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# Extent of adoption of recommended cultivation practices of rice (*Oryza sativa*) in the state of Nagaland

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**Abstract**
Nagaland is a small state in the north-eastern part of India where majority of the population depends on agriculture serving as the backbone of its economy. Cereals occupies more than two-third of the total cultivable area in the state where rice, maize and millet being the major variants cultivated. Two methods of cultivation are mainly practiced in the state namely, jhum (shifting cultivation) and terrace cultivation, which jointly makes about 86 percent of the total cultivable area. In the recent years, a high surge in population coupled with high demand of food grains is seen which is of great concern for global food security. Therefore, there ascends a need for sustainable agricultural growth for achieving global food security which can only be unraveled by putting into practice modern and innovative agricultural practices which are sustainable in the long run. A study was carried out in six selected districts of Nagaland with a sample size of 300 respondents to find out the extent of adoption of recommended cultivation practices of rice. Data was collected through personal interview method by administering a structured schedule. Findings revealed that majority (60.67%) of the farmers had moderate level of adoption for recommended cultivation practices of irrigated rice and majority (60.00%) of the respondents had moderate level of adoption for recommended cultivation practices of upland rice.

**Keywords:** adoption, extent of adoption, extension, farmers, recommended cultivation practices

## Introduction
Rice (*Oryza sativa*) also known as the "King of Cereals" is consumed as a staple source of dietary food by over one-third of the world's population. Rice being a tropical crop, flourishes well in hot and humid climate and can be grown both in irrigated and rainfed areas where there is assured rainfall annually, hence it can be grown in kharif as well as rabi seasons. Rice cultivation is of immense significance for food security in Asia, where more than ninety percent of the global rice is produced and consumed (FAO, 2010) [3]. Rice is ranked third in terms of worldwide production after sugarcane and maize according to FAOSTAT, 2017 [14] and China has the highest production contributing 28 percent of the total world's production in rice.

In India, rice serves as a vital staple food crop for majority of the population and has a great significant importance in the economic development and food security of the nation. India stands first globally in terms of area under rice cultivation grown in an area of 43.79 million hectares with a production of 112.91 million tonnes and average yield of 2578 kg per hectare (Directorate of Economics & Statistics, DAC&FW, 2018-19) [2]. In Nagaland, rice is the staple food of the people which occupies almost two-thirds of the total cultivable land and contributes more than 80 percent of the total food production in the state. Rice is mainly cultivated under two farming situations namely, jhum/shifting cultivation (rainfed/upland) and wet rice cultivation/terrace rice cultivation (irrigated). Jhum rice is grown in almost all parts of the state whereas terrace rice is mainly grown in the districts of Dimapur, Kohima, Peren, Phek and Wokha. Wet rice cultivation is mainly practiced in the foothills bordering the state of Assam. The total area under rice cultivation is 206,660 ha with a production of about 505,060 mt (Nagaland Statistical Handbook, 2018). Some of the indigenous varieties of rice grown in Nagaland are Sinsatsu, Henigido, Akatan, Kemenhya, Ngoba, Mikotchuwakelu, Sarang, Moyatsuk, Mamen, Nagaland special etc. (Rice Resource Book Nagaland, 2007) [7].

The total food grain requirement for India by the end of this century would be around 225 million tonnes as estimated by the National Commission of Agriculture (Siddiq *et al.*, 2001) [11]. The global agricultural production will need an increase of 60 percent by the year 2050 to meet the global consumption demand (Alexandratos and Bruinsma, 2012) [1]. According to a

study conducted by Singh (1992) [12], there existed a huge technological gap in adoption of recommended technology in different field crops. Efficient resource management, sustainable agricultural practices and adoption of new innovations and improved farming technologies by the farmers is very crucial in meeting the tests of producing sufficient food crop and achieving food security. Rogers (1962) [8] defined an innovation as an idea, practice or an object that is being perceived as new by an individual or other units of adoption. Adoption of new and improved technologies by farmers has been proven to increase crop productivity thereby solving the problems of food insecurity and enhancing rural livelihoods. Adoption of modern and improved rice varieties by replacing conventional varieties had shown to increase crop productivity (Ghimere *et al.* 2015) [4]. Rogers and Shoemaker (1971) [9] stated adoption as making full use of an innovation as the best course of action available. There is huge advancement and development in agriculture when farmers begin adopting modern agricultural technologies and improved cultivation practices (Ibrahim *et al.*, 2012) [6]. Keeping this in view, the present study was carried out to find out the extent of adoption of recommended cultivation practices of rice by the farmers in the state of Nagaland.

## Methodology

Study was conducted in six districts of Nagaland *viz.*, Dimapur, Kohima, Wokha, Mokokchung, Tuensang and Zunheboto which were selected purposively keeping in view the area and production of rice in these districts. A multistage purposive cum random sampling design was followed for selection of the respondents. Two rural development blocks were selected randomly from each of the districts and two villages were selected randomly from each of these rural development blocks, thus making a total of 24 villages. A total of 300 rice farmers were finally selected as respondents using random sampling technique. The data were collected personally by the researcher through the means of personal interview technique by administering a structured schedule.

## Extent of Adoption

Extent of adoption was operationalised as the degree to which a farmer accepts and adopts recommended cultivation practices of rice. For measuring the extent of adoption of recommended cultivation practices of rice, the recommended package of practices of rice developed by the Department of Agriculture Nagaland was followed. In order to check the relevancy of the recommended package of practices of rice, judges rating was conducted where the developed package of practices was mailed to various scientists, agricultural professors and KVK officials where the experts ranked each practice on the basis of its relevancy *viz*., highly relevant, moderately relevant and not relevant. Based on the responses received, the package of practices of rice (both upland and irrigated) recommended by the Department of Agriculture Nagaland was found to be highly relevant therefore this package of practices was followed to measure the extent of adoption of recommended cultivation practices of rice.

Three adoption categories namely 'full', 'partial' and 'low' with a score of 3, 2 and 1 were given for each of the practices respectively. Frequency and percentage were calculated for each category of responses by the respondents based on the respondent's compliance with recommended practices as 'full adoption' when the respondent fully complied with the recommendations for that practice, 'partial adoption' when the respondent partially complied with the recommendations for that practice and 'no adoption' when the respondent did not comply with the recommendations at all, respectively. The total score obtained for each of the practices by a respondent were summed up and respondents' extent of adoption score were calculated using the formula given below:

Adoption Score = Total adoption score obtained/Maximum obtainable score × 100

**Table 1:** Categorization was done by finding the mean and standard deviation and score range was given as below

| Category | Range (Irrigated Rice) |
|---|---|
| Low ($\bar{X}$-SD) | <61.36 |
| Medium (X ± SD) | 61.36-70.64 |
| High (Above $\bar{X}$+SD) | >70.64 |

| Category | Range (Upland Rice) |
|---|---|
| Low ($\bar{X}$-SD) | <59.85 |
| Medium (X ± SD) | 59.85-73.13 |
| High (Above $\bar{X}$+SD) | >73.13 |

## Results and Discussion

### Extent of adoption in regard to recommended cultivation practices of irrigated rice

**Table 2:** Frequency and percentage of respondents based on their extent of adoption of recommended cultivation practices of irrigated rice

N=150

| Cultivation Practices | | Extent of Adoption | | |
|---|---|---|---|---|
| | | Full | Partial | None |
| Seed treatment | Salt treatment (soaking in salt solution 500gm/12 litres of water | 0(0%) | 60(40%) | 90(60%) |
| | Selection of seeds for germination | 123(82%) | 27(18%) | 0(%) |
| | Seed germination (soaking in fresh water 12-24 hours+incubation in shade for 24 hours) | 0(0%) | 54(18%) | 96 (64%) |
| Seed rate (40-50 kg/ha) | | 33(22%) | 94(62.67%) | 23(15.33%) |
| Nursery | Seed bed preparation (30 DBP) | 104(69.33%) | 29(19.34%) | 17(11.33%) |
| | Seed bed size (1/10$^{th}$ of main field) | 102(68%) | 17(11.33%) | 31(20.67%) |
| | Type of seed bed (Raised/Flat) | 100(66.67%) | 50(33.33%) | 0(0%) |
| | FYM application (@50-100 qtl/ha) | 18(12%) | 32(21.34%) | 100(66.66%) |
| Main Field Preparation | Ploughing | 124(82.67%) | 26(17.33%) | 0(0%) |
| | Puddling (5-10cm standing water) | 100(66.67%) | 50(33.33%) | 0(0%) |
| Manures and Fertilizers | FYM | 18(12%) | 32(21.34%) | 100(66.66%) |
| | NPK (40:30:20) | 0(0%) | 37(24.67%) | 113(75.33%) |
| | Application of Urea (split dose) | 0(0%) | 41(27.33%) | 109(72.67%) |

| | | | | | |
|---|---|---|---|---|---|
| Transplanting | Estimation of leaf stage (25-30 DAS) | | 50(33.33%) | 100(66.67%) | 0(0%) |
| | Depth of transplanting (3-4 cm) | | 38(25.33%) | 93(62%) | 19(12.67%) |
| | Seedlings per hill (2-3 nos.) | | 51(34%) | 99(66%) | 0(0%) |
| | Spacing (20×15cm) | | 45(30%) | 72(48%) | 33(22%) |
| | Gap filling | | 46(30.67%) | 73(48.67%) | 31(20.66%) |
| Water management | Irrigation (Tillering to flowering) | | 124(82.67%) | 26(17.33%) | 0(0%) |
| | Water retention (Panicle initiation to flowering) | | 128(85.33%) | 22(14.67%) | 0(0%) |
| | Draining out (7-15 days before harvest) | | 57(38%) | 93(62%) | 0(0%) |
| Intercultural operations | 1st Weeding (20 DAT) | | 45(30%) | 73(48.67%) | 32(21.33%) |
| | Top dressing of urea (1st) | | 0(0%) | 34(22.67%) | 116(77.33%) |
| | 2nd Weeding (20-30 days after 1st weeding) | | 45(30%) | 73(48.67%) | 32(21.33%) |
| | Top dressing of urea (2nd) | | 0(0%) | 34(22.67%) | 116(77.33%) |
| Integrated pest management | Pest | Control | | | |
| | Rice leaf folder | Wider spacing | 14(9.33%) | 71(47.33%) | 65(43.34%) |
| | Rice caseworm | Clipping off leafs before transplanting | 97(64.67%) | 53(35.33%) | 0(0%) |
| | Stem borer | *Trichogramma*spp. egg parasitoids@50,000/ha 30 DAT | 0(0%) | 37(24.67%) | 113(75.33%) |
| | Biological control | ITKs | 71(47.33%) | 65(43.34%) | 14(9.33%) |
| Harvesting | Withdrawal of water (panicles at dough stage) | | 100(66.67%) | 22(14.67%) | 28(18.66%) |
| | Determination of ripening | | 150(100%) | 0(0%) | 0(0%) |
| | Threshing | | 120(80%) | 0(0%) | 30(20%) |
| | Cleaning | | 120(80%) | 0(0%) | 30(20%) |
| | Storage | | 150(100%) | 0(0%) | 0(0%) |

Table 2 revealed that under seed treatment majority 82 percent of the farmers fully adopted selection of seeds for germination, while 40 percent of them partially adopted salt treatment (soaking in salt solution 500 gm/12 litres of water) and 64 percent did not adopt seed germination (soaking in fresh water 12-24 hours+incubation in shade for 24 hours). Majority of the respondents (62.67 percent) partially adopted seed rate (40-50 kg/ha). For nursery preparation, 69.33 percent of the respondents fully adopted seed bed preparation (30DBP), 68 percent fully adopted seed bed size (1/10th of main field), 66.67 percent fully adopted typed of seed bed (raised/flat) and majority 66.66 percent did not adopt FYM application (@50-100 qtl/ha). 82.67 percent fully adopted ploughing and 66.67 percent fully adopted puddling (5-10 cm standing water) under main field preparation. Under manures and fertilizers, majority of the farmers did not adopt FYM (66.66 percent), NPK (75.33 percent) and application of urea (72.67 percent), respectively. Under transplanting, majority of the farmers partially adopted estimation of leaf stage 25-30 DAS (66.67 percent), depth of transplanting 3-4cm (62 percent), seedlings per hill 2-3 nos (66 percent), spacing 20×15cm (48 percent) and gap filling (48.67 percent). For water management practices, 82.67 percent fully adopted irrigation (tillering to flowering) and 85.33 percent full adopted water retention (panicle initiation to flowering) and 62 percent partially adopted draining out (7-15 days before harvest). Under intercultural operations, 48.67 percent fully adopted 1st weeding (20 DAT) and 2nd weeding (20-30 days after 1st weeding) respectively, and majority i.e., 77.33 percent did not adopt top dressing of urea (1st) and top dressing of urea (2nd) respectively. For Integrated pest management, it was found out that 47.33 percent partially adopted wider spacing for rice leaf folder control, majority (64.67 percent) fully adopted clipping off leafs before transplanting for rice caseworm control, majority (75.33 percent) did not adopt *Trichogramma* spp. for stem borer control and majority (47.33 percent) fully adopted ITKs as biological control. Lastly under harvesting, it was found that majority fully adopted withdrawal of water (66.67 percent), threshing (80 percent), cleaning (80 percent) and storage (100 percent) respectively, while there was full adoption i.e., 100 percent in determination of ripening practices.

**Table 3:** Distribution of respondents based on their extent of adoption in regard to recommended cultivation practices of irrigated rice

N=150

| Adoption Level | Range | Frequency | Percentage | Mean | SD | CV |
|---|---|---|---|---|---|---|
| Low | <61.36 | 24 | 16 | 66.0067 | 4.63 | 7.02 |
| Moderate | 61.36-70.64 | 91 | 60.67 | | | |
| High | >70.64 | 35 | 23.33 | | | |

Table 3 shows that 60.67 percent of the respondents had moderate level of adoption, 23.33 percent had high adoption level and 16 percent had low adoption level.

Table 3 showed that more than half (60.67 percent) of the farmers had moderate rate of adoption of recommended cultivation practices of irrigated rice. This trend is due to farmers still practicing traditional and conventional farming methods. And, also most importantly due to the fact that farmers practice natural and organic way of farming so most of the recommended chemical control for pest and disease management practices are not being followed by the farmers. This finding is similar to that of Salehin *et al.* (2009) [10] and Hasan (2016) [5].

**Extent of adoption of recommended cultivation practices of upland rice**

**Table 4:** Frequency and percentage of respondents based on their extent of adoption of recommended cultivation practices of upland rice
N=150

| Cultivation Practices | | | | Extent Of Adoption | | |
|---|---|---|---|---|---|---|
| | | | | Full | Partial | None |
| Land Preparation | | | Cutting & Slashing (Dec to Feb) | 97(64.67%) | 53(35.33%) | 0(0%) |
| | | | Burning (Feb to March) | 97(64.67%) | 53(35.33%) | 0(0%) |
| | | | Cleaning & collection of plant residue, twigs, branches and roots | 93(62%) | 38(25.33%) | 19(12.67%) |
| | | | Second burning | 53(35.33%) | 97(64.67%) | 0(0%) |
| Soil conservation | | | Mechanical barriers | 38(25.33%) | 93(62%) | 19(12.67%) |
| | | | Live barriers (planting of other crops) | 38(25.33%) | 93(62%) | 19(12.67%) |
| Fertilizers and manures | | | Bio-fertilizers | 75(50%) | 62(41.33%) | 13(8.67%) |
| | | | N based 60 kg/ha | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | | P based 30 kg/ha | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | | K based 30 kg/ha | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | | FYM/Compost (@10,000 kg/ha) | 0(0%) | 30(20%) | 120(80%) |
| Planting of seed | | | Seed rate (80-100 kg/ha) | 33(22%) | 94(62.67%) | 23(15.33%) |
| | | | Seed selection | 33(22%) | 94(62.67%) | 23(15.33%) |
| | | | Seed treatment (*trichoderma* @4-6gm/10ml of water for 1 kg of seed) | 13(8.67%) | 62(41.33%) | 75(50%) |
| | | | Spacing (20cm×10cm R×P) | 45(30%) | 72(48%) | 33(22%) |
| | | | Sowing Methods | 53(35.33%) | 97(64.67%) | 0(0%) |
| Intercultural operations | | | Chemical application (Butachlor @1.5 kg a.i./ha) | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | | Hand weeding (40 DAS) | 53(35.33%) | 97(64.67%) | 0(0%) |
| Insect pest and disease control | IPM | | Clean Cultivation | 53(35.33%) | 97(64.67%) | 0(0%) |
| | | | Healthy seed and timely sowing | 53(35.33%) | 97(64.67%) | 0(0%) |
| | | | Removal/destruction of disease/pest infested plant parts | 53(35.33%) | 97(64.67%) | 0(0%) |
| | | | Soil treatment (trichoderma broadcasting/hand application @1kg/50kg FYM for 1 acre of land | 0(0%) | 45(30%) | 105(70%) |
| | | | Biocontrol agents | 53(35.33%) | 97(64.67%) | 0(0%) |
| | Chemical Control (Insect-pest) | Pest | Control | | | |
| | | Brown plant hopper/green leaf hopper/leaf folder | Spray carbaryl @ 0.75 kg a.i./ha | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | | Spray monocrotophos/phosalone @ 0.5 kg a.i./ha | 0(0%) | 10(6.67%) | 140(93.33%) |
| | | | Apply carbofuran 3G @ 0.75 kg a.i./ha | 0(0%) | 5(3.33%) | 145(96.67%) |
| | | | Apply Phorate 10G @1.25 kg a.i./ha | 0(0%) | 29(19.33%) | 121(80.67%) |
| | | Disease | Control | | | |
| | | Blast | Spray carbendazim 50 WP OR tricyclazole | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | | 75 WP @ 0.6 g/1 liter of water | 0(0%) | 5(3.33%) | 145(96.67%) |
| | | Sheath blight | Spray carbendazim 50 WP @ 1g/litre | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | | Spray propicanozole 25 EC @ 0.1% | 0(0%) | 10(6.67%) | 140(93.33%) |
| | | | Spray Validamycin 3L @ 2ml/litre of water | 0(0%) | 29(19.33%) | 121(80.67%) |
| | | | Reduce or delay top dressing of nitrogen fertilizer | 0(0%) | 26(17.33%) | 124(82.67%) |
| | | False Smut | Spray carbendazim 50 WP @ 1g/litre | 0(0%) | 26(17.33%) | 124(82.67%) |
| Harvesting | | | Estimation of flowering days (25-30 DAF) | 50(33.33%) | 100(66.67%) | 0(0%) |
| | | | Estimation of moisture content (20-25%) | 65(43.33%) | 85(56.67%) | 0(0%) |
| Storage | | | Threshing | 102(68%) | 0(0%) | 48(32%) |
| | | | Drying | 150(100%) | 0(0%) | 0(0%) |

Table 4 reveals that under land preparation practices, majority i.e., 64.67 percent of the respondents fully adopted cutting and slashing (Dec to Feb) and burning (Feb to March) respectively, whereas 62 percent fully adopted cleaning and collection of plants/twigs etc. and 64.67 percent partially adopted second burning. Under soil conservation practices, majority (62 percent) of the farmers partially adopted mechanical barriers and live barriers, respectively. Under fertilizers and manures, 50 percent of the farmers fully adopted bio-fertilizers, 80 percent of them did not adopt FYM/Compost (@10,000 kg/ha), and majority (82.67 percent) of them did not adopt N (60 kg/ha), P (30 kg/a) and K (30 kg/ha) respectively. For planting of seeds, 62.67 percent partially adopted seed rate (80-100 kg/ha) and seed selection respectively, 41.33 percent partially adopted seed treatment (Trichoderma @4-6gm/10 ml of water for 1 kg of seed), 48 percent partially adopted spacing (20cm x10 cm RxP) and 64.67 percent partially adopted sowing methods. Under intercultural operations, 82.67 percent of them did not adopt chemical application (Butachlor @1.5 kg a.i./ha) and majority (64.67 percent) partially adopted hand weeding (40 DAS). For insect pest and disease control, 64.67 percent of them partially adopted clean cultivation, healthy seed and timely sowing, removal/destruction of disease/pest infested plant parts and biocontrol agents respectively, and 30 percent partially adopted soil treatment (trichodrma broadcasting/hand application @1 kg/50kg FYM for 1 acre of land) under IPM practices. Majority of the farmers did not adopt control for brown plant hopper/green leaf hopper/leaf folder *viz*., spray carbaryl @ 0.75 kg a.i./ha (82.67 percent), spray monocrotophos/phosalone @ 0.5 kg a.i./ha (93.33 percent), apply carbofuran 3G @ 0.75 kg a.i./ha (96.67 percent), apply Phorate 10G @1.25 kg a.i./ha (80.67 percent) respectively under chemical control of insect and pest. Also, majority of the respondents did not adopt chemical control for blast disease i.e., spray carbendazim 50 WP OR tricyclazole (82.67 percent) and 75 WP @ 0.6 g/1 liter of water (96.67 percent) respectively. Majority did not adopt chemical control

of sheath blight disease i.e., spray carbendazim 50 WP @ 1g/litre (82.67 percent), spray propicanozole 25 EC @ 0.1% (93.33 percent), spray Validamycin 3L @ 2ml/litre of water (80.67 percent) and reduce or delay top dressing of nitrogen fertilizer (82.67 percent) respectively. Also, majority (82.67 percent) did not adopt chemical control of false smut disease i.e., spray carbendazim 50 WP @ 1g/litre. In harvesting practices, majority (66.67 percent) of the respondents partially adopted estimation of flowering days (25-30 DAF), 56.66 percent partially adopted estimation of moisture content (20-25%) and lastly under storage practices, 68 percent of them fully adopted threshing and 100 percent of them fully adopted drying practices, respectively.

**Table 5:** Distribution of respondents based on their extent of adoption in regard to recommended cultivation practices of upland rice

N=150

| Adoption Level | Range | Frequency | Percentage | Mean | SD | CV |
|---|---|---|---|---|---|---|
| Low | <59.85 | 27 | 18 | 66.49 | 6.63 | 9.98 |
| Moderate | 59.85-73.13 | 90 | 60 | | | |
| High | >73.13 | 33 | 22 | | | |

Table 5 shows that 60 percent of the respondents have moderate level of adoption, 22 percent had high adoption level and 18 percent had low adoption level.

Table 5 showed that the adoption rate of cultivation practices of rice by the farmers in the study area is moderate. This trend is due to farmers still practicing traditional and conventional farming methods. And, also most importantly due to the fact that farmers practice natural and organic way of farming so most of the recommended chemical control for pest and disease management practices are not being followed by the farmers. This finding is similar to that of Salehin *et al.* (2009) [10] and Hasan (2016) [5].

## Conclusion

Majority of the respondents (60.67 percent) had moderate level of adoption, 23.33 percent had high adoption level and 16 percent had low level of adoption of recommended cultivation practices of irrigated rice. Whereas, more than half (60 percent) of the respondents had moderate level of adoption followed by 22 percent having high adoption level and 18% having low adoption level of recommended cultivation practices of upland rice. The findings revealed that majority of the respondents had medium level of adoption for both recommended practices of irrigated and upland rice. Having a wider knowledge and understanding of a technology and the various barriers to technology adoption is the most important criterion for strategic and effective dissemination of farm technologies. Rogers (1962) [8] gave five attributes of a good technology which are, simplicity, compatibility, trialability, relative advantage and Observability. Therefore, for a new idea or technology to be adopted by the farmers, the new technology should be easy and simple to understand and adopt by the farmers. Also, the new technology should be relevant and consistent with the farming practices adopted by the farmers, the farmer should be able to test and experiment on it and see whether the new technology will be beneficial for him in the long run. Extension plays a significant role in technology adoption by the farmers. Access to various extension services and programs should be strengthened and various capacity building programs through training programs and on-farm demonstrations, awareness programs etc. should be conducted frequently so that farmers get the opportunity to learn, understand and adopt new and improved technologies. Extension being a forerunner in agricultural technology dissemination, government should invest more in providing more avenues for growth and development in extension and research.

## Conflict of Interest

The authors of the paper declare no conflict of interest.

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