THE APPLICATION OF MOLE PLOUGH WITH ROPE APPLICATOR TO REDUCE SOFT SOIL PROBLEM IN RICE FIELD

Mohamad Fakhrul Z.O.
Engineering Research Centre,
Malaysian Agricultural Research and Development Institute,
MARDI Sintok, Kedah.
Email: fakhrulz@mardi.gov.my

Eddy Herman S.; Mohd Taufik A.
Engineering Research Centre,
Malaysian Agricultural Research and Development Institute,
MARDI Headquarter, Serdang, Selangor.

Mohammed Fauzi M.I.; Mohd Khusairy K.; Mohd Shahril Shah M.G.
Engineering Research Centre,
Malaysian Agricultural Research and Development Institute,
MARDI Seberang Perai, Penang.

Nasarudin N.S.
Horticulture Research Centre,
Malaysian Agricultural Research and Development Institute,
MARDI Sintok, Kedah.

ABSTRACT

Soft soil is one of the major problems faced by rice farmers in Malaysia's main granary regions. The soft texture of the hardpan layer causes constraints to machinery from operating efficiently. To overcome this problem, MARDI has developed a mole plough with a rope applicator for use in rice fields to improve the bearing capacity of the hardpan layer of the soil. This paper demonstrates the effectiveness of a mole drain in improving areas with soft soil. A study was conducted in a previously identified soft soil area at the Department of Agriculture Bukit Merah Station, Seberang Perai Tengah, Penang. The mole drain was installed at a depth of 45 cm in the soil using a mole plough. Meanwhile, a jute rope was used and installed in the mole drain with a rope size of 32 mm in diameter. Data collection was done every month using Penetrologger to monitor the hardpan layer bearing capacity status. Results showed that the soft soil condition of the plot was reduced from 79% to 53% and 17% in 6 and 14 months, respectively. The total reduction of soft soil condition was 62%.

Key words: Rice, soft soil, hardpan layer, mole drain, mole plough, Penetrologger.

INTRODUCTION

Soft soil is one of the challenges faced by rice farmers, particularly in areas with poor irrigation systems. In 2013 alone, the area affected by this problem was estimated as 8000 hectares in the MADA region, 5200 hectares in IADA Kemasin, Semerak and 4800 hectares in KETARA (Abdullah, 2014). This problem generally arises due to the continuously submerged soil conditions and constant land use without rest periods, which prevents the soil from returning to its normal state (Muhammad Rendana et al., 2017).

Activities such as land preparation and harvesting are now entirely mechanized, and the use of machinery in the rice sector is very significant in contributing to the production of high yielding rice. Therefore, the care and formation of hardpan or hard soil layers are very important to allow machinery to operate in the rice.

Soil hardpans, hard layers or compacted horizons, either surface or subsurface, are lands with physical characteristics that restrict the penetration of roots and the movement of water (Warren, 2011). In rice fields, the soil hardpan needs to be at least 0.40MPa in order to accommodate the weight of the machinery to be used (Azizul, 2008). However, Mohamad Nadzim et al. (2014) claimed that the soil hardpan should surpass 0.30MPa at a depth of 30 cm to allow machinery to operate in the field. Based on these studies, soft soil can be classified as an area with a low and sufficient soil bearing capacity of less than 0.30 Mpa to support agricultural machinery. Studies have shown that the most effective way to assess the hardpan strength of the soil is by using Penetrometer, an instrument that can penetrate the soil layer by force (Whalley et al., 2007).

There are a variety of methods that can be used to improve soil strength. MARDI has developed several technologies to overcome this issue, where, the most recent is the development of mole plough. The mole plough is a tractor-mounted implement which comprises of a steel frame, cutting blade, mole channel, and rope applicator. This implement is used to create a mole channel under the surface of the ground with the intention to drain trapped or stagnant water from the rice field into the drainage. This method is an improvement to the current surface irrigation in rice fields where a longer period of time is needed to remove or drain water

from the field into the drainage. Moreover, the plot drying process can run faster and the hardpan layer forming process can take place sooner. The purpose of this study is to determine the impact of mole drain usage in improving soft soils areas in rice fields.

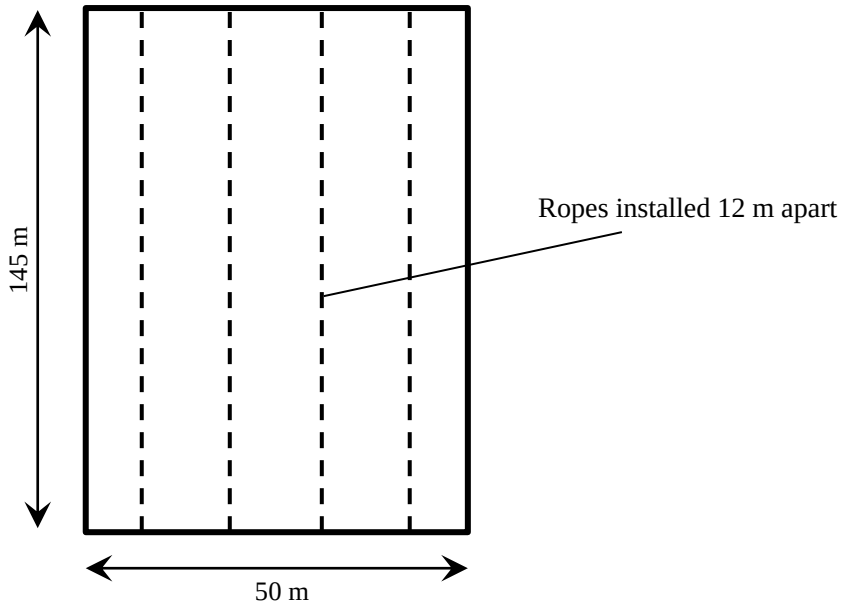
MATERIALS AND METHODS

The study was conducted on a 7,520 m^2 paddy field in the Department of Agriculture (DOA) Bukit Merah Station that has been identified as a problematic area with soft soil issue by the DOA (Figure 1). The study plot is located at the central state of Penang, Malaysia (Latitude 5°24'43.7"N and Longitude 100°25'53.8"E).

Initial soil strength data was obtained using Penetrologger (Eijelkamp, Netherlands) as a benchmark prior to the installation of the drain mole. A total of 75 sampling points was taken using a grid of 5 m x 15 m. Subsequent soil strength data was obtained on a monthly basis for two seasons between March 2018 and May 2019.

Preparation of the experimental plot began after the second land preparation was completed. The jute rope was installed along with the mole drain using the mole plough implement at a depth between 35 cm and 45 cm. The rope was installed at a distance of 12m apart, as shown in Figure 1.

Figure 1: Experimental layout



The implement used to install the mole drain is a mole plough with a rope applicator, as shown in Figure 2. This implement has a hydraulic system that is designed to facilitate the process of lifting and inserting the cutting blade into the ground. It also has a rope roller lift system for quick installation of ropes and can be operated by a single operator. In addition, this implement is ideal for use with a half-track tractor which has a higher pull power than a tractor with rubber wheels.

Figure 2: Mole plough with a rope applicator during a mole drain installation

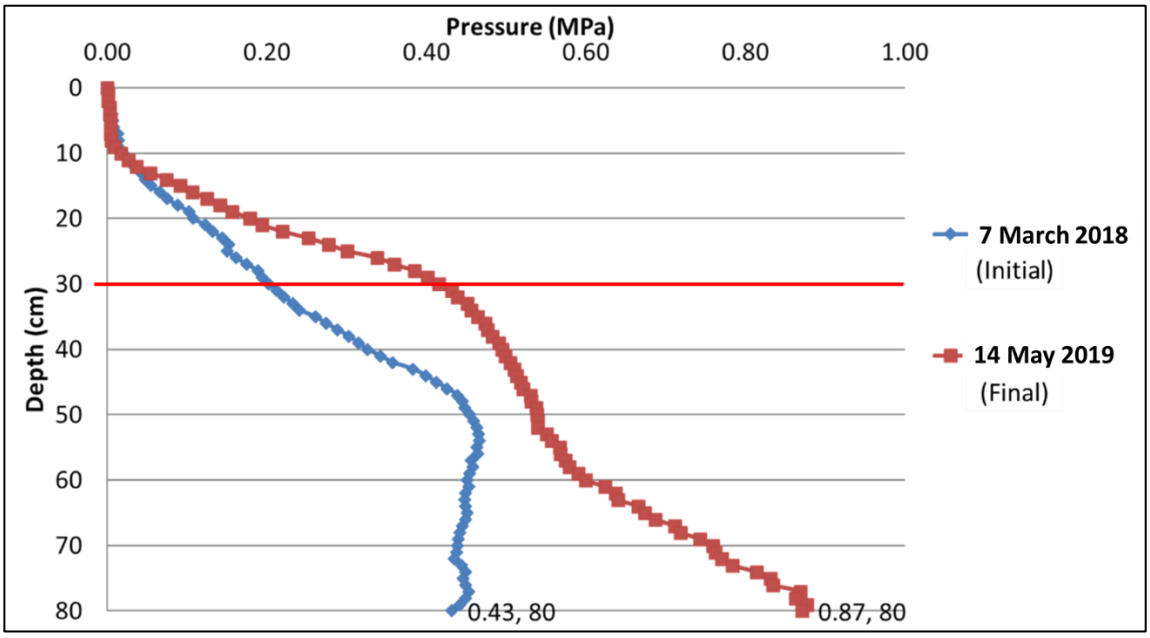
RESULTS AND DISCUSSION

Both initial and final soil strength data have the same 0.0 MPa values. This is the starting point of the ploughing range, followed by a steady rise after 10 cm, as shown in Figure 3. The initial baseline soil strength data were taken on March 7, 2018, at depths ranging from 0 to 80 cm shows that the average soil strength at 30 cm is 0.20 MPa (Figure 2). Data obtained confirmed that there is a soft soil issue as previously identified by the DOA at Bukit Merah Station.

After the mole drain installation, soil strength in the study plot was obtained throughout the rice cultivation season. This includes during transplanting, crop maintenance, and harvesting activities.

The final data taken on May 15, 2019, showed that the average soil strength at a depth of 30 cm and 80 cm was 0.42 MPa and 0.87 MPa respectively which is twice the pressure value obtained by initial data at the same depth, indicating soil strength improvement as a result of mole drain usage (Figure 3). However, for depths from 0 cm to 10 cm, the correlation of these two data sets is that there is no pressure at all. In addition, for depths between 30 cm and 60 cm, there has been a small increase in soil strength relative to the initial results, with an increase of almost 50% at a depth of 60 cm from 0.44 MPa to 0.60 MPa. In general, the final soil strength data for different depths also showed improvement compared to the initial experimental data.

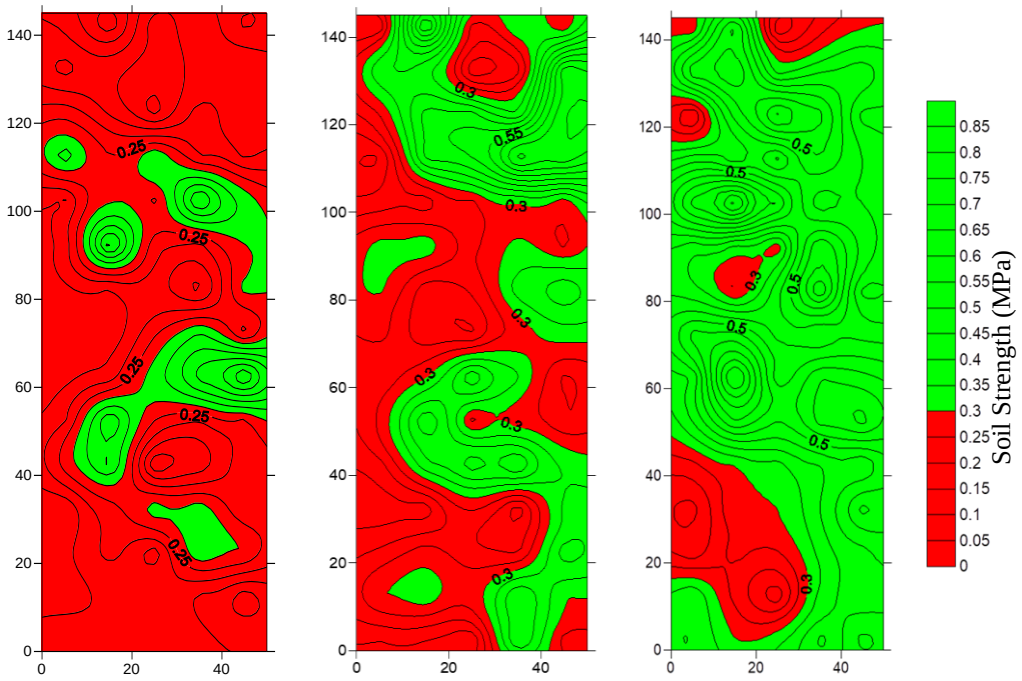
Figure 3: Average soil strength comparison between initial and final data



The average soil strength data for the initial, six months and final stage of the study at a depth of 30 cm is presented in a contour map, as shown in Figure 4. The initial soil strength condition showed that 79% of the study plot displayed values below 0.30 MPa, indicating the presence of soft soil problem. However, results after mole drain installation showed a significant increase in soil strength. The soft soil problem reduced from 79% to 53% and 17% in six and 14 months after installation, respectively. This shows a total reduction of 62% of soft soil in this study plot.

This study shows that the use of mole plough with rope can solve the problem of soft soil in rice fields. Therefore, farmers will cultivate the rice fields for the hardpan layer that have been repaired. At the same time, it can increase the income of farmers as well as the production of rice in the country in general.

Figure 4: Contour map of soil strength at a depth of 30 cm for initial (left), six months (middle) and final (right) timepoint



CONCLUSION

This study has shown that soft soil problem in rice fields can be reduced by the application of a mole plough that integrates a mole drain and rope applicator. This study also found that the process of drying water can be accelerated in the plot and thus lead to the increased strength of the hardpan soil layer. This study has opened up a new dimension to the solution of the issue of soft soil in Malaysia. Future suggestion study will be focusing on other integration material for mole drainage.

REFERENCES

Abdullah, N. (2014). Approaches to Overcome Soft Soil Problem in Muda Area. In *Proceedings of National Conference on Agricultural and Food Mechanization* (p. 162).

Azizul G. (2008) Teknik pembaikan lapisan keras tanah sawah menggunakan bajak subtanah getar/ saluran buangan alur untuk penjenteraan sawah padi. *Bulletin Teknologi Tanaman* 5: 1 – 4.

Mohamad Nadzim N., Ayob A.H., Eddy H.S., Ahmad Syafik S.S. & Mohamed Fauzi M.I. (2014) Kaedah penggantian tanah untuk meningkatkan kekuatan struktur tanah di kawasan tanah jerlus. *Jurnal Teknologi* 70 (6): 45 – 47.

Muhammad Rendana, Wan Mohd R.I., Zulfahmi A.R., Tukimat L., Habibah J. & Sahibin A.R. (2017) Kekuatan struktur lapisan keras dan ciri fizikal tanah jerlus di kawasan penanaman padi di MADA Alor Senibong, Kedah, Malaysia. *Malaysian Journal of Environmental Management.* 16 (1) (2017): 3 – 11.

Warren J. Busscher (2011) Soil hardpan: Management. Encyclopedia of Soil Science, Springer,p. 357.

Whalley, W. R., To, J., Kay, B. D. & Whitmore, A. P. (2007) Prediction of the penetrometer resistance of soil with models with few parameters. *Geoderma* 137:370 – 377