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Cost Economics of Tractor Drawn On-farm Mobile Turmeric Steam Boiler

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ABSTRACT

Turmeric is an important commercial spice crop grown in India since ancient times and named as "Indian saffron". In India during 2019-20, about 2.54 lakh ha (6 lakh acre) area and in the State of Telangana about 55,443 ha (1.37 lakh acre) was covered under turmeric. The post harvesting operations of turmeric rhizomes are boiling, drying, polishing and pulverization. Among all these operations boiling is more difficult and labour oriented. The quality of turmeric is depending upon time and method of boiling. The separated rhizomes must be boiling within two to five days otherwise it will effect on the quality. In the traditional method of boiling, the rhizomes are not cooked uniformly and injuries may be occurred by rubbing and bruising of rhizomes while taking out from the vessel. Due to lack of labour availability, the farm operations could not be carried out in time and especially for turmeric during harvesting and boiling season. To address all these problems, popular tractor drawn turmeric steam boiler was identified to reduce the cost of operation and labour for the benefit of the farmers.The cost economics of the machine and payback period of turmeric steam boiler was calculated. During the operation, the fuel cost and total operating cost of the machine was estimated as 1575Rs. h^{-1} and 1898.28 Rs. h^{-1} respectively. The break-even point of turmeric steam boiler was estimated as 78.17 hour per year with the annual usage of machine was taken as 480 hour per year. From results, the annual utility and payback period were obtained as 720 tonnes per year and 1 year respectively.

Key words: *Turmeric steam boiler, Economics, Break-even point, Payback period.*

Introduction

Turmeric is an important commercial spice crop grown in India since ancient times and it is named as "Indian saffron". It is known as the "golden spice" as well as the "spice of life" The world production of turmeric is 8, Lakh tonnes in which India hold a share of approximately 75- 80% and consumes around 80% of its own production. (Nareshbabu *et al*., 2015). Indian turmeric cultivation and production trend has increased gradually over the past decades and also area of cultivation shows an increasing trend. India accounts for about 80 per cent of world turmeric production (Dhanalakshmi *et al*., 2018). India ranks first with 90% production of turmeric, i.e. 701.16 lakh from 185.32 lakh ha of area (Shinde *et al.,* 2011). It is leading with 90% of turmeric production in the world with 2,07,570 ha of area with 1,09,22,630 tonnes.

In India during 2019-20, about 2.54 lakh ha (6 lakh acres) area was covered underturmeric. The important turmeric growing states in India are

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Telangana 55,443 ha (1,37,000 acres), Odisha 27,864 ha (68,852 acres), Tamil Nadu 18,296 ha (45,209 acres), West Bengal 17,711 ha (43,764 acres), Karnataka 17,598 ha (43,895 acres), Assam 16,550 ha (40,895 acres), Maharashtra 14,511 ha (35,857 acres) and Andhra Pradesh 13,223 ha (32,674 acres) (Anonymous, 2020)(Agricultural Market Intelligence Centre, PJTSAU).

The post harvesting operations of harvested turmeric rhizomes are boiling, drying, polishing and pulverization. Among all these operations boiling is more difficult and labour oriented. Boiling is the first post-harvest operation to be performed at the farm level which involves cooking of fresh rhizomes in water until soft before drying. Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product (Rajendra Pethkar *et al*., 2017). Boiling softens the rhizomes and removes the raw odour. Also during boiling, the starch is gelatinized, which reduces the drying time required and the colour is uniformly distributed throughout the rhizome. Starch gelatinization not only facilitates rapid drying but also provides protection against insect attack during storage (Gursimran Singh Sangha and Tarsem Chand Mittal, 2021). The harvested turmeric rhizomes are cleaned and separated from mother rhizomes for boiling and boiled separately. The quality of turmeric is depending on time and method of boiling. The separated rhizomes must be boiling within two to five days otherwise it will effect on the quality.

In the traditional method of boiling, the rhizomes are immersed in water in a big vessel and cooked until foam formation and white fumes comes out with good odour. To boil one vessel it may take around 45 minutes to 1 hour in conventional method. Fire wood and agricultural waste is used as a fuel for cooking. In this method the rhizomes are not cooked uniformly and injuries may be occurred by rubbing and bruising of rhizomes while taking out from the vessel. After cooking, the cooked turmeric is spreaded in open yard for sun drying. It is a skill orienteddrudgeries and laborious operation and requires more time which increases the cost of processing. Due to lack of labour availability, the farm operations could not be carried out in time and especially for turmeric during harvesting and boiling season. Considering all these constraints,popular tractor drawn turmeric steam boiler was identified to evaluateand demonstratefarmers in Telangana state. To address all these problems, "Value chain approach on Farm Mechanization and Post harvesting processing in turmeric" project was implemented by PJTSAU at CFST, RS & RRS and KVK, Rudrur, Nizamabad to reduce the cost of operation and labour for the benefit of the farmers.

Materials and Methods

The post harvesting operations of harvested turmeric rhizomes are boiling, drying, polishing and pulverization. Among all these operations boiling is more difficult and labour oriented. Atractor drawn turmeric steam boiler was selected and evaluatedto reduce the human drudgery, labour and cost of operation for promoting the farmers in Telangana. The selected Turmeric steam boiler consists of 4 cooking tanks, water tank/ boiler, water inlet valve, flush valve, pressure gauge, temperature gauge, furnace, steam passage pipe, steam control valves, safety valve and steam relief valve which are mounted on tractor trolley platform. The technical specifications of the turmeric steam boiler are given in Table 1.

Procedure for Operation of Turmeric steam boiler

To boil the water in the tank of turmeric steam boiler, the fire wood and agricultural waste is used as a fuel and burned in the furnace. The capacity of water tank is about 5000 liter. Time taken to start the steam from boiling tank was 1h 15min to 1 h 30 min after burning the fuel. The steam pressure maintained in the boiler was 1kg cm^{-2}. The steam generated in the boiler was used for cooking of turmeric in cooking tanks. Each cooking tank capacity is about 250 to 300 kg. The cooking can be done in batch process. Each batch two tanks can be cooked in 20 minutes. The steam is passed to the cooking tanks by steam passage pipe and controlled by steam control valves. About 150 kg of fire wood is required to cook 1 ton of turmeric rhizomes. While cooking, white fumes are comes out from the cooking tank with good odour which indicates that the turmeric rhizomes were cooked. The turmeric rhizomeswere properly cooked or not can be tested with pricked by a small twig. If the turmeric rhizome was pricked with a small twig, it enters into the rhizome softly, and then it is assumed that the cooking of rhizome was properly boiled and cooking process is completed. Two wheel trolleys were used to collect the cooked rhizomes and poured on an open yard as a heap and left undisturbed for 4- 5

Table 1. The technical specifications of turmeric boiler

S.No	Machine parameters	Details
1	Cost of machine, Rs/-	4,77,000/-
1	Capacity of boiler, kg/ h	1500
2	Water tank capacity, L	5000
4	Water tank diameter, m	1.80
5	Water tank height, m	1.40
6	Each cooking tank diameter, m	0.81
7	Each cooking tank height, m	1.15
8	Furnace diameter, m	1.68
9	Steam pressure maintained in boiler, kg/ cm^2	1
10	Turmeric boiler along with trolley dimensions (L x W x H), m	5.33x 2.04x 3.35
11	Fire wood required for boiling of 1 ton turmeric rhizomes, kg	125-150
12	Time required to boil / batch, min	20
13	Capacity of boiler per batch, kg	250-300
14	Time required for loading and un loading, min	15
15	Skilled Labour required for boiling	8
16	Fuel used	Fire wood or Agricultural waste

h. During the process the time required to loading and unloading is about 15 min. Eight number of skilled labour was required to complete the boiling operation. The heap was spreaded up to 5 to 6 cm thickness after 4-5 h, and allowed to sun drying for 10 -12 days until the final moisture content of rhizomes reaches up to 8-10 per cent. It saves the time about 40 minutes compared with traditional method and reduces the human drudgery, labour and cost of processing.The view of turmeric steam boiler is shown in Plate 1.

Plate 1. View of turmeric steam boiler.

Cost Analysis

The total cost of operation of turmeric steam boiler in Rs. h^{-1} was estimated by considering the fixed cost and operational cost of the machine by making following assumptions. The cost of operation was based on the prevailing market rates during the season and location (Jayaprakash *et al*., 2015).

A. Fixed cost

Fixed cost includes depreciation, interest, housing, insurance and taxes.

i. Depreciation

It is the loss of value a machine with the passing of time.

$$D = \frac{C - S}{L\,H}$$

Where
C = Capital cost
D = Depreciation, Rs. /h
S = Salvage value, 10 per cent of capital
H = Number of working hours per year, and
L = Life of machine, year.

ii. Interest

Interest was calculated on the average investment of the machine taking into consideration the value of in first and last year.

$$I = \frac{C + S}{2} x \frac{i}{H}$$

Where
I = Interest per year
I = Interest rate per year, per cent
C = Capital cost

iii. Housing, insurance and taxes

Housing, insurance and taxes for the turmeric steam boiler was taken as the 1 per cent of the initial investment of the machine.

Operating cost

Operating cost includes fuel cost, lubricants, repairs, maintenance, and other costs.

Fuel cost (fire wood)

Fuel cost (fire wood) was calculated on the basis of actual firewood used for the operation of machine.

Repairs and maintenance

Cost of repairs and maintenance was taken as 5 per cent of the initial investment of the machine.

Other costs

It includes wages for operator, labour cost based on the prevailing market rates per day of 8 hours.

Break-even point

The break-even point is the point at which the gains equal to the losses.

BEP = FC/ (CF-C)

Where

BEP = Break-even point, h y^{-1}
FC = Annual fixed cost, Rs. y^{-1}
CF = Custom fee, Rs. h^{-1}
C = Operating cost, Rs. h^{-1}
CF = 1.25 (C+0.25C)

Payback period (PBP)

The payback period (PBP) is defined as the length of time required to recover an initial investment through cash flows generated by the investment.

PBP = IC/ ANP

Where

PBP = Payback period, year
IC = Initial cost of machine, Rs.
ANP = (CF-C) AU

Where

ANP = Annual net profit, Rs.
AA = Average annual use, h y^{-1}
AU = AA x EC

Where

AU = Annual utility, h y^{-1}
EC = Effective capacity of machine, tons h^{-1}

Results and Discussion

The cost analysis of the turmeric steam boiler was

Table 2. Total operating cost ofturmeric steam boiler.

S. No	Machine parameters	Details
1.	Name of the machine	Turmeric boiler
2.	Cost of the boiling machine(C), (Rs.)	477000
3.	Life of the machine (L) in years	10
4.	Working hours per year (H)	480
5.	Salvage value (S), (Rs.)	47700
6.	Depreciation per hour (Rs.)	89.4375
7.	Rate of interest I per hour (Rs.)	54.65625
8.	Housing per hour (Rs.)	9.9375
9.	Insurance per hour (Rs.)	9.9375
10.	Taxes per hour (Rs.)	9.9375
11.	Total fixed cost per hour (Rs.)	173.9063
12.	No. of skilled labours Required for operating the machine	8
13.	Wages for skilled labour per hour (Rs400/day of 8 hours) (Rs.)	50
14.	Wages for skilled labour per day of 8 hours	3200
15.	Repair and maintenance cost per hour(Rs.)	99.375
16.	Capacity of boiler per (kg/h)	1500
17.	Fire wood required for boilinig 1 ton of rhizomes (kg)	150
18.	Fire wood required for boilinig of rhizomes (kg /h)	225
19.	Cost of fire wood (Rs./Quintal)	700
20.	Cost of fire wood (Rs./h)	1575
21.	Total Variable cost per hour	1724.375
22.	Total cost per hour (Rs.)	1898.281
23.	Total cost per day of 8 h(Rs.)	**15186.25**

Table 3. Cost of economics for Turmeric steam boiler

S. No	Machine parameters	Details
1.	Fixed cost, Rs./h	173.90
2.	Average annual use, h/year (AA)	480.00
3.	Annual fixed cost, Rs./year (FC)	83472.00
4.	Operating cost, Rs./h (C)	1898.28
5.	Custom fee Rs./h (CF)	2966.06
6.	Effective Capacity, tonnes /h (EC)	1.5
7.	Annual Utility, tonnes	720
8.	Custom fee Rs./h (CF)	2966.06
9.	Breakeven point, h/year (BEP)	78.17
10.	Annual net profit, Rs. (ANP)	512535.60
11.	Payback period, year (PBP)	0.93 similarly equal to 1 year

estimated based on performance of the machine. The life span of the machine was considered as 10 years. Table 2 comprises the data i.e., initial investment, salvage value, fixed cost, operating and maintenance cost, expected life of assetfor the turmeric steam boiler. The investment cost of the machine is Rs. 4, 77,000/-. The average number of working hours per year assumed as 480 hour. Fire wood was used as fuel and the cost of fuel and total operating cost of the machine was estimated as 1575Rs. h^{-1} and 1898.28 Rs. h^{-1} respectively.

The cost economics of turmeric steam boiler is given in Table 3. The break-even point of turmeric steam boiler was estimated as 78.17 hour per year with the annual usage of machine as 480 hour per year. The payback period of turmeric steam boiler was calculated in terms of annual utility in tonnes per year and total payback period in years. From results, the annual utility and payback period were obtained as 720 tonne per year and 1 year respectively.

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