EVALUATION AND MODIFICATION OF A MANUALLY OPERATED COFFEE PULPER

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ABSTRACT

The modified coffee pulper is made of wood, galvanized iron sheet and steel plates. The average output is 50.7 kg/hr, about 1.5 times the output of the original machine. The storage duration of the berries after harvesting significantly affected the pulping capacity of the machine. The pulping capacity was highest (51.1 kg/hr) when the berries were stored 5 days prior to pulping and was lowest (49.9 kg/hr) at one day storage duration.

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KEY WORDS: Coffee berries. Modified coffee pulper.

INTRODUCTION

In the coffee industry, various researches had been conducted towards increasing its output (Anonymous, 1976). These researches focused on management, marketing, post-harvest technologies and other aspects of processing coffee beans. Many studies have been conducted also to convert the berries into marketable products with the use of large machineries. However, only the large scale coffee growers can avail of large machineries. Considering the fact that small coffee growers constitute the main bulk of the industry, it is advantageous and necessary to develop a simple machine for pulping coffee berries.

Avena (1982) developed a pulper and reported that it was more efficient in separating the coffee beans from their parchment skin than the conventional pulping method (Fig. 1). However, it was observed that this machine has some noticeable defects especially during the pulping process, namely: a) difficulty in rotating the crank when over-fed since it is hand-operated, thus tiring the operator easily; b) pulping capacity is lower because

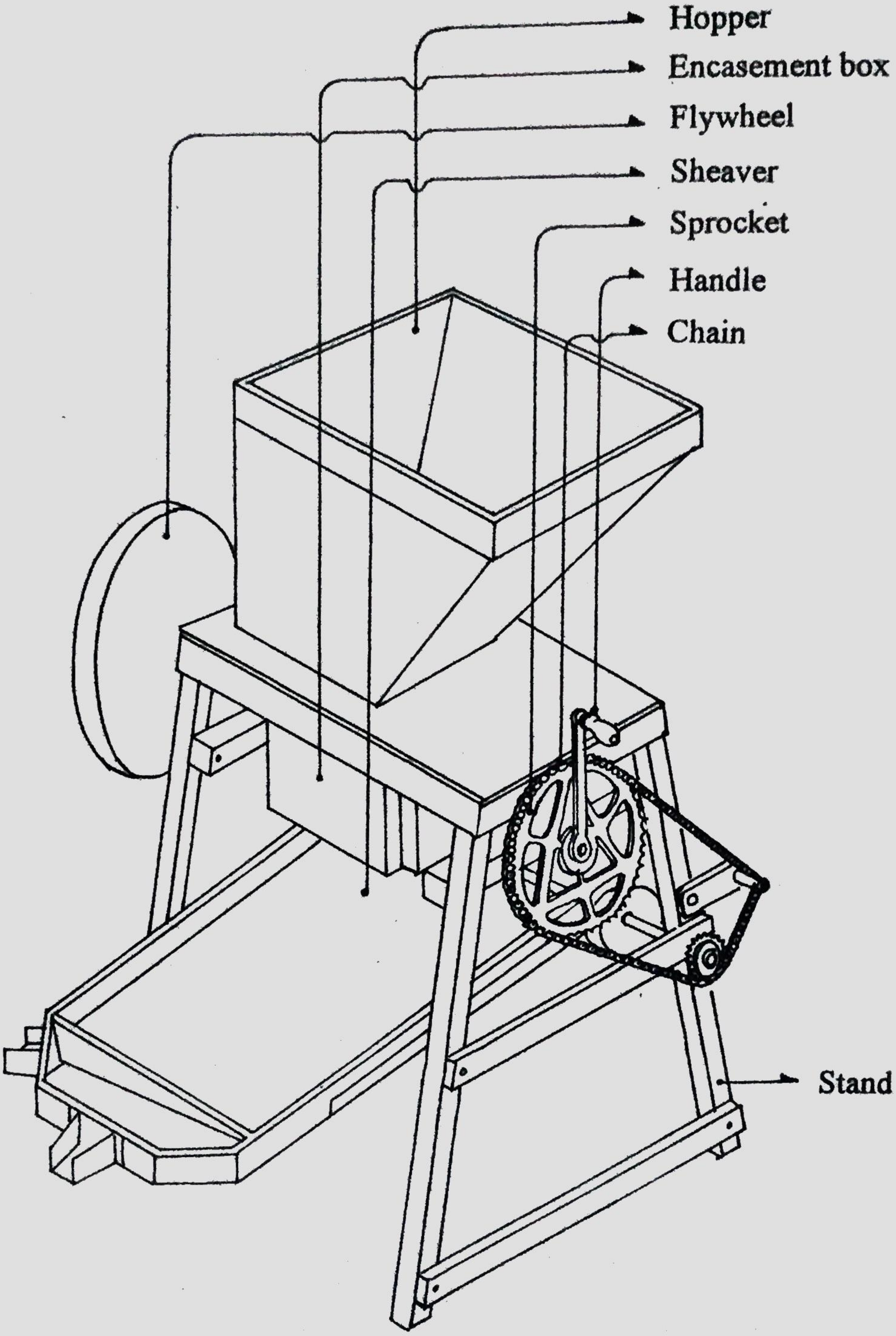


Figure 1. Isometric drawing of the Avena machine.

only four roller blades perform the pulping process; c) the roller and the counterblades are close to each other, hence, some get broken; d) difficulty in rotating the crank if the chain is connected to the sprocket coupled to the driving wheel of the sheaver due to the friction produced between the pipe rollers and the base of the sheaver, and; e) the pulp or the parchment skin cannot be separated through the sheaver.

In the light of the above flaws of the available coffee pulping machine, modifying it is advantageous to suit the needs of the small coffee farmers. The modification was undertaken with the following improvements: a) the machine was made pedal-operated for greater power, ease in feeding and longer operating time; b) more roller blades and feeder bars were used to augment the pulping capacity; c) the roller blades and cylinder wall clearance were adjusted to lessen bean damage; d) plastic ball rollers were utilized between the sheaver and the angle bars, and; e) the sheaver eyes were increased in size and a blower was constructed to detach the parchment skin of the coffee beans.

MATERIALS AND METHODS

Plan and construction

The construction of the machine utilized the following materials, namely: G.I. sheet, wood, steel plates, machine bolts, pillow block bearings, plywood, wire screen, nails and bicycle parts.

The pedal-operated coffee pulper has six main parts, namely: 1) the stand and seat assembly which supports the other parts and where the operator is positioned for operation; 2) the pedal, sprocket and chain assembly which serves as the power source of the machine; 3) the hopper which holds the coffee berries to be pulped; 4) the encasement box which encases the cylinder during the pulping process; 5) the cylinder or drum which performs the pulping operation, and; 6) the sheaver which separates the pulp from the beans (Figs. 2-5). Its maximum height is 1.28 m and its width and length are 0.60 and 1.50 m, respectively.

The joints of the new coffee pulper are connected by bolts and nuts. The hopper is made of plywood in trapezoidal shape. The rotating cylinder is made of wood with six steel rollers and feeder bars (Fig. 6). They are positioned inside the encasement box made up of two curved pieces of wood to fit the wooden cylinder. It is attached to the stand assembly by angle

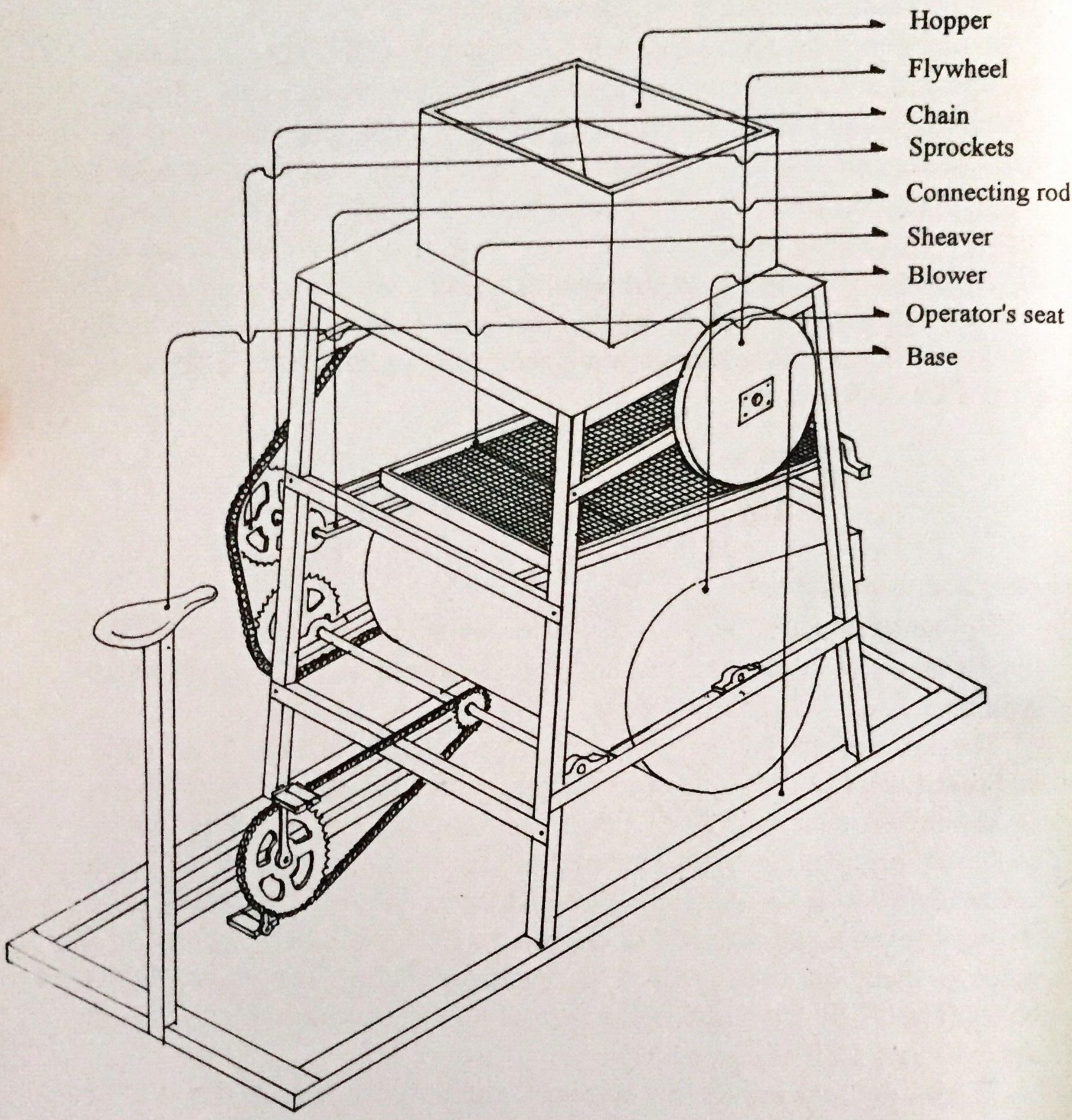


Figure 2. Isometric drawing of the pedal-operated coffee pulper.

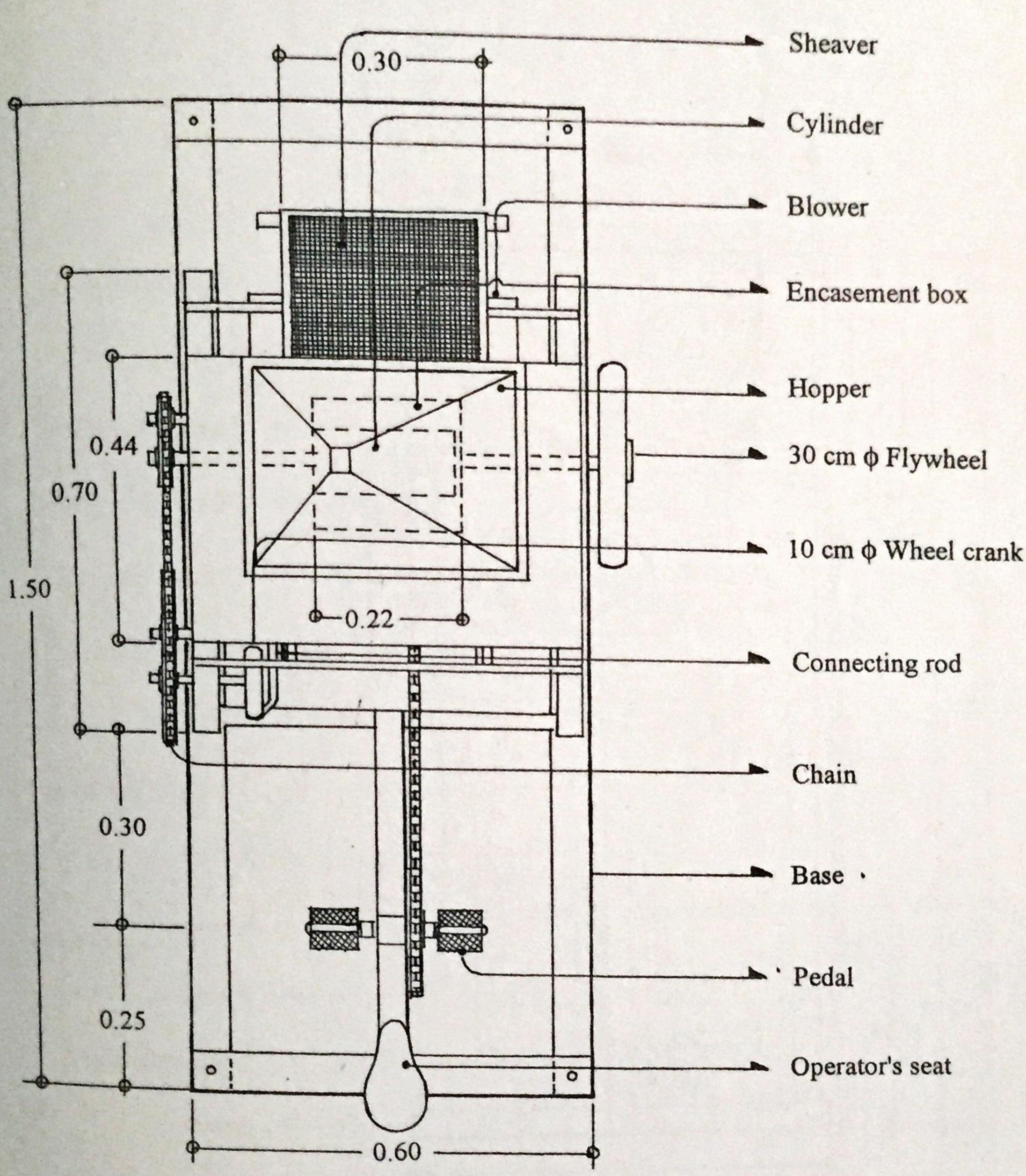


Figure 3. Top view of the pedal-operated coffee pulper (dimensions in meters).

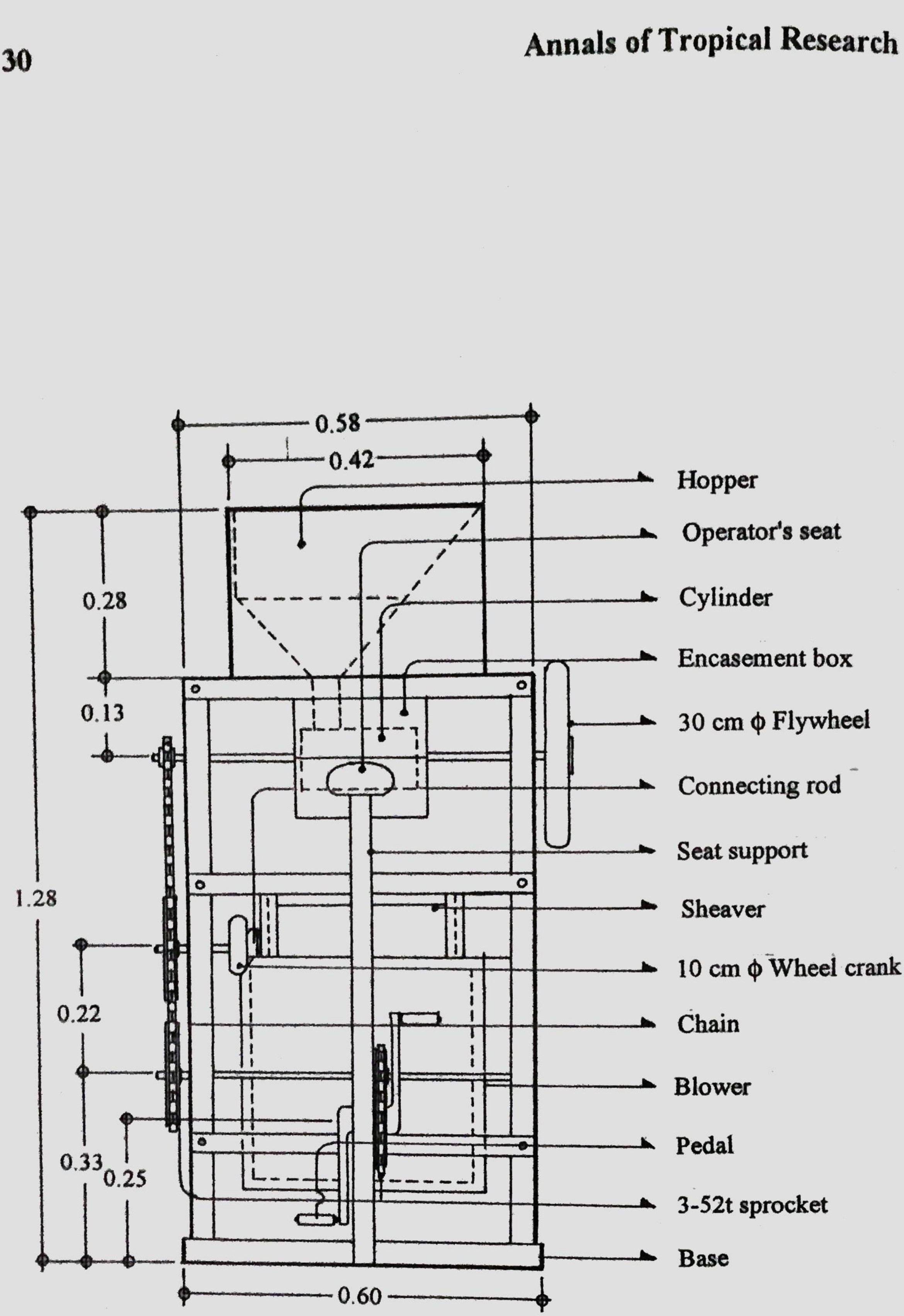


Figure 4. Front view of the pedal-operated coffee pulper (dimensions in meters).

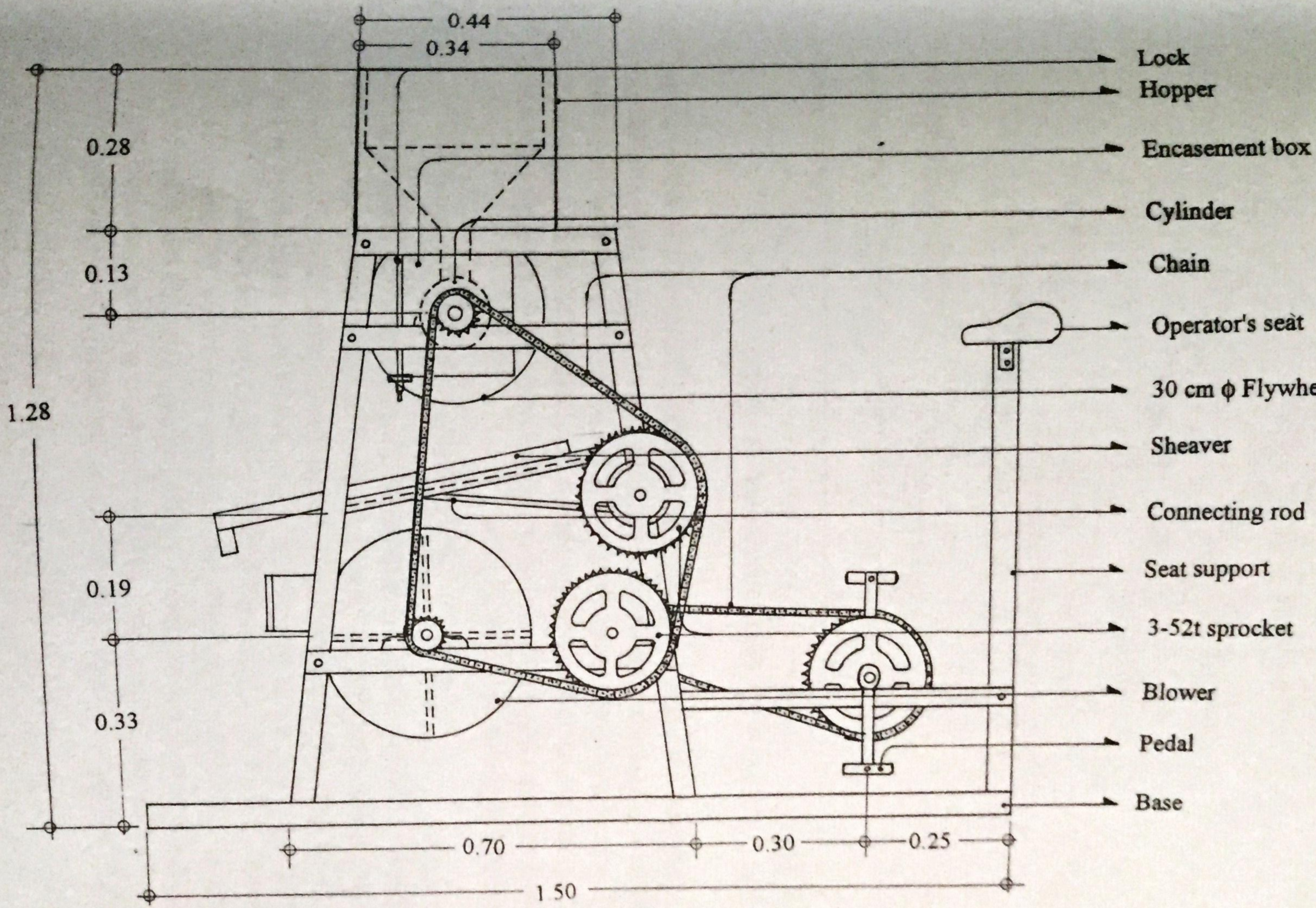
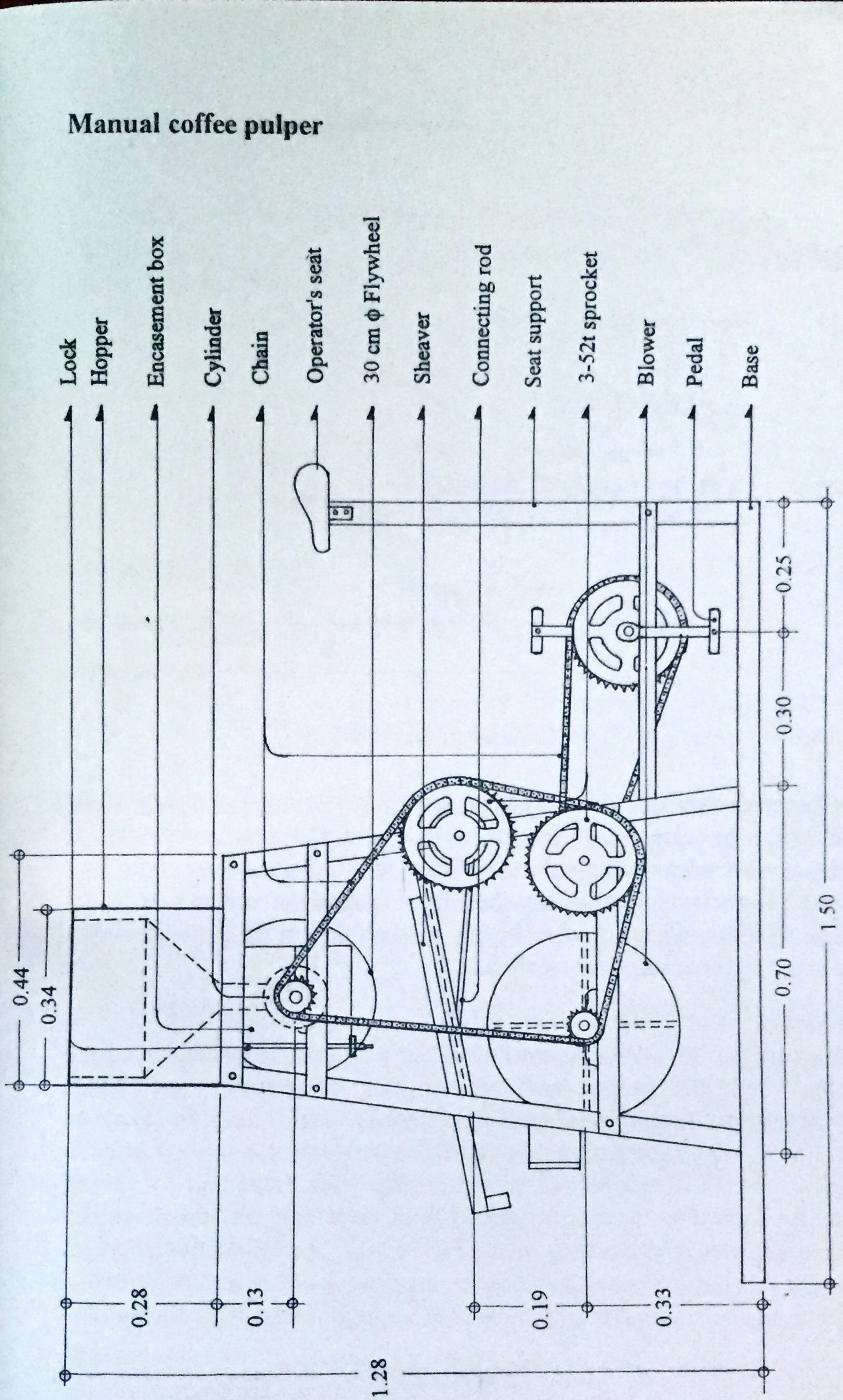


Figure 5. Side view of the pedal-operated coffee pulper (dimensions in meters).



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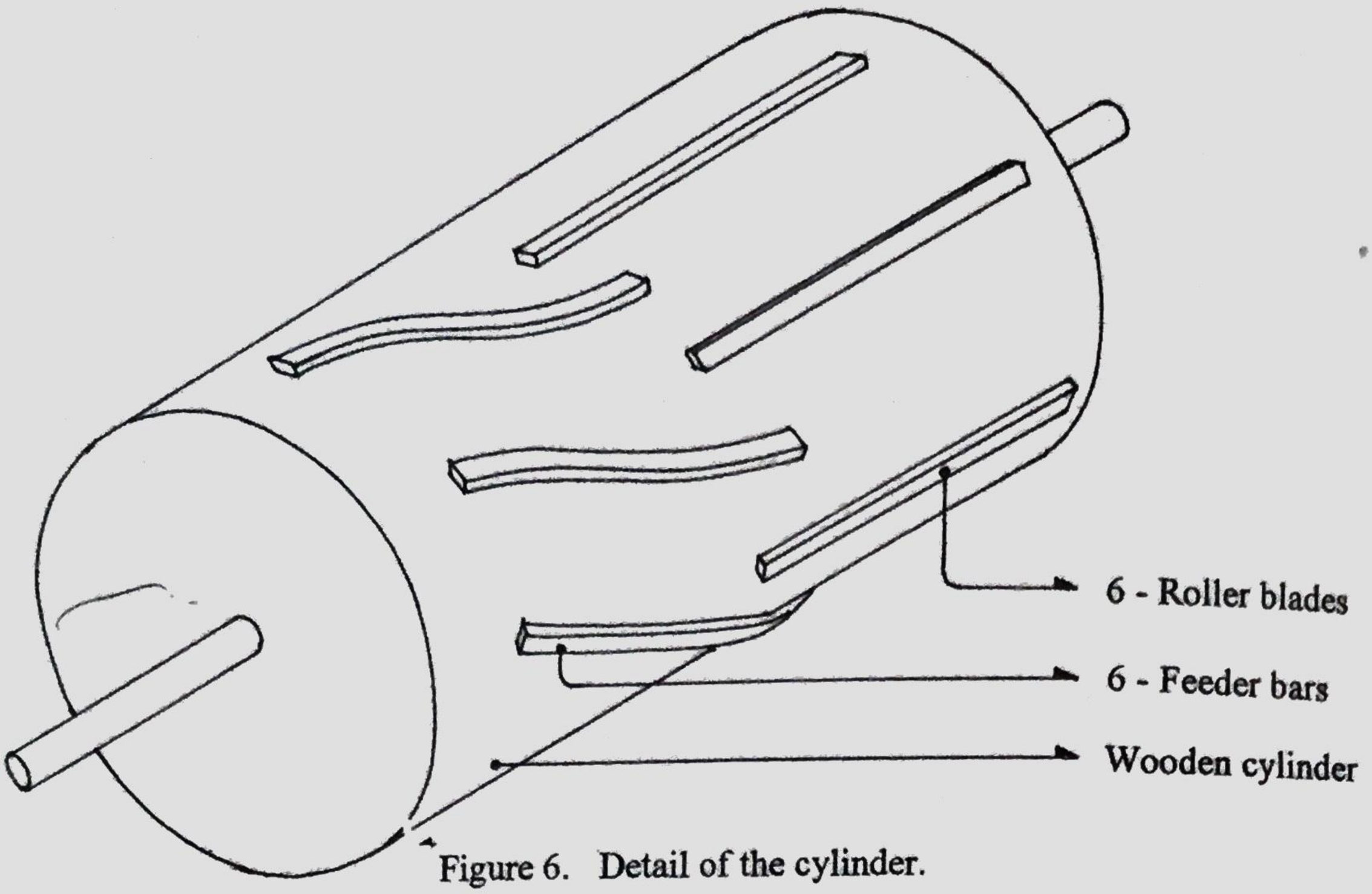

Figure 6. Detail of the cylinder.

bars fastened with screws. The rotating wooden cylinder is keyed to the shaft with a sprocket and flywheel at both ends. The vibrating sheaver at the lower part of the machine's stand is made up of mesh wire and wood. Ball rollers are used between the sheaver and the angle bars.

The machine works by distributing power through the pedal sprocket connected to the machine by a chain.

Evaluation

Robusta coffee variety, procured from one plantation in Barangay Bunga, Baybay, Leyte, Philippines, was used for testing. The samples were divided into three parts of equal weight and stored for 1, 3, and 5 days, from harvest to pulping. The moisture content of the beans was determined prior to pulping. Mold development during storage was prevented by proper aeration. The beans were safeguarded from insect and rodent attacks by hanging the screen containing the coffee beans in a well-ventilated room. After the pulping process, the coffee beans were sundried and analyzed.

Only one person operated the machine throughout the evaluation study.

Pulping capacity (Output). Three kilograms of berries per storage time per trial were fed into the machine. Pulping time*i.e.*, the time from feeding until all the berries had passed through the machine, was recorded.

For the modified machine, an average of 80 rpm of the pedal crank was kept constant for each trial. An average of 80 rpm of the driving crank was also maintained for Avena's machine.

The formula used to determine the pulping capacity was:

$$C = \frac{W}{T}$$

where: C = Pulping capacity, kg/hr
W = Weight of the pulped berries, kg
T = Pulping time, hr

Relative efficiency

$$\text{Efficiency (\%)} = \frac{E_1 - E_2}{E_2} \times 100$$

where: E_1 = Improved machine's pulping capacity, kg/hr
E_2 = Avena machine's pulping capacity, kg/hr

Percentage of unpulped coffee berries. One hundred grams of the output per machine per storage time per trial was taken at random. The pulped and unpulped berries were separated and their respective weights were recorded. A triple beam balance was used to measure the weight. The following formula was used to compute the percentage of unpulped coffee berries:

$$\%\ UP = \frac{W_u}{W} \times 100$$

where: % UP = Percentage unpulped berries, %
W_u = Weight of the unpulped berries, g
W = Total weight of the sample, g

Experimental design

A 2 x 3 factor factorial experiment in a randomized complete block design (RCBD) was used in the study. The factors were the kind of pulping machines and the storage time (*i.e.*, 1, 3 and 5 days). There were three replications per treatment combination. Analysis of variance was done and the Duncan's multiple range test (DMRT) was used to test the significance between treatments.

RESULTS AND DISCUSSION

Machine operation

The modified machine could be operated by one person feeding the berries and turning the pedal crank simultaneously. The rate of feeding coffee berries is regulated by adjusting the shutter. The berries are squeezed between the roller blades and counterblades thereby detaching the pulp of the beans. They are then separated in the oscillating sheaver and blower of the machine (Fig. 7).

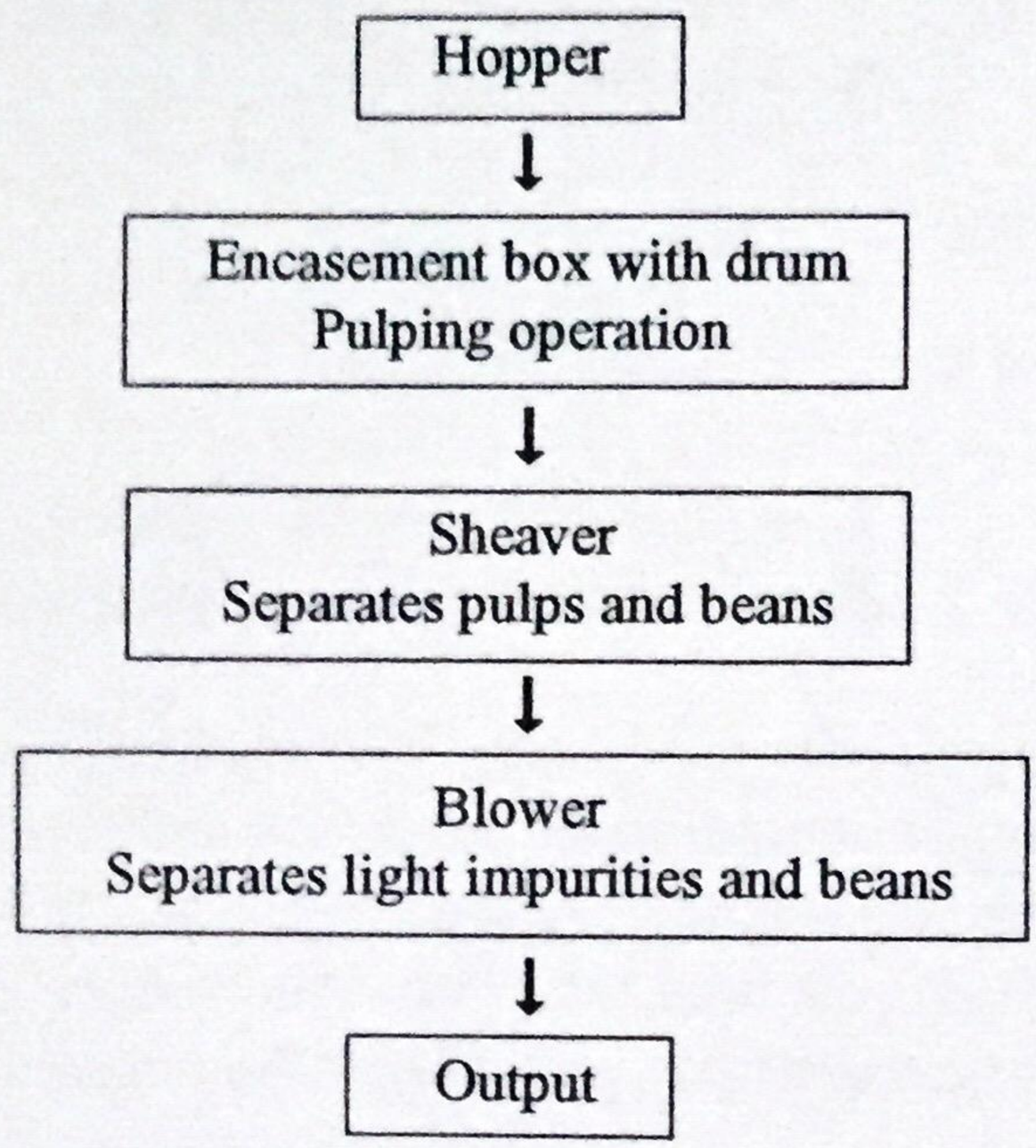

Figure 7. Schematic diagram of the pulping process using the machine.

Capacity of the machine

The improved machine has a mean capacity of 50.7 kg/hr, while the Avena machine has only 34.3 kg/hr. Furthermore, the machine's output is significantly enhanced by the storage time of the coffee berries (Table 1). This is because during storage the pulp of the berries become softer, hence, increasing pulping output.

Relative efficiency of the improved machine

The improved machine's relative efficiency compared to that of the Avena machine is 48%. This indicates that its mean pulping capacity of 50.7 kg/hr is about 1.5 times higher than that of the Avena machine which is only 34.3 kg/hr.

Percentage of unpulped coffee berries

The percentage of unpulped coffee berries was not significantly affected by the pulping machine and storage time (Table 2).

Advantages of the improved machine

The improved machine is more advantageous and comfortable to use than the Avena model because of the following reasons: a) it can be operated with only one person feeding the berries and at the same time cranking the machine, b) it is easier to crank because ball rollers were provided between the sheaver and the angle bars, and c) it can be continuously operated by a person for a longer duration because it is pedal operated and hence, less tiring. Moreover the sheaver of the Avena machine cannot separate the

Table 1. Pulping capacity (kg/hr) as affected by the pulping machine and storage duration[1]

Pulping Machine	Storage Duration			Mean
	1 day	3 days	5 days	
Improved machine	49.85	51.07	51.10	50.67a
Avena machine	34.00	34.22	34.57	34.26b
Mean	41.93b	42.64ab	42.84a	42.46

[1]Means of pulping capacity and storage time followed by a common letter are not significantly different at 5% level, DMRT.

Table 2. Percentage of unpulped coffee berries as affected by the pulping machines and storage duration.

Pulping Machine	Storage Duration			Mean
	1 day	3 days	5 days	
Improved machine	1.20	1.11	1.08	1.13
Avena machine	1.32	1.13	1.20	1.18
Mean	1.26	1.12	1.10	1.18

pulp of the beans well. Hence, a blower was constructed for this purpose. Thus, the product of the improved machine is cleaner than that of the Avena machine.

Although the machine was found to be more efficient than the Avena machine, still it requires further improvements before its adoption by the farmers is recommended. Suggested areas for further studies are the following: a) eccentricity of the sheaver; b) wind speed of the blower; and c) suitable material to minimize wear of the working parts.

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