

Finding Design Parameters Of Rice Transplanter For The Agricultural Land Of Nepal

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Abstract— Most of the Nepalese depend upon rice for their routine meals. Rice is the most common source of food in Nepal. But the production of rice in Nepal is not sufficient to fulfill the demand of people living in Nepal. Based on the average per capita milled rice consumption of 122 kg per year and the total population of 27.6 million, the total demand for rice in Nepal is estimated at 5.04 million tons of paddy in 2012. But the country produced only 4.50 million tons paddy. Considering only 80% of the total harvest is available for human consumption, the total milled rice produced in the country available for consumption is only 2.38 million tons (3.60 million tons of paddy). This means the country has a shortfall of about 1 million tons of milled rice (1.5 million tons paddy) [1]. The main reason behind this is the inappropriate methods of transplantation and lack of mechanization. Thus, to reduce the production-supply gap Nepal needs to march towards mechanization in the agricultural field with the appropriate methods of transplantation.

In order to contribute to the mechanization, in the field of agriculture, there is need of rice transplanter. By using rice transplanter, one to two persons can easily finish the transplantation of paddy seedlings in the field. The design of rice transplanter is essential for effective mechanization in the agricultural field. For effective transplantation and production, the design parameters should be decided according to the appropriate method of transplantation.

To find the best method of transplantation, real field survey with farmers and an experiment was carried out. The experiment was performed on the growth of paddy seedling from its seed from which we got the depth of the root of seedling that could go underneath the soil level. From this data, we concluded to keep the height of the seedling tray to be not less than 6.1 cm for the soil of Syangja and Kaski district. From the real field survey, the transplanting distance between two successive seedlings was found to be 180mm in a column and 180mm in a row with 2 seedlings at a time. The planting depth was found to be 50mm. The average height of seedlings before transplantation and number of seedlings to be transplanted at a time are found to be 280mm and 2 respectively. These data give the design parameters of the rice transplanter, to be used in Nepal.

Index Terms— Mechanization, Methods of transplantation, Planting depth, Rice transplanter, Seedlings.

1 INTRODUCTION

Nepal has a diverse land structure that varies from steep mountain ranges to plain land of Terai. Terai has the most arable land and most of the people of Terai are engaged in the agricultural sector. The rate of people involving in the agricultural sector, however, decreases as we move toward the hilly region up to the mountain region because the land in the hilly region and mountain region are not as arable as that of Terai. So, rice transplanter is the solution. A rice transplanter is a machine that transplants rice seedlings in the paddy field. It saves time and money when compared to manually transplanting the seedlings.

To manufacture and develop rice transplanter, it needs to be designed first. The most difficult task in design is to set the design parameters. Design parameters are the qualitative and quantitative aspects of physical and functional characteristics of a component, device, product or system that are input to its design process. The design parameters for rice transplanter are as follows:

1. Depth of transplantation.
2. Distance between two successive seedlings in row and column.
3. Height of seedling tray.
4. Average height of seedlings before transplantation.

5. Number of seedlings to be transplanted at a time.

Thus, the major objective of this research is to determine the design parameters of rice transplanter.

2 LITERATURE REVIEW

The following mentioned researchers and their papers have played a vital role in our research.

B. Ibrahim et al. (2014) performed an experiment on System Rice Intensification (SRI) Paddy Transplanter. They found the planting of one seedling per hill spaced in 25 cm×25 cm for better usage of water, nutrient and pest management [2].

A. Sharma et al. (2016) designed a transplanter that maintained the sapling distance of 0.17m. Their design could transplant 135 seedlings in one-meter square in 56 seconds time [3].

U. Patel et al. (2017) designed rice transplanter in which they maintained 300 mm distance between two paddy seedlings in the same column. They maintained 460mm distance between two paddy seedlings in a row. Their prototype was able to plant 4200 seedlings in one hour's time [4].

S.K. Pawar et al. (2017) designed and developed 2-row manual rice transplanter by using the 4 bar mechanism in which the feeding rate was determined to be 1.5 km/hr and the depth of transplantation was kept 4 to 6 cm [5].

3 METHODOLOGY

The research was carried out by performing the sections below.

3.1 Experiment to determine the depth of seedling root growth

In order to study the depth of root growth of paddy plant, we collected the soil from different places of Pokhara valley (Batu-lechaur and Lekhnath) and Syangja district. After its collection, the germinated seed of paddy was sown in a damped soil of different places. The seed was sown and observed until 25 days. The first data was observed after 5 days of sowing and other data was observed at different time intervals as illustrated in the table below. It was observed that after certain days of the plantation of seeds the amount of water required for its growth also increases. The average grown plant was plugged out from the soil and the length of the root was measured. The moisture content was ensured to be 100% every day by using a moisture sensor programmed in Arduino. The observed data are shown in the table 1.

TABLE 1

Paddy root growth at different time interval after sowing

28 th April 2019	Depth of root (cm)
Lekhnath soil	3.4
Syangja soil	2.1
Batulechaur soil	3.1
3 rd May 2019	Depth of root (cm)
Lekhnath soil	4.9
Syangja soil	2.7
Batulechaur soil	3.2
11 th May 2019	Depth of root (cm)
Lekhnath soil	4.5
Syangja soil	6.3
Batulechaur soil	6.4
18 th May 2019	Depth of root (cm)
Lekhnath soil	6
Syangja soil	6.2
Batulechaur soil	6.1

Within these 25 days of seed germination and growth, it was observed that 6.1 cm in an average of the root grows inside the soil. The average was taken because the data of the three places were close enough. So, the seedling tray with soil height more than 6.1 cm should be designed. Thus, we get this design parameter (height of the seedling tray) by performing this experiment. The growth graph is shown in fig. 1.

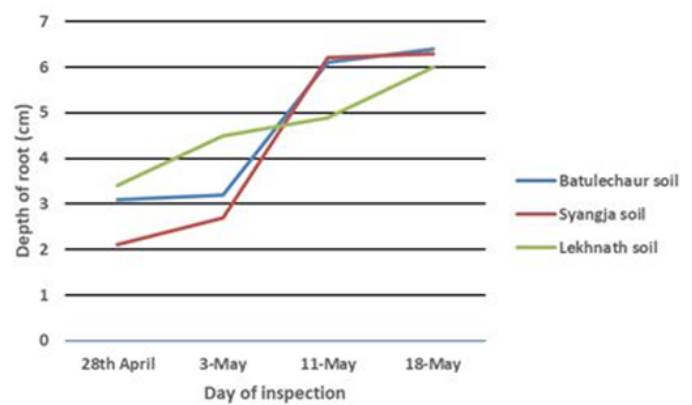


Fig. 1. Graph showing root growth (in cm) of paddy seedlings on three samples of soil.

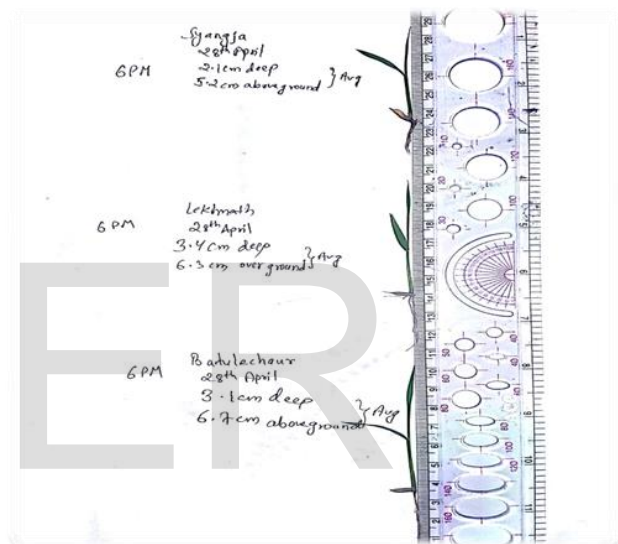


Fig. 2. Measurement of paddy root on 28th April, 2019.



Fig. 3. Checking moisture content using Arduino.

3.2 Research on other design parameters through the survey

Other design parameters are achieved by conducting a real survey with farmers of Lekhnath and Batulechaur. We consulted with experienced farmers and asked them the direct data of design parameters. The data were analyzed and the data with maximum repetition was concluded to be the design parameters. The data obtained by the survey are shown in the graphs below.

From the survey for Lekhnath, the distance between two successive seedlings, in both, row and column was concluded to be in the range 170mm to 199mm. Similarly, for Batulechaur, the distance between two successive seedlings was concluded to be in the same range of 170mm to 199 mm. Both data matched. Thus, the distance between two consecutive seedlings in both, row and column was concluded to be 180mm as an average.

Similarly, from the survey in Lekhnath, depth of transplantation of seedlings was concluded to be in the range of 50mm to 59mm and for Batulechaur depth of transplantation of seedlings was concluded to be in the range of 40mm to 49mm. Thus, the mechanism of rice transplanter should be designed such that the hitting arm with seedling goes 50mm (avg) below the ground surface in the mud.

Similarly, other concluded design parameters from the survey are:

1. average height of seedlings before transplantation: 280mm
2. number of seedlings to be transplanted at a time: 2

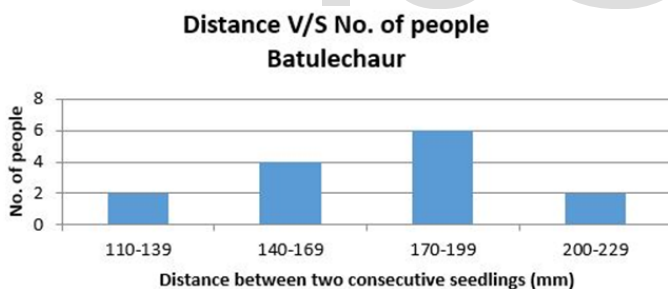


Fig. 4. Distance between two successive seedlings vs Number of people.

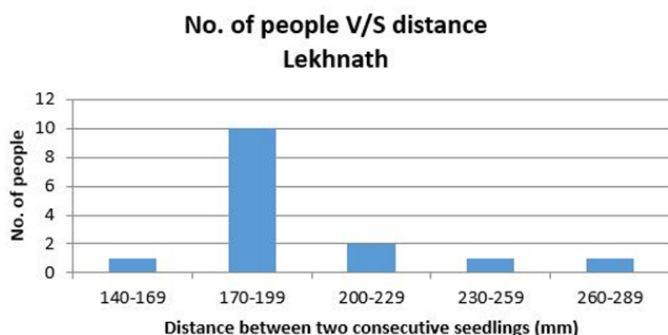


Fig.5. Distance between two successive seedlings vs Number of people.

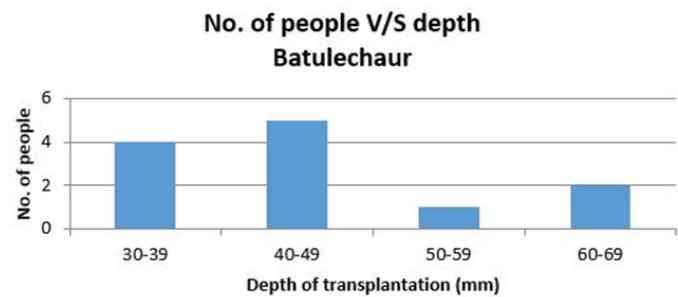


Fig.6. Depth of transplantation vs Number of people.

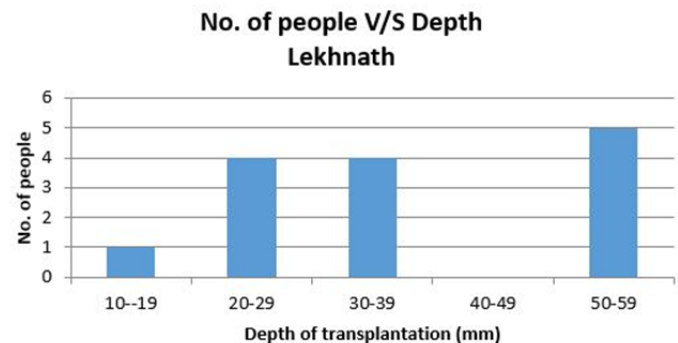


Fig.7. Depth of transplantation vs Number of people.

4 RESULTS AND CONCLUSIONS

The experiment on the growth of paddy seedling from its seed showed that the depth of the root of seedling that could go underneath the soil level. The seedling tray is required in which seedlings are grown so that the transportation of seedlings to the transplanter is easy and fast. So, from the above data, we concluded to keep the height of the seedling tray to be not less than 6.1 cm.

By conducting on field survey, we found various parameters regarding paddy seedling transplantation which is: depth of transplantation, the distance between two consecutive seedlings, the average height of seedlings before transplantation and number of seedlings to be transplanted at a time, which are found to be 50mm, 180mm, 280mm and 2 respectively.

Thus, the rice transplanter should be developed such that it sows the seedlings 50mm deep from the surface of muddy land. The mechanism of transplantation should be made in such a way that transplanter sows seedlings at a distance interval of 180mm and picks 2 seedlings at a time. The seedling tray chassis in transplanter should be made in accordance with the average height of seedlings before transplantation i.e. 280mm.

5 REFERENCES

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