ACTA SCIENTIFIC AGRICULTURE (ISSN: 2581-365X)

Volume 3 Issue 10 October 2019

Review Article

Study of Management Practices for Lowland Rice in Nepalese Context

Shobita Neupane* and Tirsana Khadka

College of Natural Resource Management, Puranchaur, Kaski, Agriculture and Forestry University, Nepal

***Corresponding Author:** Shobita Neupane, College of Natural Resource Management, Puranchaur, Kaski, Agriculture and Forestry University, Nepal.

Received: August 19, 2019; **Published:** September 26, 2019

DOI: 10.31080/ASAG.2019.03.0666

Abstract

Rice (*Oryza sativa*) is an important food crop for the Nepalese population. Total rice production should be amplified to feed the increasing population of Nepal. Rice varieties like CH 45, Chaite 2, Hardinath, Masuli, Makwanpur 1 etc are cultivated in Terai; Taichung 176, Khumal 11, Rhada 4 etc are prominent in mid-hills and Palung 2, Machhapuchhre 3, Chandannath 1 and 3 etc are grown in high-hills under lowland condition. The anaerobic environment in rice field is created by flood-irrigation that results in a unique and challenging environment for efficient management of soil. Use of organic fertilizers and right land management practices can increase the yield up to 4.9 tons/ha. Supplying essential nutrients at right doses from the right sources with correct application methods and times are important factors to increase the productivity and sustainability of rice. Plus, following the integrated weed management system including different herbicides, hoeing at 30 and 45 days after transplanting in addition to weedy check gives the best result over traditional hand weeding. This review emphasizes in current, research-based knowledge of management practices in rice for increasing the efficiency and sustainability of lowland rice and identifies where more research is essential.

Keywords: Lowland; Research; *Oryza sativa*

Introduction

Rice (*Oryza sativa*) is a perennial grass that belongs to Poaceae family. Rice is believed to be domesticated in the Pearl River valley region of China and then it spread all over south and Southeast Asia [1]. In today's date, rice is cultivated across diversified environments ranging from tropical to semi-tropical and warm temperate. It is the major cereal crop which is consumed as a source of food by over 85% population in the world and around 90% population in Asia [2]. In Nepal, rice covers 59% of the total cultivated land i.e. 1,469,545 ha with production of 5,151,925 mt and the productivity of 3.5t/ha [3]. Rice production contributes about 20% to the agricultural gross domestic product (AGDP) and about 7% to gross domestic product [4,5]. As rice fulfills the major calorie requirement in Nepalese diet, its demand is increasing with the growing population. However, to meet this requirement the crop should transact to its full potential. The reported maximal yield of rice grain was 8 Mg/ha in the research station at Khumaltar [6]. But the average yield of rice grain in farmers fields is 3.55 mt/ha [3]. This yield gap is observed due to divergent cultivation practices like variety choice, soil management, nutrient management, and weed management.

The development of paddy and its yield depends on the selection of variety that fits the agro-climatic and ecological condition. Modern varieties including hybrids and local varieties by districts and ecological regions have been suggested by the Ministry of Agriculture department. The varieties like CH 45, Chaite 2, 4, and 6, Savitri, Taichung 176, Khumal 4 etc is suitable under the lowland condition of Nepal [3]. For the incensement of yield, selection of good quality seed having high germination percentage is vital.

The anaerobic soil environment generated by flood-irrigation creates a challenging and unique environment for efficient soil nutrient management in lowland rice. Supplying indispensable nutrients in adequate rates and sources through right application methods and application time are crucial factors that interfere with the productivity and sustainability of rice.

In lowland rice cultivation, problems as nutrient deficiencies (N deficiency being the major one), declining soil organic matter, early season water logging plus the late-season drought are the major restrictions [7]. While the recommended does for low-land rice is 100 kg N ha^{-1}, in 2000 farmers were reported to apply less than 30 kg ha^{-1} yr^{-1} [8]. Under such criteria, the proficient use of systems internal resources like recycling crop residues and manures, the addition of N by biological nitrogen fixation and minimization of nutrient losses must be exploited to a larger extent than at present [9].

In Nepal, the decline in yield due to uncontrolled weed growth in transplanted lowland is 50% to 80% [10]. Altogether 52 weed species i.e. 25 monocots and 27 dicots, belonging to 32 genera and 15 families ravaged the paddy [11]. The dominant weeds in lowland paddy field were found to be *Echinochloa colona, Cyperus iria, E. crus-galli,* and *Ageratum conyzoides* [12].

Methodology

This paper is based on an extensive secondary literature survey. Research published in different local and national papers related to rice production was studied. A desk study on the earlier published papers was done to collect the secondary data. Collection and sorting of information from different national documents, brochure, booklets, and research was done.

Results and Discussion

In 1951, with the collection of 930 rice germplasm from 54 districts, formal rice research in Nepal started at Parwanipur [13]. Till date total of 56 varieties have been released in Nepal and the first one i.e. CH 45 was released in 1958 [14]. For the main season rice, 81.67 percent of the area is under Modern varieties, 10.37 percent is under local varieties and 7.96 percent under hybrid [4].

The major rice production systems in Nepal under lowland condition along with their recommended varieties for different ecological zones are explained below:

For terai

Chaite dhan: CH 45, Chaite 2, 4, and 6, and Hardinath-1.

S.N	Name of Variety	Recommended year (BS)	Maturity Days	Productivity ton/ hectors
1	CH-45	2023	118	3.5
2	Chaite-2	2044	125	4.8
3	Chaite-4	2044	118	4.5
4	Chaite-6	2048	123	4.8
5	Hardinath-1	2060	110	5.0

Hardinath- 1 has the highest productivity with shorter maturity days as compared to CH-4 which is the oldest released variety of Nepal.

Source: [3].

Main season irrigated rice: Sabitri, Radha 4 and 12, Kanchhi Masuli, Masuli and, Makwanpur 1.

S.N	Name of Variety	Recommended year (BS)	Maturity Days	Productivity tons/ hector
1	Sabtri	2036	140	4.0
2	Radha-12	2051	155	4.6
3	Radha-14	2051	125	3.2
4	Mansuli	2030	155	4.6
5	Makwanpur-2	2044	150	4.8

For the main season, Makwanpur- 2 has the highest productivity i.e. 4.8 ton/ hector while Radha-12 has the short life but the productivity is also less.

Source: [3].

Main season rain fed rice: Bindeswari, Ghaiya 2, Chaite 2 and Hardinath 1.

S.N	Name of Variety	Recommended year (BS)	Maturity Days	Productivity tons/ hector
1	Bindeswari	2038	128	4.0
2	Ghaiya 2	2044	113	3.4
3	Chaite 2	2044	125	4.8
4	Hardinath 1	2060	110	5.0

For the main season rainfed rice, Hardinath 1 has the highest productivity with the least number of maturity days. So Hardinath 1 is the recommended variety for Terai.

Source: [3].

Valley and mid hills

Chaite rice: Taichung 176, Chainung 242 and Khumal 11, Hardinath 1.

S.N	Name of Variety	Recommended year (BS)	Maturity Days	Productivity tons/ hector
1	Taichung-176	2024	144	7.9
3	Khumal- 11	2058	144	10.0
4	Hardinath- 1	2060	110	5.0

Kumal-11 released in 2058 has the highest productivity i.e. 10 tons/ hector with the maturity days of 144 while Hardinath-1 has the shortest number of maturity days.

Source: [3].

Normal rice: Radha 7, Makwanpur2, Radha Krishna 9, Masuli, and Rampur Masuli.

S.N	Name of Variety	Recommended year (BS)	Maturity Days	Productivity tons/ hectors
1	Radha7	2048	148	3.5
2	Makwanpur 2	2044	150	4.8
3	Radha Krishna 9	2048	150	3.8
4	Masuli	2030	155	3.5
5	Rampur Masuli	2056	135	5.7

Rampur Masuli having highest productivity and shortest maturity days is recommended normal rice for Hilly region. Makwanpur 2 is second in the list with the productivity of 4.8 ton/ hectors.

Source: [5].

Warm temperate rice: Taichung 176, Chainung 242 and Khumal 11.

For High hills

Cool temperate rice: Palung 2, Machhapuchhre 3, Chandannath 1, Chandannath 3 and Chhamrong.

S.N	Name of Variety	Recommended year (BS)	Maturity Days	Productivity tons/ hector
1	Taichung-176	2024	144	7.9
2	Chainung-242	2024	144	7.3
3	Khumal-11	2058	144	10.0

Khumal-11 has the highest productivity among the warm temperate rice variety in Hilly region.

Source: [3].

S.N	Name of Variety	Recommended year (BS)	Maturity Days	Productivity tons/ hector
1	Palung-2	2044	172	6.1
2	Machhapuchhre -3	2053	174	5.0
3	Chandannath-1	2058	191	6.0
4	Chandannath-3	2058	194	6.3

For the high hills, Chandannath-3 has the highest productivity but the maturity days are more while Palung-2 has less maturity days with similar productivity.

Source: [3].

Soil Management for lowland rice

The decrease in the average growth rate of rice yield with the increasing use of high-yielding, modern irrigated rice production technology is a common phenomenon in rice-growing areas [15]. Inefficient use of nitrogen fertilizers and negative balances of potassium in irrigated land [15] were claimed as the crucial reasons for rice yield growth decline. Studies have marked the important role of organic matter in rice cultivation [16] including compost that enhances microbial biomass and has a positive effect on rice [17]. The average rice yield can be increase by meliorating efficient soil management practices.

Field experiments were conducted in a rice-growing field site in Chitwan District with 4 treatments levels of land management options i.e. bare mungbean, fallow, mucuna, and maize along with two levels of wheat straw i.e. 0 and 2 Mgha-1 [9]. During dry-to-wet season transition period of rice-wheat system, when fields are left to bare, fallow massive loss of soil nitrogen occurs which can be avoided by returning the wheat straw into the plots itself instead of removal and burning which reduces nitrate leaching losses by temporary N immobilization and N_2O emission [9]. It also preserves the soil moisture, improves the physical property of the soil and microbial activity of the soil [9].

Some suggested soil management practices for farmers

- **Organic fertilizer:** Uniform application of manure, straw, tree leaves, compost and rice husk across the field shortly before land preparation is vital. The recommended quantity is 2 tons per hectare [18].
- **Land preparation:** Plowing under organic fertilizer, weeds and stubbles at the starting of the cropping season (3-4 weeks before transplanting) is suggested. Second plow is best done 10-20 days later which is followed by one harrowing [18].
- **Leveling:** Leveling is done with a shallow water layer in the rice field [18]. Leveling allows the water level to be equally deep in the whole field and no visible mounds of soil above a shallow water layer.
- **Bund repair:** Compact the bunds destroy rat burrows and repair gaps.

Nutrient management

Paddy consumes the highest amount of the total fertilizers sold in Nepal. Every ton of grain produced uptakes 60-80 kg/ha of nutrient [19]. Every harvest drains large amounts of nutrients from the soil. Erosion, imbalanced fertilizer use and no use of micro-nutrients are also responsible for soil nutrient depletion.

A study in Makawanpur district in the year 2000 on Chaite dhan showed that the average doses of N, P_2O_5 and K_2O application by farmers is 99: 22: 38 kg/ha (organic and inorganic sources) [20]. From the total of 85 filed sample analysis, it was found that an average of 30-ton FYM/ha/year was used in rice-wheat rotation which is not enough to sustain yields in the long term [21]. From the trail in Morang district viz. Itahara and Babiyabirta, it was found that highest yield i.e. 5.46 ton ha-1 was obtained from Nutrient Expert recommendation followed by 4.79ton ha-1 from Government Recommendation (100: 30: 30 NPK/hec) and 4.43ton ha-1 from Farmers Practice [2].

The blanket recommendation for lowland rice is 115kg/ha, 75kg/ha and 35kg/ha for N, P_2O_5 and K_2O respectively (Reddy and Reddy) gives 4594kg/ha of grain yield.

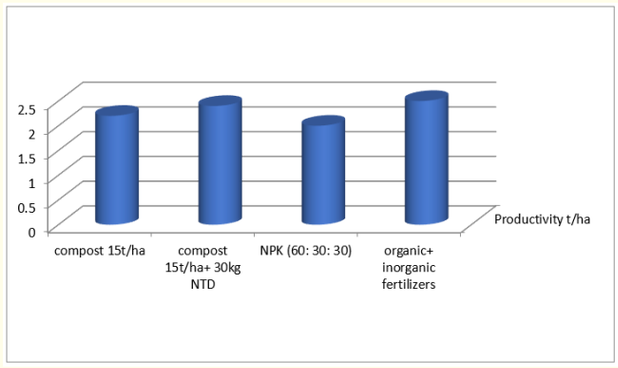

Figure 1: Inorganic and organic manure on rice.

Source: [22].

Modes of application

The Large part of nitrogen applied through ammonium fertilizers (urea) is lost by volatilization. Thus few centimeter deep placements are considered profitable [23,24].

Application of manure and fertilizer during the time of land preparation results in slightly higher yields due to the moderate deep placement of N- fertilizer in the reduced soil horizon.

Timing of fertilizer application

Split application of N-fertilizer reduces nitrogen losses and improves the uptake efficiency of crop [25]. Basal application of half amount, one/fourth at 1st topdressing and remaining one/fourth at 2nd topdressing of N is recommended. Plowing-in FYM should be done about 10-14 days before planting [18].

Sources of nutrients

Farm Yard Manure and Poultry Manure are widely used organic sources of nutrients. Farm Yard Manure application has a positive impact on yields but the poultry manure showed a negative correlation with yields.

Results suggest that rice yields improve through the application of Urea and Muriet of Potash and not when Diammounium Phosphate or Ammonium sulphate is applied [20].

Weed management

Weeds compete with the crop for nutrient, light, and moisture eventually causing the decrease in yield. A weed usually grows faster than rice plant due to their varied composition and thus has an advantage over mono cropped rice. Weed competition for N is severe during the 1st half of the rice-growing season [26].

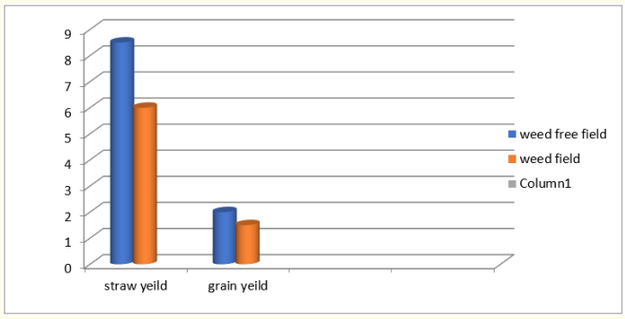

Figure 2: The comparison in a grain and straw yield in a rice field. Source: [10].

The major weed species recorded in the paddy fields of Kirtipur were Cyperus difformis, Echinochloa colona, Cyperus iria, Ageratum conyzoides, Spilanthes iabadicensis, Drymaria diandra, Galinsoga parviflora Cab etc [11,12].

The major cause of maximum yield loss due to weed in lowland rice is the consequences of traditional wedding practices. In Nepal, hand weeding is the most common method to control weeds. It was reported that the days after transplanting to 1st weeding showed a significant negative correlation with yield. The best time for 1st weeding in the rice field is reported to be 25 days after transplanting [20].

Farmers who adopted manual weeding along with herbicide application produced relatively higher yields [20]. Pretilachlor, MCPA-500 and butachlor were the most used pre-emergence herbicide by the farmers of south Aisa [18]. But a research showed that, in Chitwan district, out of 64% farmer; majorities were rejecting to use herbicides and were following the traditional system of wedding. The fear of negative effect in health and environment was the major issue caused due to lack of awareness [27]. Thus it is important to teach the farmers about the proper dose and application method of herbicide to improve the rice yield [28].

Integrated Weed Management (IWM)

It's a matter of fact that a single weed control method is not enough to keep weeds below an economic threshold level. Integrating the use of herbicides with physical, cultural, and biological weed management practices to reduce the reliance on herbicides alone is the best practice.

Pyrazosulfuran ethyl application at 2-3 leaf stage along with hand weeding at 45 days after seeding (DAS) [29] or the application of pyrozosulfuran-ethyl at a week after transplanting (DAT) combined with one supplement hand weeding is effective in managing weeds [30]. IWM together with balanced nutrient management reduces the weed loss and increases grain yield. Application of pendimethalin fb ethoxysulfuron fb and one hand weeding with 120 kg N ha^{-1} results the highest net profit [31]. IWM also involves the use of Herbicide-tolerant species. The BRRI dhan 34 with pre-emergence application of ethoxy-sulfuron was reported to give highest grain yield due to better weed management [32].

Conclusion and Recommendation

Majority of the people in Nepal are engaged in agricultural practices; rice being cultivated by most of them. Thus it is the most important and nutritional cereal crop in Nepal. However, there is a huge yield gap between experimental station and farmer's field. Various research works have been done in different research station which helped in narrowing the gap.

Selection of viable, weed seed free and pathogen-free seed with high germination percentage capacity have high yield potential. For Terai, Hardinath 1 (Chaite Dhan) and Makwanpur 2 is best suited as main season irrigation rice. For hilly region Khumal- 11 (Chaite Dhan) and Rampur Masuli (Main season rice) is recommended. Similarly, Chandannath-3 has highest productivity as cold season rice for Hilly region. For the best soil management, application of 2 tons of organic fertilizers and 2 plowing (1 months and 15 days before transplanting) followed by harrowing, planking and bund repairing is recommended. Basal application of 75kg/ha P_2O_5, 35kg K_2O and split application of 115 Kg of N is suggested as blanket recommendation. Integrated weed management practice i.e. application of Pyrazosulfuran ethyl at 2-3 leaf stage along with one hand weeding at 45 days after seeding along with right cultivation practice is best for weed control in rice field.

Cost and energy-efficient land preparation techniques, integrated nutrient management (INM) system, and conservation agriculture such as the system of rice intensification (SRI) would help in higher yield of rice.

Bibliography

1. Harris D., *et al*. "On-Arm seed priming in semi-arid agriculture: Development and evaluation in maize, rice and chickpea in India using participatory methods". (1999): 15-29.

2. Amgain LP. "Evaluation of different nutrient management practice in yield and growth in rice in Morang district Advances in Plants and Agriculture Research". *Advances in Plants and Agriculture Research* 3.6 (2016).

3. MoAD. Krishi Diary 2075. Lalitpur: Nepal Government 2075.

4. Krishi Diary. Lalitpur: Nepal Government 2073.

5. MOAD. Statistical information on Nepal agriculture. Monitoring, Evaluation and Statistics Division, 2015/16.

6. Panday S., *et al*. "Risk analysis of a rainfed rice production system in Tarlac, Central Luzon, Philippines". *Research Gate* (1999): 225-237.

7. Gami Sanjay L., *et al*. "Long-term changes in yield and soil fertility in a twenty-year rice-wheat experiment in Nepal". (2001): 73-78.

8. Mishra S., *et al*. "Long-term changes in yield and soil fertility in a twenty-year rice-wheat experiment in Nepal". Springer Link 34.1 (2001): 73-78.

9. Pandey KR. "Soil Management for Better Nutrition of Lowland Rice". *Nepal Journals Online* 27 (2006).

10. Bhurer KP., *et al*. "Effect of integrated weed management practices on performance of direct seeded rice". *Agronomy Journal of Nepal* 3 (2013).

11. Manandhar S., *et al*. "Weeds of Paddy Field at Kirtipur, Kathmandu". Research Gate (2010).

12. Manandhar S., *et al*. "Weeds of paddy field at Kirtipur, Kathmandu". Central Department of Botany, Tribhuvan University (2003).

13. V Kuma., *et al*. "Integrated weed management in rice". *Research Gate* (2017).

14. Khatiwada K S and Upreti K H. "Highlights on Rice Varieties of Various Environments of Nepal". Proceedings of the Third SASN Convention. Lalitpur: NARC (2008).

15. Dobermann A., *et al*. "Performance of Site-Specific Nutreint Management in Intensive Rice Crpopping System of Asia". *Better Crops International* 16 (2002).

16. Eneji and A Egrinya Eneji. "Rice growth and nutrient uptake as affected by livestock manure in four Japanese soils". *Journal of Plant Nutrition* 24.2 (2001): 333- 343.

17. Nayak AK., *et al*. "Fertiliser Best Management Practices in Rice for Higher Productivity". *Research gate* (2013).

18. IRRI. "Best Management Practices for rainfed lowland rice in Lao PDR". n.d.

19. NARC. "NARC Annual Report 2055/56 (1998/1999)". Lalitpur: Lalitpur NARC (2000).

20. Thapa M. "Factors affecting fertilizer use efficiency in dry season paddy production in Makawanpur district, mid hill, Nepal". *NEPJOL* 10 (2010).

21. Regmi A P., *et al*. "Yield and Soil Fertility Trends in a 20-Year Rice–Rice–Wheat Experiment in Nepal". *American society of Agronomy* 3 (2002): 857-867.

22. Sherchan DP and Karki KB. "Plant nutrient management for improving crop productivity in Nepal". Kathmandu, Nepal: soil Science Division, Nepal Agricultural Research Council (NARC), n.d.

23. Devkota BP., *et al*. "Rice Science and technology in Nepal". (2000).

24. Pokhrel TP. "Rice development programme in Nepal".

25. Roy RN., *et al*. plant nutrient for food security. Rome : FAO Fertilizer and plant nutrient bulletin (2006).

26. Janiya JD. and K Moody. "Weed control in Transplanted rice grown under different regimes". *Philippines Journal of Weed science* (1982): 28- 35.

27. Himalaya S. "Weed Management in Cereal Production System under Chitwan District, Nepal". *American Open Agriculture Journal 1* (2013): 1-12.

28. Rao AN., *et al*. "Overview of Weeds and Weed Management in Rice of South Asia". *Research gate* (2017): 247-281.

29. Shultana R., *et al*. "Fertilizer and Weed Management Options for Direct Wet Seeded Rice in Dry Season". *Bangladesh Journal Online* 20 (2016).

30. Roslaili A., *et al*. "Determination of Heavy Metals Uptake in Soil and Paddy Plants". *Research gate* (2015).

31. Khandakar M., *et al*. "Development of New Submergence Tolerant Rice Variety for Bangladesh Using Marker-Assisted Backcrossing". *Science Direct* 22 (2015): 16-26.

32. Kabir MS., *et al*. "Rice Vision for Bangladesh: 2050 and Beyond". *Bangladesh Rice Journal* 19 (2019).

Volume 3 Issue 10 October 2019