

## ENERGY VALUE OF ELEPHANT LABOUR

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ไม่เคยมีผู้ใดทำการคำนวณพลังงานที่ช้างต้องใช้ในการทำงานเลย ซึ่งมีอีกหลายประเทศที่ช้างยังคงมีบทบาทสำคัญในอุตสาหกรรมป่าไม้ การศึกษาครั้งนี้ได้คำนวณพลังงานที่ช้างจะต้องใช้ในการทำงาน 1 ชั่วโมง คิดเป็น 13,003.77 กิโลแคลอรี ซึ่งแตกต่างจากค่าที่มีผู้กำหนดให้สำหรับสัตว์ใช้งานขนาดใหญ่ และได้แสดงข้อกำหนดในการทำงานของช้างเพศผู้ที่ยังเด็กที่ไว้คิ้ว แม้ว่าช้างจะถูกลดบทบาทและแทนที่ด้วยเครื่องจักรกลในอุตสาหกรรมป่าไม้ แต่ก็สมควรที่จะได้มีการอนุรักษ์เอาไว้ทั้งในด้านที่เป็นแหล่งพลังงานที่สามารถทดแทนขึ้นมาใหม่ และในฐานะที่เป็นศิลปะชั้นสูงที่นับวันมีแต่จะหายไป

## ABSTRACT

Never before has anyone attempted to calculate the energy value of an elephant at work. There are several countries where the elephant still plays a significant role in the forestry industry. This study calculated the energy expended per hour by a working elephant to be 13,003.74 kcal. It differs from assigned values for large draft animals. The working specifications for a full-grown bull elephant were also given. Even though the elephant has given way to machinery in the timber industry, it is worthwhile preserving both as a renewable form of energy and as an exotic art form.

## INTRODUCTION

The intricate relationship between the elephant and Thai society dates back centuries. The annals of Thai history contain a number of epic battles fought on the backs of war elephants. In addition, Thailand is one of the few countries in the world where the elephant still plays a significant role in the forestry industry. The practice of using elephants for forestry work was imported into Thailand from neighboring Myanmar (Burma) and India (Corvanich, 1976). Since then, the art of training working elephant has become a source of national pride.

In order to obtain a net energy analysis of any system involving elephant labour, which is used almost exclusively in the forestry industry, it is first necessary to calculate the amount of energy expended by the elephant at work.

## METHODS OF STUDY

The calculations are based upon the following facts and assumptions :

1. the daily intake of a mature working elephant is 250 kilograms of biomass (Leaves, branches, grass, straw, and stalks) (Corvanich, 1976),

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2. the energy value of the above food-stuffs was estimated, on average, as follows:		
stalks and straw	3300.0 kcal/kg	(Mitchell, 1979)
leaves	4229.0 kcal/kg	(Mitchell, 1979)
stems and branches	4267.0 kcal/kg	(Golley, 1961)
average	3783.5 kcal/kg	

3. the elephant is capable of metabolizing 33% of its energy input (Benedict, 1936).

4. the amount of energy an elephant is capable of metabolizing;  
= energy of basal metabolism - energy expended on daily work,

5. the basal metabolism of an elephant is 49,000 cal/day (Benedict, 1936).

## RESULTS AND DISCUSSION

In accordance with the above data base, the expenditure of a working elephant was calculated and the results presented in Table 1.

Never before has anyone attempted, in an analytical study, to calculate the energy value of an elephant at work. Leach (1976) assigned the value of 8 MJ/hr (1910.68 kcal/hr) to the amount of energy expended by all kinds of draft animals. Cox and Atkins (1979) quoted the energy value for the labour of large draft animals as 2400 kcal/hr. This study calculated the energy expended per hour by a working elephant to be 6.8 and 5.4 times higher than both figures respectively. The discrepancy may

be attributable to differing degrees of difficulty of the work itself, this is in accordance with the observation by Rose (1938), that energy expenditure is variable, depending on the degree of difficulty involved. Conversely, most of these large draft animals were employ in agriculture, which is generally less demanding in terms of energy expenditure than forestry work. On the other hand, Corvanich (1976) mentioned that a full-grown elephant might be assigned to haul a 2 tons load of timber over very rough terrain.

The working specifications for a full-grown bull elephant are shown in Table 2.

An elephant reaches maturity at about the age of 25, with an average weight of 4,000 kilograms. It can haul a load half its body weight. The elephant is unable to work continuously. Its working hours should be limited to 3 days, followed by a 2-day break. The elephant itself, however, would prefer to work from early morning to noon only, and requires a vacation during the long, hot, dry summer (March-May). The mahout, who works with and elephant for life, starting with the training period and lasting until the retirement of the one or the other, allows the elephant to retreat into the jungle for a peaceful rest during the summer. Elephants working in Thailand are employed exclusively by the Forest Industry Organization, a government enterprise, which has drawn up a set of set of specifications for using elephants in forest silviculture according to the difficulty of the terrain, as follows (Corvanich, 1986),

Very rough terrain	: 1 elephant for production volumes of 150 - 300 m <sup>3</sup>
Moderately rough terrain	: 1 elephant for production volumes of 300 - 450 m <sup>3</sup>
Fairly good terrain	: 1 elephant for production volumes of 450 - 600 m <sup>3</sup>

Table 1. Energy expenditure of an elephant at labour

Item	Value
Energy input (per day)	945,875.00 kcal
Energy capable of metabolizing (per day)	312,138.75 kcal
Energy needed to perform work (per day)	312,089.75 kcal
Energy expended on work (per hour)	13,003.74 kcal

Table 2. Working specifications of an elephant engaged in forestry work

Duration of working life	25 – 50 year
Weight at maturity	4,000 kg
Daily working hours	7 hrs
Working days per annum	164 days
Maximum capable of hauling	2,000 kg
Maximum capable of lifting	700 kg
Maximum load capable of carrying	180 kg
Maximum speed	4 km/hr

(modified from corvanich, 1976)

Even though the elephant has given way to machinery in the timber industry, it is definitely worthwhile preserving both as a renewable form of energy and as an exotic art form.

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