

Ergonomical Researches on Modernization of Farm Work

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Since many agricultural zones in our country are located around the industrial zone, thickly-populated, agricultural productions in these zones are changing the characters from production as a principal occupation to that as a side business. And the change in the population engaged in agriculture is also apparent.

But some types of agricultural production are realizing high productivity which is able to compete with other industries.

If we could expect that these agricultural productions would be continued to increase the productivity as rapid as any other industry, the new farm work techniques should be prepared now as a technical countermeasure corresponding with quantitative and qualitative changes in members of the work groups.

In modernized farm work systems, high efficiency by utilizing improved mechanics should be realized with little physical burden of workers as possible. Special emphasis is laid on the latter in our studies.

Here, we call such rational work as fitting to worker's physical strength and giving little physical burden "comfortable work", and the grade of rationality in terms of physical burden "comfortableness".

Then our problem is attributed to "How to improve farm work systems more comfortably over high efficiency?" For solving this problem, we must first of all clarify. "How to measure comfortableness?"

From the point of view mentioned above, we have investigated at first, some indexes which would represent comfortableness. In

the next, we discussed on the necessary care to be taken when we express the comfortable-ness with those indexes. And finally, we suggested a procedure of farm work analysis based on the concept of comfortableness of works.

It was assumed that farm works consist of motions using three kinds of strength or load: muscular strength of arms, that of legs and mental load. As examples representing each component of motion, walking and running, lifting and combined-harvester operation were adopted. On each component of motion, relative metabolic rate, blood pressure and heart rate of workers were investigated and estimated those adequacy as the indexes of comfortableness of works. (Fig. 1)

Relative metabolic rate or its components, blood pressure and heart rate of operators working were measured. The work by means of power tiller led to significant energy saving compared to the work with human hands of the hoe, and the work by means of tractor led to significant energy saving compared to the work with power tiller.

The work by means of binder led to significant energy saving compared to the work with sickle and the work by means of combine led to significant energy saving compared to the work with binder. And a simple functional relation was found between a worker's energy expenditure or his physical burden and velocity of efficiency of the work in all the works investigated. These facts suggested that the most important caution for a worker's healthy

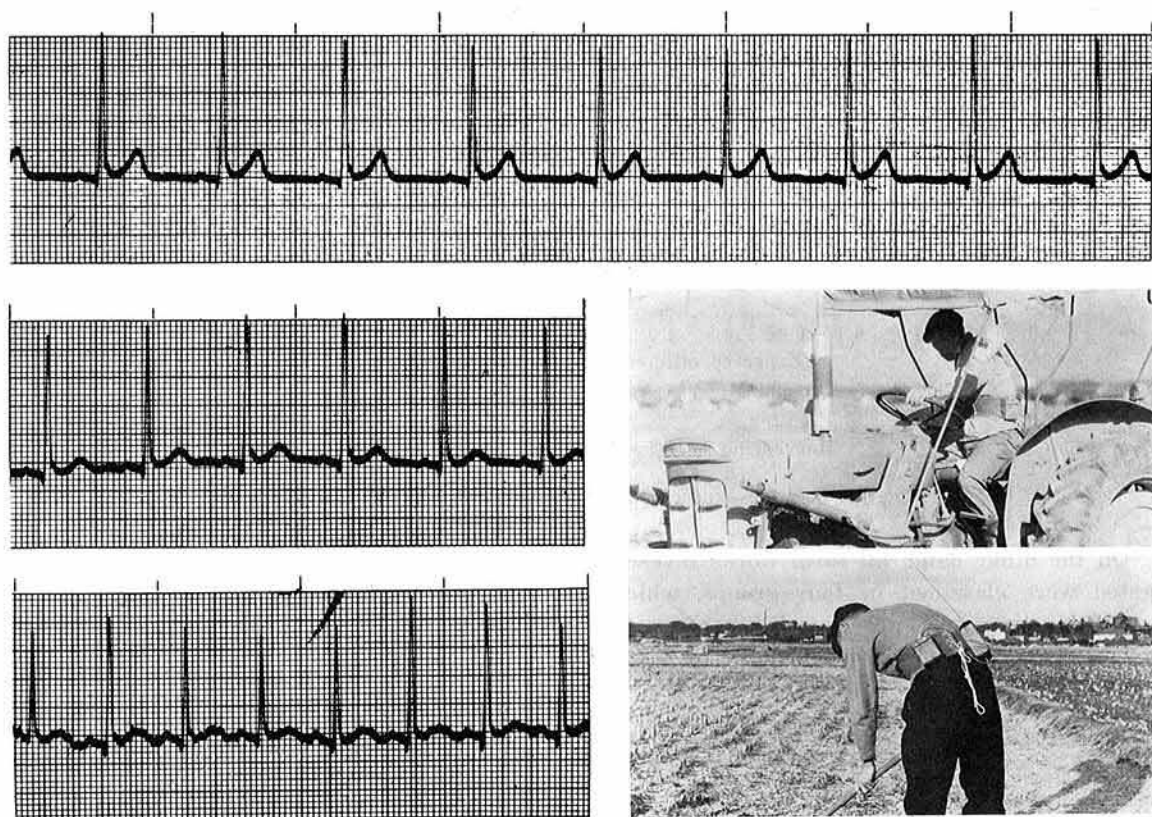


Fig. 1. An example for correspondence between the farm work and the cardiogram of worker

Top: A part of cardiogram of the worker in keeping quiet (heart rate 70)

Middle: Mechanized ploughing by tractor and a part of cardiogram of the worker (h.r. 87)

Bottom: Manual ploughing by hoe and a part of cardiogram of the worker (h.r. 112)

work was an appropriate program for work schedule.

Relative metabolic rate of its components, blood pressure and heart rate of operators working with human hand at planting, spraying and fruit harvesting in green houses were also measured.

The results of measurements suggest the facts that the most important cautions for a worker's healthy work, on the works in greenhouses, are not only an appropriate program for work schedule but introduction of automation techniques and improvement of work environments to more comfortableness.

The energy expenditure of the worker or his physical burden with farmwork was analyzed mathematically, and a method to

estimate practically optimum work-rest duration ratio for worker's healthy work was proposed.

With the simulation of the relation between work and load to the relation between weight and position, the increasing rate of heart rate of the worker (y) would be able to be expressed by functions of times (t).

$$y = \frac{B}{A}(1 - e^{-At}) + He^{\frac{D}{2}t} \quad (\text{during work})$$

$$y = -e^{-A't} - H'e^{\frac{D'}{2}t} \quad (\text{after work})$$

Starting from these functions, stable increasing rate of heart rate in the work and reduction in unit duration were estimated from $B'/A' - H'$ and $HD'/2 - B'$ respectively.

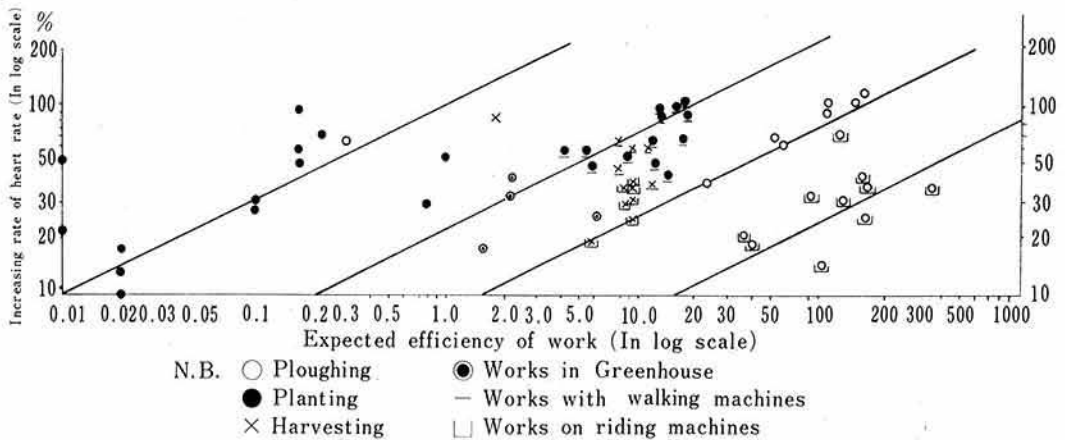


Fig. 2. Relation between expected efficiency of work and increasing of heart rate

On the other hand, all farm works investigated were classified in four groups, which were approximately agreed with respect to values (y) expected from efficiency of work (x),

$$y = e^{0.5 \log x + 2.0}$$

$$y = e^{0.5 \log x - 0.6}$$

$$y = e^{0.5 \log x - 2.4}$$

$$y = e^{0.5 \log x - 4.4}$$

After this estimation and classification, a method for estimating the increasing rate of heart rate of worker an optimum work-rest duration rate of every farm works were proposed.

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