydrolysis	50^{o}C, 72 h, Extent of Reaction: Cellulose 90%, Xylose 80%, Enzyme loading 3% of cellulose and Hemicellulose	[20,22–24]
Storage	Intermediate storage Cellulose, Hemicellulose, lignin, and others, 1 h	[20,23]
Fermentation	35^{o}C, 72 h, Extent of Reaction: Glucose 95%, Xylose 70%	[20,23]
Storage	Intermediate storage produced ethanol and others, 1 h	[20,23]
Heat Exchanger	Hot Fluids: Produced ethanol and Water from distillation column-II	[20,22,23]
Distillation Column-I	Light Key: Ethanol, Heavy Key: Water, 98% ethanol at top stream, Relative Volatility of ethanol to water: 2.22:1	[22,23]
Distillation Column-II	To increase ethanol concentration, Light Key: Ethanol, Heavy Key: Water, 98% ethanol at top stream, Relative Volatility of ethanol to water: 2.22:1	[22,23]
Cooling-II	Exit temperature: 30 ^{o}C	[22,23]
Ethanol dehydration	To remove water, Backwash: Air, 90 ^{o}C, 99 % ethanol to	[25–27]
	Ethanol yield: 26.15%, Lignin Production: 668 MT/Day, selling price of produced ethanol: \$0.9 /kg, \$ 3.4/gallon	

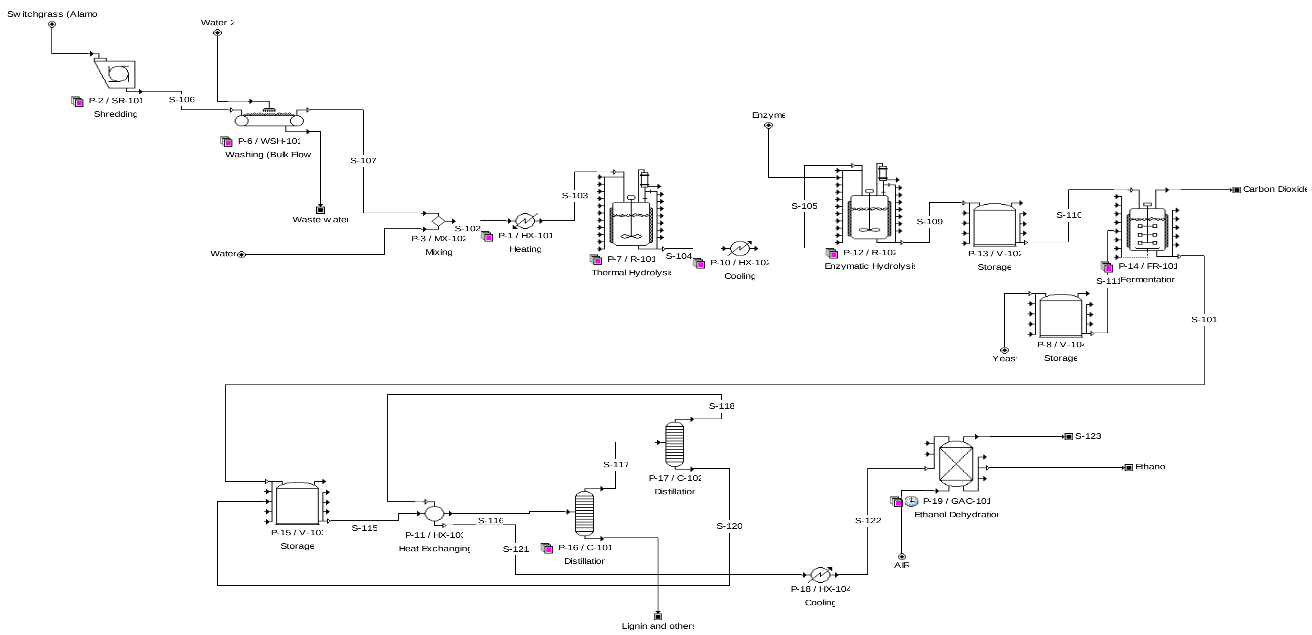

Figure 9: Process flow diagram for ethanol production from switchgrass using SuperPro Designer.

Table 8: Reactions involved in the reactors for ethanol production from switchgrass reactor [20,28]

Thermal Hydrolysis	**Extent of Reaction**
Cellulose + Water ===> Glucose 162 g 18 g 180 g	70%
Hemicellulose + Water ===> Xylose 132 g 18 g 150 g	80%

Enzymatic Hydrolysis	
Cellulose + Water ===> Glucose 162 g 18 g 180 g	90%
Hemicellulose + Water ===> Xylose 132 g 18 g 150 g	80%
Fermentation	
Glucose ===> Yeast + CO_2 + Water 100 g 60 g 20 g 20 g	3%
Glucose ===> EtOH + CO_2 180 g 88 g 92 g	95%
Xylose ===> Yeast + CO_2 + Water 100 g 60 g 20 g 20 g	3%
Xylose ===> EtOH + CO_2 150 g 76 g 74 g	70%

Cost Analysis

The developed design to produce ethanol from switchgrass, which is an abundant source of lignocellulosic biomass in the US. The plant scale for the 1000 MT/day ethanol production and the base case has a feedstock flowrate of 3850 MT/day of wet biomass of switchgrass for 330 operation days, 24 working hours per day. The annual operating cost summary presented in the table 9. From the table 9 the information can be depicted that the production cost of ethanol from switchgrass is higher due to the high operating cost. The operating cost is higher because of the facility dependent cost. Facility dependent cost involves the equipment's usage and availability rates, lumped facility rates, production rate of the process and capital investment. The growing price of all sorts of equipment's calculated as reference year of 2024. Figure 10 represents the annual operating cost in pie chart and showing which can occupy the maximum costs. After facility dependent cost (67%) the maximum cost involve for raw materials (23%) followed by utilities 8%).

The table 10 displays the breakdown of the materials cost. The cost of enzymes is estimated by specifying a purchasing price that corresponds to $0.4/gal of ethanol produced. The industry's objective is to drive that cost down to $0.1/gal of ethanol through R&D in the future. The table 11, which is copied from the economic analysis, provides detailed information on utilities costs. The unit cost of steam (representing low pressure steam) is set to zero because it is produced on-site in the Utilities section. The Profitability Analysis is shown in table 12, which is copied from the economic analysis, displays the project evaluation results. The revenue is generated by the ethanol production but the produced lignin as co-product contributes to make the plant profitable. The product (ethanol) unit selling price is $0.9/kg whereas the production cost is $1.87/kg (this includes all governmental subsidies). The lignin production cost also calculated in the ethanol production section, so there is no cost involve for lignin production. The produced lignin selling price is $0.5/Kg. but the lignin can be sold for much higher price and the payback will be reduced and the profit will be increased.

Table 9: Annual Operating Cost- Process Summary

Cost Item	$	%
Raw Materials	142,240,000	22.56
Labor-Dependent	10,333,000	1.64
Facility-Dependent	425,910,000	67.55
Laboratory/QC/QA	1,550,000	0.25
Consumables	208,000	0.03
Waste Treatment/Disposal	0	0.00
Utilities	50,274,000	7.97
Transportation	0	0.00
Miscellaneous	0	0.00
Advertising/Selling	0	0.00
Running Royalties	0	0.00
Failed Product Disposal	0	0.00
TOTAL	630,514,000	100.00

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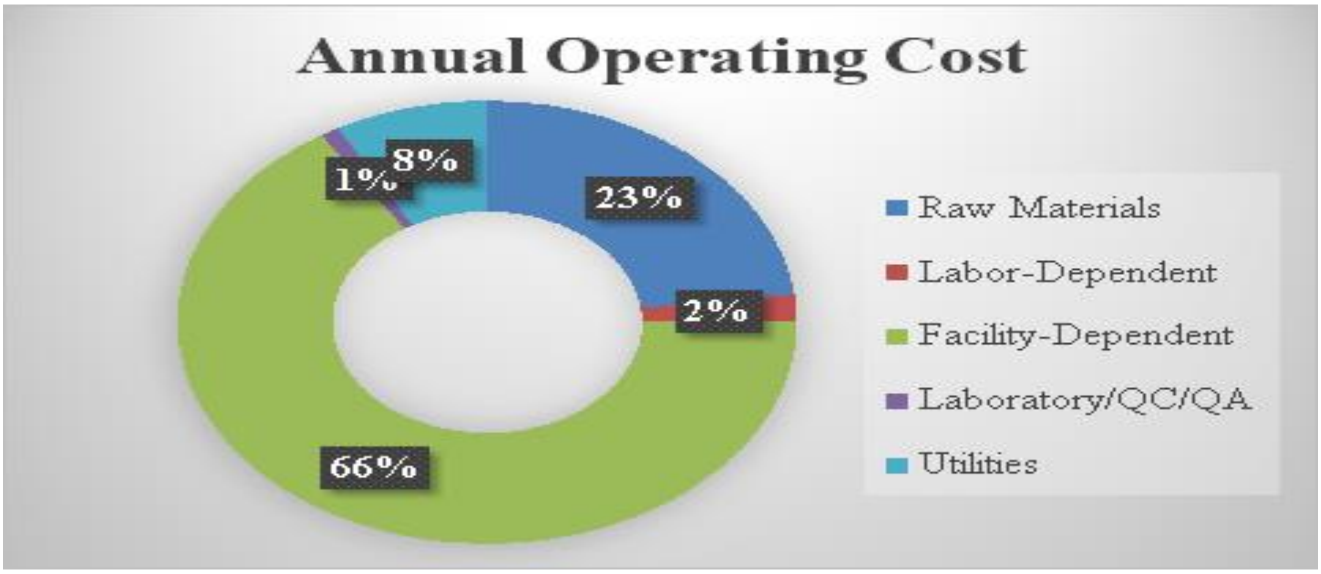

Figure 10: Annual Operating cost for ethanol production from switchgrass.

Table 10: Materials Cost - Process Summary

Bulk Material	Unit Cost ($)	Annual Amount		Annual Cost ($)	%
Air	0.00	160,790	kg	0	0.00
Biomass	0.11	1,270,500,000	kg	139,755,000	98.25
Enzymes	1.20	148,500	kg	178,200	0.13
Water	0.00	99,792,000	kg	29,938	0.02
Yeast	2.30	990,000	kg	2,277,000	1.60
TOTAL				142,240,138	100.00

NOTE: Bulk material consumption amount includes material used as:
- Raw Material
- Cleaning Agent
- Heat Transfer Agent (if utilities are included in the operating cost)

Table 11: Utilities Cost- Process Summary

Utility	Unit Cost ($)	Annual Amount	Ref. Units	Annual Cost ($)	%
Std Power	0.20	123,505,914	kW-h	24,701,183	49.13
Steam	12.00	561,782	MT	6,741,380	13.41
Steam (High P)	20.00	389,961	MT	7,799,215	15.51
Cooling Water	0.05	72,557,571	MT	3,627,879	7.22
Chilled Water	0.40	18,510,750	MT	7,404,300	14.73
TOTAL				50,273,956	100.00

Table 12: Profitability Analysis Ethanol Production from Switchgrass

Direct Fixed Capital	2,217,034,000 $
Working Capital	18,441,000 $
Startup Cost	110,852,000 $
Up-Front R&D	0 $
Up-Front Royalties	0 $
Total Investment (A+B+C+D+E)	2,346,326,000 $
Investment Charged to This Project	2,346,326,000 $
Revenue/Savings Rates	
Ethanol (Main Revenue)	337,261,843 kg /yr
Lignin and others (Revenue)	700,509,982 kg /yr
Revenue/Savings Price	
Ethanol (Main Revenue)	0.90 $/kg
Lignin and others (Revenue)	0.50 $/kg
Revenues/Savings	
Ethanol (Main Revenue)	303,535,659 $/yr
Lignin and others (Revenue)	350,254,991 $/yr
Total Revenues	653,790,650 $/yr
Total Savings	0 $/yr
Annual Operating Cost (AOC)	
Actual AOC	630,514,000 $/yr
Net AOC (K1-J2)	630,514,000 $/yr
Unit Production Cost /Revenue	
Unit Production Cost	1.87 $/kg MP
Net Unit Production Cost	1.87 $/kg MP
Unit Production Revenue	1.94 $/kg MP
Gross Profit (J-K)	23,276,000 $/yr
Taxes (40%)	9,310,000 $/yr
Net Profit (M-N + Depreciation)	224,584,000 $/yr
Gross Margin	3.56 %
Return On Investment	9.57 %
Payback Time	10.45 years

Economic and Environmental Impacts

The economic and environmental aspects also considered for the commercial application of ethanol production from switchgrass [12,16]. The most important factors for economic and environmental attributes are discussed below:

1. Switchgrass is a very potential resource for ethanol production.
2. Due to high product yields and economic considerations switchgrass can guarantee cultivation in more lands for future perspectives.
3. Soluble sugars fraction of total switchgrass dry weight and generate more revenue as following more extraction of sugars to improve process economics.
4. Ethanol production from switchgrass can ensure less GHG emissions in comparison with gasoline.
5. The ethanol yield from switchgrass is almost equal to or greater than the maize grain and stover.
6. Depending on yield and conversion efficiency, switchgrass can meet the biorefinery feedstock demand.
7. Switchgrass based biorefinery can be more environmentally friendly.
8. The USA is moving biorefinery based renewable energy sources, switchgrass can make it to meet the increasing demands for feedstock to commercial applications.

CONCLUSIONS

In this report the several important aspects are considered and analysed for the ethanol production from switchgrass as potential bio-based energy source, and the feasibility of switchgrass cultivation and harvesting in the different parts of USA. Switchgrass can be considered as great resource for ethanol production, and it is great fit for the biochemical and thermochemical platforms. Ethanol from switchgrass can reduce the burden from fossil fuels and replace them based on the efficiency and environmental considerations and confirms the less emission of greenhouse gases. Switchgrass has different cultivars, based on the weather conditions the cultivars can adjust the weather and ensure higher ethanol yields. For the ethanol production and sugar conversion and products yield; all operating conditions, reactions, varieties, cost calculations, and profitability analysis conducted based on the literature data. A completely different scenario is presented and developed for ethanol production from switchgrass is presented by using process simulation software SuperPro Designer, which represents the unit cost calculation of produced products and minimum selling price to ensure and predict a profitable process before entering into commercial applications, and it also can reduce the external barriers to overcome difficulties for industrial biofuels production from switchgrass.

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