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Hisashi Horio graduated from Department of Agricultural Engineering at Kyoto University in 1967. He was engaged in education and research on farm machinery in Kobe University, and retired in 2009.

He was and is also engaged in study on history of agriculture, especially agricultural technology and ethnology. At present, Dr Horio is a member of AIMA Executive Committee and President of Japan Society of History of Industrial Technology.

WATER AND APPROPRIATE TECHNOLOGY BY RICE CULTIVATION PLOUGH OF WIDE AND MEDIUM-LONG SOLE

INTRODUCTION

The sufficient water supply is the fundamental condition for growing rice. The right land condition is always limited. In the regions of rice cultivation as primary crop, anywhere indiscriminately, somewhere far from right land, peoples have been forced to cope with disadvantage; less water supply and/or heavy water leakage. The construction of large scale irrigation system requiring investment had/has been limited, especially at developing stage or in developing area. And, the retentivity (keeping water in soil) is important problem even in developed stage and areas.

How to keep water in rice paddy field at developing stage or in developing area far from advanced technology? Wide and medium-long sole plough is the appropriate technology as arranged for keeping retentivity.

WATER IN RICE PADDY FIELD

The schematic is shown in Fig.1. Soil pan is formed by harrowing and ploughing flooded paddy field and prevents water leakage and controls vertical penetration (certain vertical penetration is need). By harrowing the fine-particles of soil set and cover soil pan, and by ploughing the wide sole bottom plasters soil pan (called as water-ploughing for distinct from normal upland ploughing).

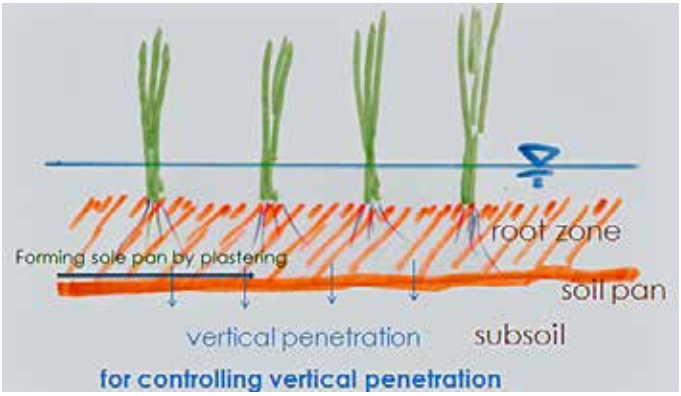

Fig.1 *Schematic of rice paddy field*

FUNCTIOAL ASPECTS FOR VARIOUS KINDS PLOUGHS

Two types of plough were introduced from north China and Korean Peninsula in ancient time, respectively the one was long sole plough and the other was no sole plough (Fig.2).

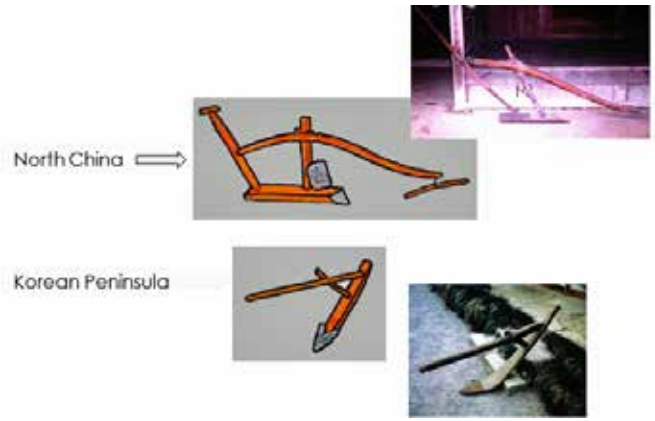

Fig.2 *Introduction of ploughs to ancient Japan*

Long sole plough was developed in ancient era of China by modified from transferred from the middle East World for fitting to dry farming of shallow tillage. The shallow ploughing is stably conducted by wide and long sole. Deep tillage is impossible by large draft resistance caused by soil adhesive resistance.

No sole plough was used in upland farming. It requires less draft resistance by lacking sole. Deep tillage is possible by limited power of one animal. The fatal defect is extremely unstable draft and requirement of heavy work for operation

The farm literature edited in middle 18 C. at south region of Japan, "Fukuoka Noushi" (Farm Pictorials)", shows interesting figure of four kinds as shown in Fig. 3.

The figure shows medium long sole and short sole ploughs, which are considered to be formed as a cross between long sole and no sole.

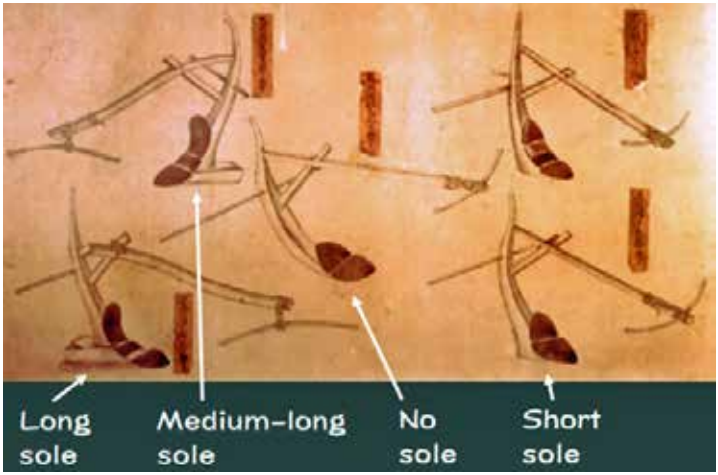

Fig.3 *Various type of ploughs in the middle18 C., Japan from "Fukuoka Noumushi (Farm Pictorials in Fukuoka)"*

Table 1 Functional Comparison

	Draft stability	Draft resistance	tillage depth	plastering
Long sole	High	ext. large	shallow	well
No sole	No	less	deep	no
Medium-long sole	Enough	intermediate	intermediate	enough well
short sole	Enough	small	deep	poor

The functional comparison of various plough-types used in rice cultivation of Asia is presented in Table 1. Indigenous short sole plough used in local area of south Japan was modified to high performance for deep tillage and complete soil inversion (turning) in Modern Era.

After the closing the three hundred years seclusion, the knowledge introduced from the Western World was a subject of national development attaching the interest of Japanese, also in the sector of agriculture. Tillage device and method was especially understood to be free from the common sense; the deep tillage by a plough was impossible. The improvement of tillage method was understood as the matter to be settled for time being. Transferred western plough was so heavy to be drafted by one animal. The development of usable plough to satisfy the condition of deep tillage and less draft power was encouraged. Advanced short sole plough had widely prevailed and supported high yield rice production in modern Japan.

MEDIUM-LONG SOLE PLOUGH

The general view and the bottom view of medium-long sole plough is shown in Fig.4. This plough is considered to be formed as a compromise of both function of plastering of the long sole and tillage depth of the short sole.

Fig.4 *General view and bottom view of wide and medium-long plough (photo by Horio)*

Advanced short sole plough has less plastering function because of its extremely narrow sole. After the diffusion of advanced short sole plough, medium-long sole plough was yet used in the field of heavy water leakage in objecting plastering as 'Appropriate Technology'.

When we turn our observation to other area, we can see same cases or examples. Let introduce the case at Laos from author's field works in 1993 and 1994 (Fig. 5). Medium-long sole plough was selectively used in rice paddy field. The interesting case was surveyed; tractor mounted rotary tiller was introduced under the land consolidation project supported by JICA (Japan International Cooperation Agency) and designed by 'specialist'. Introduced rotary tiller gathered rust

and was put at field side. Farmers turned to use indigenous medium-long sole plough. Rotary tiller was not available in the field of heavy leakage. Rotary tiller was excluded. Soil pan had to be plastered by sole bottom of plough. Even by such plastering water loss in depth was recorded over 10 cm par one night from author's investigation. Iron pipe flamed ploughs were put at the farm tool shop, which were designed with indigenous medium long sole (Fig. 6).

Fig. 5 *(left) Water ploughing by medium-long sole plough, in Laos, 1993 (photo by Horio)*

Fig. 6 *(right) Present-made medium-long sole ploughs in Laos,1994 (photo by Horio)*

CONCLUDING REMARKS

This paper shows one example of 'Appropriate Technology' by citing the short history and field survey of 'Medium-long Sole Plough'. Even at the diffusion stage of advanced technology, Indigenous technology has/had been applied as 'Appropriate Technology'.

FURTHER PROBLEMS

E. Werth's "Grabstock, Hacke und Pflug" and P. Leser's "Entstehung und Verbreitung des Pfluges" present many kinds ploughs all over the world. The great works by Emil Werth and Paul Leser give us the way to world-wide discussion on ploughs.

However, they may be limited in morphological matter. We are requested to expand the study on left problems; to be approached from comparative and functional view points, and also in relating to farm operations.

The authorlike to present final remark; such approach requires wide co-operations between historians, ethnologists, technologists and so on. The development of such studies may be managed and supported by museums' activities, and AIMA.