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Economic of Value Addition of Food Grain: A Case Study

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ABSTRACT

The economic of value addition of food grain i.e., green gram gram was worked out for better opportunities in entrepreneurship. The purpose of study to evaluate techno-economic evaluation of developed system for the benefit of farmers and young entrepreneurs. The techno-economic evaluation of the system developed is worked out for the cost of operation of drying for the temperature (OC) of 45, 55 and 65. The cost operation (Rs/kg) for the temperature (^{O}C) of 45, 55 and 65 were observed to be 8.6, 6.1 and 6.09, respectively for drying of green gram. The net profit (Rs/kg) for the temperature (^{O}C) of 45, 55 and 65 were observed to be 3.15, 5.65 and 5.66, respectively for drying of green gram. The economical feasibility of the system for drying of green gram was worked out using the discounted cash flow technique. The net present worth was found for the temperature (^{O}C) of 45, 55 and 65 is positive and therefore investment in the project is feasible. The benefit cost ratio was found for the temperature (^{O}C) of 45, 55 and 65 is 1.30, 1.83 and 1.83, respectively. The internal rate of return (%) was found for the temperature (^{O}C) of 45, 55 and 65 is 19.80, 35.20 and 35.70, respectively. The all economical parameters evaluated showed that investment in project of biomass air heating system is feasibility in perspective of business utility.

Keywords-- Food, Grain, Economic, Capital, Cost

I. INTRODUCTION

In developed countries, bioenergy is promoted as an alternative or more sustainable source for hydrocarbons, especially for transportation fuels, like bioethanol and biodiesel, the use of wood in combined heat and power generation and residential heating. In developing countries bioenergy may represent opportunities for industrial development and economic growth. In least developed countries traditional biomass is often the dominant domestic fuel, especially in more rural areas without access to electricity or other energy sources. There are multiple challenges and opportunities for bioenergy as a potential driver of sustainable development, given enough economic and technological support. Around the world, woody biomass is used for cooking, production of electricity and heat for industries, towns and cities and production of liquid biofuels. Drying is a highly energy-intensive process, accounting for 10–20% of total industrial energy use in most developed countries. The main reason for this is the need to supply the latent heat of evaporation to remove the water or other solvent. There are thus clear incentives to reduce energy use in drying: to conserve finite resources of fossil fuels, to reduce carbon footprint and combat climate change, and to improve process economics, but it is a challenging task facing real thermodynamic barriers.

The present work is caried out to evaluate the opportunities of agro-business at farm level for benefit of farmers.

II. METHODOLOGY

Economics of Biomass Combustion System for Grain Drying

One of the main benefits of biomass energy is economic gain, both for individuals and for communities. Individuals can save money on their energy bills and even make money, by using the thermal energy for the drying purpose in the rural area. Communities can diversify their economies and enjoy greater reliance on local resources when their members invest in large capacity application of biomass combustion system for the thermal application for drying of the grain.

Biomass based Thermal Energy Costs

The costs of these (biomass, wind, solar etc.) renewable energy systems have decreased significantly over the past 15 years. The three methods customarily used to measure the costs and economic performance of biomass combustion system for thermal application. The measures begin with the installed capital cost, continue with the specific capital cost (the installed capital cost for the overall drying capacity in term of per ton of grain dried per year), and end with the cost of energy (NWCC,1997).

Installed Capital Cost: The simplest of the three measures of cost for biomass based grain drying system is the installed capital cost. This measure includes all planning, equipment purchase, construction and installation costs for a turnkey, ready to operate. As such this cost will include the all cost to developed the system, system

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installation, at the site together with all electrical, maintenance and other supporting infrastructure (Barish, 1962; NWCC, 1997; Ravindranath and Hall, 1995).

Specific Capital Cost: The second measure of cost combines the installed cost, the strength of the installed system in relation to the performance, minimum drying time. This cost measure is called the specific capital cost or the per ton of drying capital cost (NWCC,1997 and Barish, 1962). The specific capital cost is the installed cost to obtain a ton of drying per year. That is, the cost to procure, install and make ready drying capacity that will dry a tonn-hour per year.

$$C = \frac{\text{Installed capital cost}}{\text{Drying capacity per year}} \quad \text{Rs./(kWh/y)} \qquad (3.83)$$

This second cost measure, the specific capital cost, still is not all-inclusive. It does not include the cost of operation and maintenance over the lifetime of the facility, the costs of frequent major overhauls or the cost of capital.

Life-cycle cost of thermal energy: The third and most comprehensive measure of thermal energy cost is the life-cycle cost of energy (CoE) for the thermal application in drying of grain. This measure incorporates all elements of cost i.e., installed capital cost, cost of capital, cost of operations and maintenance over the life the installation and cost of major overhauls and subsystem replacement.

$$CoE = \frac{ICC + FCR + O\&M + (LRC)}{\text{Drying capacity / year}} \qquad (3.84)$$

Where, ICC = Installed capital cost, FCR = Annual fixed charge rate ,O&M= Annual operation and maintenance cost and LRC= Levelized replacement cost

Economic Feasibility of Biomass based System for Thermal Application

The project evaluation technique was used to measure the economic feasibility of biomass based thermal system for the drying of grain. This technique measures the productivity of capital invested and for which the flows of costs and returns over the life period of the system required. These costs and be brought to refer to the particular point of time i.e., present period by discount/ compounding them.

Comparative picture of different measures of capital productivity used in economic evaluation of investment in biomass thermal system were use are net present value, benefit cost ratio, internal rate of return and payback period (Aktar,1996; Burton *et at*., 2001; Fabrycky, and Thuesen, 1975; Gittenger,1982; Mitchell, 1995; Varadarajan and Jeya Kumar, 1991).

Net Present Value: In this method, generally the discount rate/compound rate, which reflects the price of the investment funds, is used to arrive at costs and returns to a common point of time. These costs are subtracted from the return to get the net present values of the system. The positive net present values indicate that the investment is worthwhile and the size of the net present value (NPV) indicates how worthwhile the project is in utilizing the resources to maximize income. Following expressing is used to work out the net present value.

$$NPV = \sum_{t=1}^{N} \frac{R.t - C.t}{(1+i)^t} \qquad (3.85)$$

Where R is the returns in year t, C is the costs in year t, N is the project life, i is the discount rate in per cent

The decision for profitability criteria are:

If NPV >0 Investment is worthwhile
NPV<0 Investment is not worthwhile
NPV=0 Indifferent case

Benefit Cost Ratio: The benefit cost ratio measures the returns or benefit per unit of cost of investment.

$$\sum_{t=1}^{N} \frac{R.t}{(1+i)^t}$$

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$$\text{Benefit cost ratio} = \frac{}{\sum_{t=1}^{N} \frac{C.t}{(1+i)^t}} \qquad (3.86)$$

The decision criteria are:

If B-C>1 Investment is worthwhile
B-C<1 Investment is not worthwhile
B-C=1 Indifferent case

Internal Rate of Return (IRR): The internal rate of returns means the discount/ compound rate at which the present value of returns equals that of costs. According the derived discount rate (IRR-r) is compared with the price of the investment funds to the know the worthiness of the project.

$$IRR = \sum_{t=1}^{N} \frac{Rt-Ct}{(1+i)^t} \qquad (3.87)$$

Solve this equation to find the value of IRR-r
The decision profitability criteria are:

If r >1 Investment is worthwhile
r<1 Investment is not worthwhile
r=1 indifferent case

Payback period: This is the simplest of the techniques for evaluating an investment proposal. It is defined as the time period within which the initial investment of the project is recovered in the form of benefits. In other words, this is the length of time between the starting time of the project and the time when the initial investment is recoupled in the form of yearly benefits. Expressing it in notation:

$$P = \frac{I}{C} \qquad (3.88)$$

Where, P is the payback period, I is the initial investment, and C is the yearly net cash flow.

III. RESULT AND DISCUSSION

Economics of System for Drying of Green Gram

Effect of System Performance on the Economic Feasibility

The system effect and the performance has been mainly associated with the economical gain in the activity. Table 1 shown the operational temperature range and their effect of the operational parameters of the system.

Table 1: Techno-economical parameters of the system economics feasibility

SN	**Operational parameters**	**Operational temperature range (^oC)**		
		45	**55**	**65**
1	Fuel consumption (kg/batch)	43.8	43.68	68.67
2	Fuel consumption (kg/h)	3.65	5.46	9.81
3	Drying time per batch (h)	12	8	7
4	Number of batches in year	500	750	860
5	Per batch drying capacity, kg	200	200	200
6	Drying capacity, ton/year	100	150	172
7	Net drying capacity, ton/year (due to loss of moisture from 20 % to 12 %= 8 % moisture loss), ton/year	92	138	158

The calculated value shown in the Table 4.81 clearly indicating that system operation in respect of temperature is changes. The system drying temperature impacted on the drying capacity and the fuel consumption rate. The drying capacity for the temperature (^oC) of 45, 55 and 65 were found to be 100, 150, and 200 ton/year respectively. The fuel consumption rate for the temperature (^oC) of 45, 55 and 65 were found to be 3.65, 5.46 and 9.81

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ton/year respectively. The temperature of the system has greatly affected on the drying time. The drying time for the temperature (°C) of 45, 55 and 65 were found to be 12, 8 and 7 h/batch respectively. The operational parameters associated with economics of the system are mainly drying time and the drying capacity of the system for the temperature set during the drying of the grain.

Economics of Biomass Air Heating System for Grain Drying

The economics of biomass air heating system for grain drying and feasibility of the project is examined by estimating per unit cost of drying and by estimating NPV, B-C ratio, IRR and payback period This analysis were used for the biomass air heating system for grain drying prediction for their feasibility and various parameter in in the system application. Table 2 shows system cost analysis for the different drying temperature.

Drying Cost

In biomass air heating system for grain drying, three costs were examined for the evaluation of the production cost of the energy generation. They are installed capital cost, specific capital cost and life cycle cost of operation.

Installed Capital Cost

This cost measures the all cost those are needed for the initial installation of wind farm. This cost included the all cost for the system design, development, construction and fabrication. The installed capital cost (Rs/(kg/year)) for the system operation of temperature (°C) range of 45, 55 and 65 were observed to be 625, 417 and 363 respectively. It is observed that temperature of operation for the drying is affected on the installed capital cost. The change in the installed cost for the temperature (°C) range of 45 and 55 were observed to be 42. 92 % and 14.88 % over the temperature of 65 °C. The installation cost (Rs/(kg/year)) value change for the temperature (°C) range of 45 and 55 were observed to be in respect of the more than 65 °C was observed to be 262 and 54 respectively.

Table 2: Biomass system cost of operation analysis for the different drying temperature

SN	Cost Parameters	Operational temperature range (°C)		
		45	55	65
1	Installed capital cost, Rs/kg of drying	625	417	363
2	Specific capital cost, Rs/(kg/year)	2.5	1.67	1.45
a)	Capital cost component, Rs/kg	0.025	0.017	0.015
3	Operation and maintenance cost, Rs/kg			
b)	Cost of fuel, Rs/kg	1.095	1.092	1.711
c)	Labor cost, Rs/kg	5.25	3.5	3.05
d)	Electrical cost, Rs/kg	1.8	1.2	1.05
e)	Annual operation cost, Rs/kg	0.2	0.13	0.12
4	Operation and maintenance cost, Rs/kg (b+c+d+e)	8.345	5.925	5.926
5	Levelized replacement cost, Rs/kg	0.25	0.17	0.15
6	Life cycle cost of operation, Rs/kg (a+b+c+d)	8.6	6.1	6.09

Specific Capital Cost

The second measure of cost combines the installed cost, strength of the wind resources and the matching of the drying capacity of the system for drying of the grain. The installed capital cost per kilogram (Rs/kg) of the grain were was observed to be 625, 417 and 363 for the system operation of temperature (°C) range of 45, 55 and 65 and the net annual drying capacity of the developed system was worked out to be 100, 150 and 172 ton/year.

Using the annual drying capacity for temperature (°C) 45, 55 and the specific installed capital cost values of Rs 2.5, 1.67 and 1.45 per kg of drying capacity, Details of calculation are given in Appendix M.

Life Cycle Cost of Operation

The third and most comprehensive measure of biomass energy system for the thermal application is the life cycle cost, which incorporates all elements of cost. They are capital cost component, annual operation and maintenance cost, and Levelized replacement cost occurred in the during the operation of the system. The replacement cost and annual maintenance cost parameters were considered 10 per cent and 5 per cent over the installation cost. Capital cost component on a specific capital cost with

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fixed charge rate of 10 per cent was worked for the temperature range of (oC) 45, 55 and 65 were observed to be 0.025, 0.017 and 0.015 Rs/kg of dried product. Annual operation and maintenance cost (kg/h) for the temperature range of (oC) 45, 55 and 65 were observed to be 0.2, 0.13 and 0.2, respectively. The levelized replacement cost were examined by considering the 10 per cent on the system installation cost of about Rs 25000 for the temperature range of (^{o}C) 45, 55 and 65 were observed to be 0.25, 0.17 and 0.15, respectively. The electrical energy cost for the sub system and drive of the system of temperature range (oC) 45, 55 and 65 were observed to be 1.8, 1.2 and 1.05 Rs/kg respectively. The labor cost to operate the system for temperature range (oC) 45, 55 and 65 were observed to be 5.25, 3.5 and 3.05 Rs/kg, respectively. The cost of fuel required for the operation of system for temperature range (oC) 45, 55 and 65 were observed to be 1.095, 1.092 and 1.711 Rs/kg, respectively.

The operational cost parameter has been worked out of addition of all operation cost parameters like, cost of fuel, cost of labor, cost of electricity, levelized replacement cost and the annual maintenance cost. The operational cost of the system for the temperature range of 45, 55 and 65 were determined to be 8.345, 5.925 and 5.928 Rs/kg, respectively.

Combining the all above cost component of the life cycle cost of drying was worked out for the temperature range of 45, 55 and 65 was 8.6, 6.1 and 6.09 Rs/kg. This measure of cost is the cost of drying of the green gram per kilogram. The cost of drying associate with system developed for the drying of grain has been resolved into components of capital cost (via fixed charge rate), operation and maintenance cost, and the levelized replacement cost. The calculated values are portrayed and summarized in Table 3. The relative magnitudes of these estimated values provide insight into where the overall economics of this system impacted. From Table 4.83 that the leading components of cost of is operational cost parameter, followed next by the levelized replacement cost. The operational cost component represents for the temperature range of 45, 55 and 65 was 97.03, 97.13 and 97.30 per cent of the total cost of operation, respectively. The levelized replacement cost represent for the temperature range of 45, 55 and 65 was 2.90, 2.78 and 2.46 per cent of the total cost of operation respectively. The capital cost component of the system represents for the temperature range of 45, 55 and 65 was 0.29, 0.27 and 0.24, per cent of the total cost of operation respectively.

Profit Statement of Biomass System for Grain Drying

Information presented in the Table 4 shows the profit statement of biomass-based air heating system for thermal application. This reveals that the gross annual income of the thermal system was worked out (temperature range of 45, 55 and 65)10.81, 16.21 and 18.56 lakhs respectively. The total cost of drying of grain in one year for temperature range of 45, 55 and 65 was found 8.59, 9.13 and 10.44 lakhs. The profit for per kg of the drying of the grain was worked out the first year of operation.

The profit per kg of drying of grain represent for the temperature range of 45, 55 and 65 was 3.15, 5.65 and 5.66 Rs/kg, respectively for biomass air heating system for thermal application for grain drying.

Table 3: Comparison of calculated cost of operation (CoO) component

CoO component	**Value (Rs/kg) Temperature**			**Basic of estimate**	**Percent of total CoO Temperature**		
	45	**55**	**65**		**45**	**55**	**65**
Capital cost	0.025	0.017	0.015	Used FCR = 10% per year	0.29	0.27	0.24
Operation and maintenance cost	8.345	5.925	5.926	As per the actual working of system for the grain drying	97.03	97.13	97.30
Levelized replacement cost	0.25	0.17	0.15	10 % on the capital cost	2.90	2.78	2.46
Total CoO	8.6	6.1	6.09	Total of all cost component	100	100	100

Table 4: Profit per kg of operation

SN	**Particular**	**Per kg (Rs)**		
	Drying temperature	45	55	65
1	Total cost of operation (a+ b+ c)	8.6	6.1	6.09
a)	Capital cost component, Rs/kg	0.025	0.017	0.015

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b)	Operation and maintenance cost, Rs/kg	8.345	5.925	5.926
c)	Levelised replacement cost	0.25	0.17	0.15
2	Return per kg of drying product	11.75	11.75	11.75
3	Net profit (2-1), Rs/kg	3.15	5.65	5.66

Economic Feasibility of Biomass System for Grain Drying

While working out the costs and returns from biomass combustion system for the grain drying in the above analysis which was carried out for first year the time factor was not considered. To bring the past and future costs to present worth compounding and discounting technique was used and it was done at 10%. The economic feasibility of developed system was examined by working out the net present value (NPV), benefit-cost ratio (B-C ratio), internal rate of return (IRR), payback period, and the same is presented in Table 5.

Table 5: Financial outlay for biomass combustion system for thermal application

SN	Particular	Amount (Rs) and per cent		
1	Drying temperature range	45	55	65
2	Present worth of cost	7067408	7529694	8640714
3	Present worth of benefit	9203162	13804743	15805431
4	Net present value (NPV)	1635754	5775049	66647 16
5	Benefit-cost ratio (B-C)	1.30	1.83	1.83
6	Internal rate of return (IRR)	19.80	35.20	35.70

The information presented in Table 4.85 reveals that the net present value (NPV) is positive and so the project is feasible and suitable for further consideration. The net present worth (Rs in lakhs) for biomass system for thermal application in grain drying for the temperature range of 45, 55 and 65 was worked out to be 16.35, 57.75 and 66.64 respectively. With the 10% discount rate, the discount factor in the year 20 is 0.1486 This indicates that the present value of income stream in that year is 14.86 % of its cash value.

The project is highly sensitive to operation and maintenance costs at the level of each year. The B-C ratio for the biomass system for grain drying for the temperature range of 45, 55 and 65 was found 1.30, 1.83 and 1.83, respectively. Since the ratio is greater than unity, the investment is financially justified. However, the capital investment of one rupee in system shows a profit of Rs.0.30, 0.83 and 0.83 for the temperature range of 45, 55 and 65, respectively.

The internal rate of return of the developed system for the 20 years life period was worked out from the trial and error method of calculation. The internal rate of return means the rate at which the present value of benefit and cost equals zero. The IRR (%) in present case worked out to for the set drying temperature was found to be 19.80, 35.20 and 35.70 per cent, respectively. This IRR simply the investment net present value zero at the 19.80, 35.20 and 35.70 per cent rate at which benefits and costs are equal. Present worth of costs and present worth of benefit for the temperature range of 45, 55 and 65 were found to be 70.67, 75.29, 86.40 and 92.03, 13.80, 15.80 lakhs, respectively.

The cash flow used in the computing of payback period is net cash flow i.e., yearly operation and maintenance cost deducted from the gross annual income of the system. Payback period of the developed system for the temperature range of 45, 55 and 65 in hour of operation was found to be 6772, 2119 and 1846, respectively.

While, once we seen at the batchwise operation, payback period in term of the number of batches for the temperature range of 45, 55 and 65 was calculated to be 967, 302 and 263, respectively.

It is again essential to estimate the payback in the year, month and days of the system. The system working days in the year is 250 days, so that for the temperature range of 45, 55 and 65 was calculated to be 1.93 =~2 years, 101 days and 77 days, respectively while the life of biomass combustion system is considered as 20 year (Appendix-N).

This means that the investment in the project recoupled for the temperature range of 45, 55 and 65 within 6772, 2119 and 1846 hours of operation of biomass system for grain drying with rated drying efficiency of 44, 46 and 48 % in the operation is recovered for the drying capacity of 100, 150 and 172 ton in a year respectively.

IV. SUMMARY AND CONCLUSIONS

The techno-economic evaluation of the system developed has been worked out for the cost of operation of drying for the temperature (^{O}C) range of 45, 55 and 65. The cost operation (Rs/kg) for the temperature (^{O}C) of 45, 55 and 65 were worked out for drying of green gram. The net profit (Rs/kg) of the system for the temperature (^{O}C) range of 45, 55 and 65 were computed for drying of green gram.

The economic feasibility of the system for drying of green gram was worked out using the discounted cash

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flow technique. The net present worth, total benefit and cost were computed in the cash flow for the temperature range (^{O}C) of 45, 55 and 65 is positive and therefore investment in the project is feasible. The benefit cost ratio and internal rate of return (%) is computed and it was observed feasible for the thermal application. The all economical parameters evaluated showed that investment in the project of biomass air heating system is feasibility in perspective of business utility.

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