

RESEARCH ARTICLE

Survey of Rice Farmers in Andhra Pradesh, India - Farming Practices Posing a Threat to Biodiversity

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ABSTRACT

The survey was conducted in the Southern zone of Andhra Pradesh in 9 Agricultural sub-divisions (blocks), 22 mandals, and 3 districts to study the farmer's attitudes and knowledge on rice farming practices. Data was collected from 210 farmers from 50 villages by face-to-face interview using an Open Data Tool Kit-based survey developed by CSISA through a preliminary survey and deployed on smartphones. Excessive usage of agrochemicals, accounting for about 70-75%, a significant threat to insect biodiversity. The use of agrochemicals discriminately is being proposed to protect biodiversity.

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INTRODUCTION

Rice is the primary cereal crop in Andhra Pradesh, holding first place in consumption. Each person gets 700 calories per day through rice consumption (Sangeetha and Baskar, 2015). Rice is an important staple food crop for more than 60 per cent of the world's population and contributes about 40 per cent of the total food grain production (Ganesh *et al.* 2023). India contributes about 22 per cent of world rice production, ranking in second place after China, followed by Indonesia with 8 per cent, Bangladesh with 7 per cent, and Vietnam with 6 per cent). India occupies an area of 4366 lakh ha and produces 11,887 lakh tonnes with an average productivity of 2,722 kg/ha (Anonymous, 2023). Andhra Pradesh is called the Rice Bowl of India.

To be sustainable, more productive and functional biological diversity is important and needs to be maintained through integrated farming systems.

Biodiversity conservation is the key factor to achieve sustainability. Farming practices like mono cropping, excessive and indiscriminate use of fertilizers and pesticides, poor management practices, burning of residues, and deployment of natural resources are dangerous to biodiversity.

Farmers are the custodians of biodiversity, and their management and farming practices can help estimate a farming system's health and diversity

Hence, the survey was conducted with farmers of Annamayya, Tirupati, and Chittoor districts in the Southern zone of Andhra Pradesh to identify the farming practices being followed by farmers that are potential threats to biodiversity.

METHODOLOGY

The survey was conducted in the Southern zone of Andhra Pradesh in 2 Agricultural sub divisions (blocks) and 5 mandals in Annamayya district; 3 Agricultural sub divisions (blocks) and 8 mandals

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in Tirupati district, and 4 Agricultural sub divisions (blocks) and 9 mandals in Chittoor district (Table 1 and Fig. 1). Data was collected from 210 farmers from 50 villages by face-to-face interview using Open Data Tool Kit based survey developed by CSISA through preliminary survey and deployed in smart phones. Interviews were conducted with randomly selected farmers of the villages with cooperation from the Department of Agriculture. Interviews were conducted at the shared place where all the farmers meet during evening times and in rice fields. Interview time was about 60 90 minutes. The interview gave a clear-cut picture of farming practices in rice being followed by farmers. Questions were asked to each farmer in the local language (Telugu) and translated to English, and they completed the survey. The GPS locations of each farmer's field were also recorded.

Data analysis: Data obtained from farmers through a questionnaire was entered into MS Excel, and frequencies and percentages were calculated.

RESULTS AND DISCUSSION

Educational level, gender, and age group of the farmers:

Educational level:

Out of 210 farmers surveyed, 26.7% of the farmers were illiterate, 31.9% of the farmers had attained education upto primary school, 17.6% of the farmers completed matriculation, 9.0% of the farmers attained

senior secondary education, 11.9% had graduated with degree and 2.9% were mastered (Table 2 and Fig. 2). Importance of agriculture in India is visible as well educated were also involved in farming.

Even though a few farmers had attained formal education, most (58.6%) of the surveyed farmers were illiterate or had an average literacy rate. Due to a low literacy rate, communication is the primary barrier to the farmers, which makes it very difficult to make policies or to conduct training on pest management through integrated practices. Training can be organized in the local language to prevent the communication barrier between the farmer and the resource person. Heong *et al.*, (2008) reported the same trend in terms of education levels of rice farmers. Most of the farmers had elementary education, and the average years spent in school by the farmers was 8 years, an equivalent level of 2nd year high school before quitting (Florencia G. Palis, 2020)

Age group of the farmers:

Out of 210 farmers surveyed, young farmers (< 30 years) are contributing 9.5%, middle-aged farmers (30-45 years) are contributing up to 36.2%, and old-aged farmers (>45 years) are contributing 54.3% (Table 2). It is visible that most (90.5%) of the farmers were above 30 years, which indicates that young people below 30 years are less engaged in Agriculture and middle-aged and older people are more engaged in Agriculture. Muhammad Asghar *et al.* (2013)

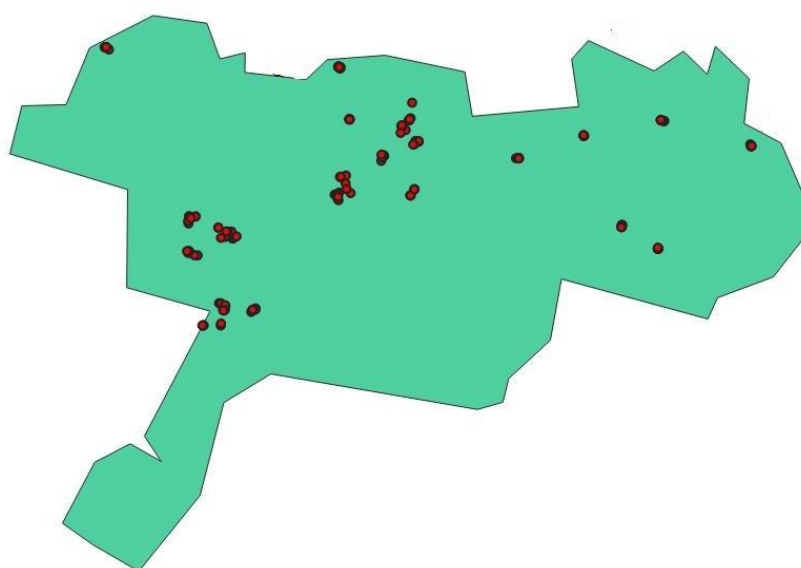


Fig.1 GPS map of surveyed farms

Table 1. Details of the villages surveyed:

District	Agri. Subdivision (Blocks)	Mandal	Villages
Annamayya	Piler	Chinnagottigalli	Kumaripalli,Thippireddigaripalli, Kodekambhamvaripalli
		Rompicherla	Rompicherla, Bestapalli, Kuripartivaripalli, Vankireddigaripalli
		Sodum	SM Palli, Sodum, Nadigadda, Bayareddigaripalli, Bandaravaripalli, Yerrathivaripalli
		Kambhamvaripalli	Garnimitta
Tirupati	Madanapalli	Mulakalacheruvu	Mulakalacheruvu
	Tirupati	Chandragiri	Mittapalem
		Pakala	Vallivedu, Pakala
		Pulicherla	Yerravandlapalli, Mangalapalli, Ayyavandlapalli
		Renigunta	Venkatapuram
	Srikalahasti	BN Kandriga	Kallivettu
		Srikalahasti	Vedam, Inagalur
		Thottambedu	Thottambedu
	Satyavedu	Varadaiahpalem	Santhavellore
Chittoor	Punganur	Chowdepalli	Chintamakulapalli, Agasthapalli, Diguwapalli, Etavakili, chinagornigunta, peddagornigunta, P L Kothuru, Kateperi
		Gangavaram	Gandrajupalli, Dandapalle
		Peddapanjani	Appinapalle, Gutturu, Chinnappareddipalli, Sankaralayapeta
	Puttur	Karvetinagar	Gopichettipalli
		Narayanavanam	Thiruvatyam
		VeduruKuppam	VedurKuppam
		Nindra	Elakatur
	Nagari	Srinagarajapuram	Pullur
	Puganur	Punganur	Etavakili, Prasannayagaripalli, Kuravuru, Nethigutlapalli

Table 2. Age group, gender, and educational qualification of farmers in surveyed villages

Gender of the farmers			Educational levels of the farmers			Age groups of the farmers		
Gender	Frequency	Percentage	Education level	Frequency	Percentage	Age groups	Frequency	Percentage
Female	25	11.9	Illiterate	56	26.7	Young (Up to 30 years)	20	9.5
Male	185	88.1	Primary (Upto6 th grade)	67	31.9	Middle-aged (30-45 years)	76	36.2
			Matriculation	37	17.6	Old (>45 years)	114	54.3
			Senior secondary (Up to19 12 th)	19	9.0			
			Bachelors	25	11.9			
			Masters	6	2.9			

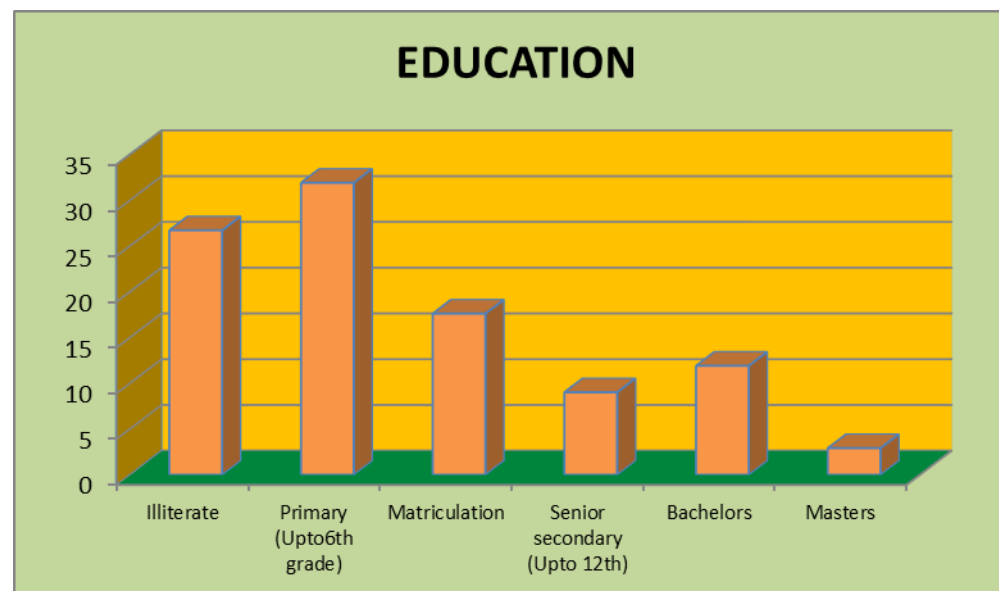


Fig. 2 Distribution of farmers based on their education

reported that most of the farmers are above the age of 30. The overall percentage of farmers aged 30 years and below was 2.3%: 0.7% in Iloilo, 2.0% in Agusan, and 3.6% in Isabela (Florescia G. Palis, 2020).

Results indicate that the young generation is less involved in agriculture. Older people who are unable to do farming were involved, which shows an increasing trend with age.

Gender of the farmers:

11.9% of the farmers were female, and 88.1% were male out of 210 surveyed farmers (Table 2). It shows women's interest in agriculture. Results indicate that mostly male farmers were actively involved in agriculture, and there is a need to increase the involvement of women also, as labour scarcity is the major problem in farming in India.

Land Holding and Area under Rice:

Most farmers (82.8%) have land holdings of < 2 ha, out of which 35.7% were marginal farmers with a land holding size of < 1 ha, and 47.1% were small farmers with an area of 1-2 ha. 14.8% of the farmers

belonged to semi medium category with 2-4 ha of land holding size and 2.4% were medium farmers having land of 4-10 ha (Table 3 and Fig. 3). Out of the total 210 farmers 71.0% of the farmers are growing rice in < 1 ha, 27.1% of the farmers are growing in 1-2 ha and 1.9% in 2-4 ha. It is evident that semi-medium and medium farmers are diverting lands to other crops, along with rice. These results conform with a statement of Mironga (2005)

Results showed that no large farmers were present in these districts. Small and marginal farmers use more chemicals for pest and disease management than medium and large farmers as they fear losing yields and income due to pest damage. Hence, vigorous use of fertilizers and pesticides can be observed in farmers' fields, which is a significant threat to Biodiversity.

Area of different varieties and source of seed& fertilizers:

It is shown that farmers are growing a wide range of varieties in their fields (Table 4 and Fig. 4), but 70.0 % of the farmers are purchasing seed from private input dealers (Table 5). As farmers are relying on private

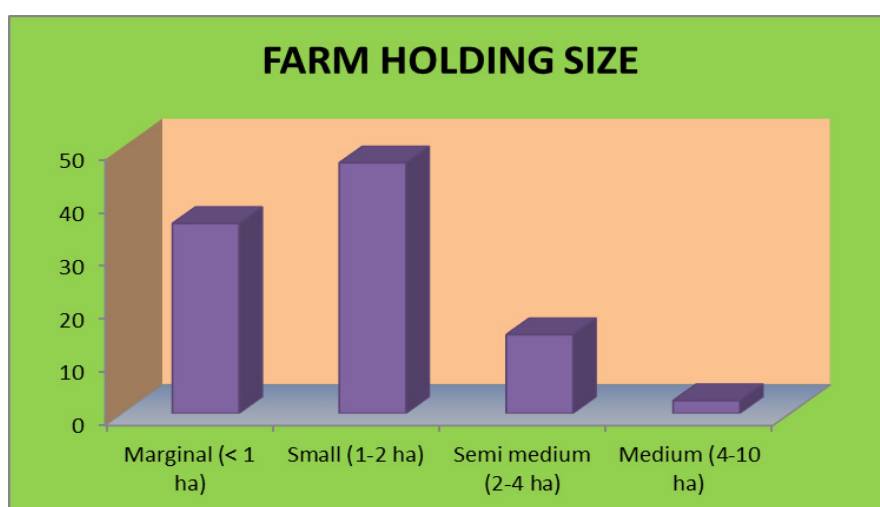


Fig. 3 Distribution of farmers based on their farm holding size

Table 3. Land holding and Area cultivated under Rice of the surveyed farmers

Land holding			Area cultivated under Rice		
Farm size	Frequency	Percentage	Area	Frequency	Percentage
Marginal (< 1 ha)	75	35.7	< 1 ha	149	71.0
Small (1-2 ha)	99	47.1	1-2 ha	57	27.1
Semi medium (2-4 ha)	31	14.8	2-4 ha	4	1.9
Medium (4-10 ha)	5	2.4			

dealers, seed admixture is the major problem being faced by farmers, and due to a lack of quality seed, the crop is more prone to pests and diseases, which increases the usage of pesticides and poses a threat to biodiversity.

75.2% of the farmers purchase fertilizers from private input dealers (Table 5). Due to a lack of quality fertilizers, farmers are dumping excess fertilizers into their fields to improve yields, which results in deteriorating plant and soil health due to toxicity, and also, excess nutrients improve succulence of the crop, which makes the crop susceptible to pests and diseases. Due to this, farmers need to use more

pesticides to control pests and diseases, which affects biodiversity.

Crop establishment methods and Ecology of rice:

95% of the farmers established rice through random transplantation in puddle fields manually followed by line transplanting (7%) and direct broadcasting (3%) (Table 6). Farmers in these areas lack mechanization, and crop establishment is labor-consuming. Even though there is scope for the usage of machinery, transplanting and sowing are done manually. In manual transplantation, more seedlings were sown per hill compared to machine transplantation. As the

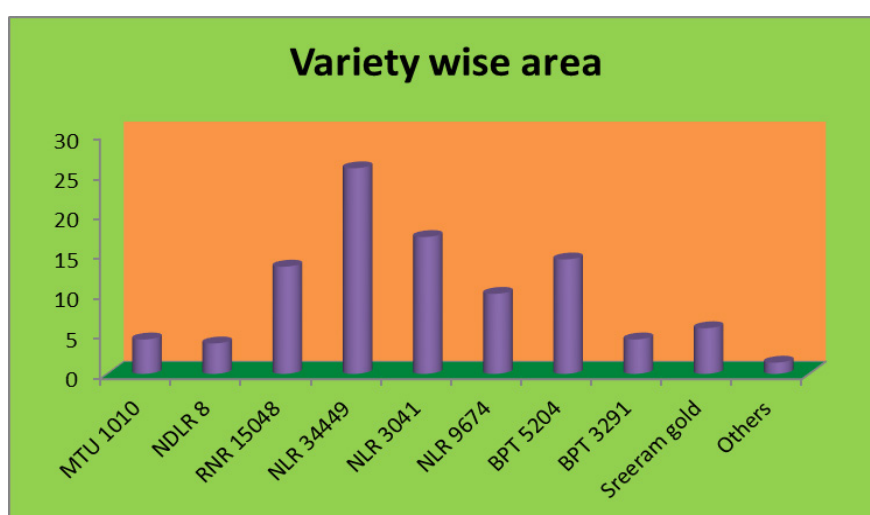


Fig. 4. Distribution of different rice varieties

Table 4. Area sown under different rice varieties

Variety	MTU 1010	NDLR 8	RNR 15048	NLR 34449	NLR 3041	NLR 9674	BPT 5204	BPT 3291	Sreeram gold	Others
Frequency	9	8	28	54	36	21	30	9	12	3
Percentage	4.3	3.8	13.4	25.7	17.1	10.0	14.3	4.3	5.7	1.4

Table 5. Source of seed and fertilizers

Source of seed			Source of fertilizers		
Source	Frequency	Percentage	Source	Frequency	Percentage
Cooperative	1	0.5	Agriculture department	52	24.8
Government institutes	28	13.3	Input dealers	158	75.2
Neighbors/Relatives	14	6.7			
Private dealer	147	70.0			
Self saved	20	9.5			

plant population increases, to supply nutrients and manage pests and diseases, excess fertilizers and pesticides are being used. Most of the rice is cultivated in medium lands, accounting for 80% of the total rice cultivated area, followed by low land (17%), and only 3% of the total area is from upland (Table 6). The tractor-operated rice transplanter increases the labor productivity by 32.22 times and saves about 66.69% average transplanting cost compared to manual transplanting (Neeraj Kumar Singh *et al.*, 2023).

Cropping systems:

Fig 5 shows that 42% of the farmers follow the Rice-Rice-Rice cropping system. 14% of the farmers are following vegetables-rice-vegetables, 12% of the farmers are following pulses-rice-fallow, other 12% of the farmers are following cereals-rice-fallow, 6% groundnut-rice-vegetables, 5% groundnut-rice-groundnut, 5% vegetables-rice-groundnut, 4% vegetables-rice-rice. Growing the same crop without crop rotation adversely affects biodiversity by acting as a host to pests and diseases. Crop rotation with pulses/vegetables should be followed to reduce pest & disease attack and protect soil health. Growing the same crop requires more pesticides compared to crop rotation. Crop rotation is a traditional and practical way

for managing agroecosystem biodiversity by enhancing soil health, repressing pests and disease outbreaks (Barbieri *et al.*, 2019)

Indiscriminate use of chemical fertilizers:

51.9% of the farmers use farm yard manure, which is a perfect practice, and only 30.0% of the farmers use green manures (Table 7). FYM and green manures are abundantly available in these areas, but due to some circumstances, farmers are not interested in using organic manures completely, which can replace 25% of the chemical fertilizers.

Among 210 farmers, 6.2% are not using urea, 52.9% are using 50 kg urea, 31.9% are using 51-100kg urea, and 9.0% are using 101-150 kg urea. 62.4% of the farmers do not use DAP, and 37.6% use 50 kg DAP. 100% of the farmers are using up to 50 kg MOP. DAP and Urea supply nitrogen, but farmers use fertilizers to get higher yields for higher profits. Excess nitrogen is not only toxic to crops but also attracts pests & diseases and severe weed growth, which leads to higher usage of pesticides. The average yield of excessive nitrogen application (345 kg N ha⁻¹) was 2.68–6.31% lower than that of appropriate nitrogen application (270 kg N ha⁻¹) (Can Zhao *et al.*, 2022).

Table 6. Crop establishment methods and Ecology

Establishment method	Frequency	Percentage	Ecology	Frequency	Percentage
Direct Broadcasting	3	2	Upland	7	3
Random transplanting in puddle fields manually	202	95	Medium land	168	80
Line transplanting in puddle fields manually	7	3	Low land	35	17

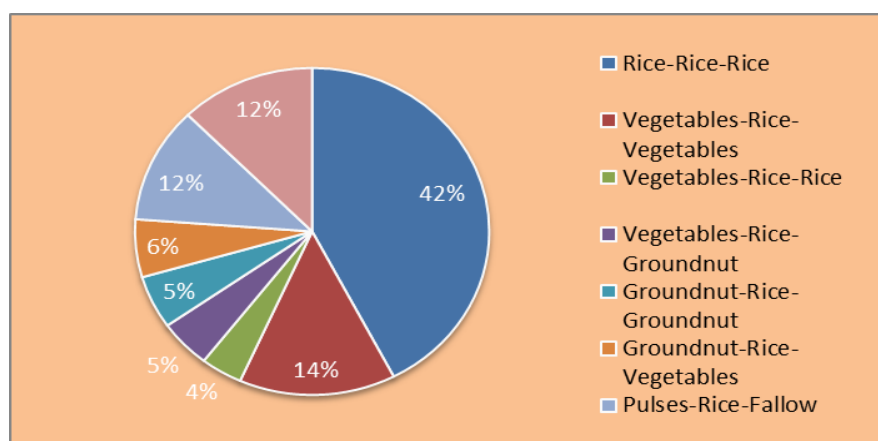


Fig 5. Cropping systems of surveyed farmers

Table 7. Organic manures/Inorganic Fertilizers used by farmers (Basal + Top dressing)

Amount of fertilizers (Kg)	FYM		Green manure		Urea		DAP		MOP	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Organic manures										
Not using	101	48.1	147	70.0	-	-	-	-	-	-
Using	109	51.9	63	30.0	-	-	-	-	-	-
In organic fertilizers										
No use	-	-	-	-	13	6.2	131	62.4	0	0.0
0-50	-	-	-	-	111	52.9	79	37.6	210	100
51-100	-	-	-	-	67	31.9	0	0.0	0	0.0
101-150	-	-	-	-	19	9.0	0	0.0	0	0.0

Table 8. Irrigation source and no. of irrigations

Source	Source of irrigation		No. of irrigations		
	Frequency	Percentage	Number	Frequency	Percentage
Canals	28	13.3	5	2	1.0
Deep tube wells	124	59.0	6-10	134	63.8
Shallow tube wells	9	4.3	11-15	74	35.2
Canals + Deep tube wells	27	12.9			
Canals + shallow tube wells	22	10.5			

Source of irrigation and number of irrigations:

Table 8 shows that 59.0% of the farmers get irrigation water from deep tube wells, followed by canals (13.3%), canals + deep tube wells (12.9%), canals + shallow tube wells (10.5%), and shallow tube wells (4.3%). Most of the farmers (63.8%) irrigate 6-10 times, followed by 11-15 times (35.2%) and 5 times (1.0%).

Results clearly showed that farmers are giving more irrigations than required. However, rice is a water-loving crop, excess water causes root rot, sheath blight, and attracts insects like BPH, which leads to excess usage of pesticides. Haonan Qi *et al.*, 2022 reported that alternate wet and dry irrigation had a significant yield-increasing effect (average 2.57% increase)

Pesticide application:

Most of the farmers use pesticides once. 69.5% of the farmers use herbicides once, 84.8% use insecticides once, and 82.4% use fungicides once (Table 9). 2.4% of the farmers are using herbicides twice. Only a few farmers, i.e., less than 30% of the farmers, are not using any pesticides. Farmers must spray pesticides to control pests, but proper usage is also essential. Farmers are using wrong pesticides, places, doses, and times as they are unaware of the symptoms of nutrient deficiencies, toxicity, disease damage, pest damage, and the type of weeds. Using the wrong insecticide/fungicide may not control

the insect/disease, but using the wrong herbicide at the wrong dose and time is harmful to the crop. The estimated economic loss due to excess use of nitrogenous and plant protection chemicals for the TBP area was Rs. 8618.4 lakhs (Patil *et al.*, 2014).

Table 10 clearly shows that 74.8% of the farmers use pesticides by consulting private dealers. As some of the unauthorized dealers are unaware of the pests' farmers end up using growth regulators, fungicides and insecticides at once to control only one kind of pest. It not only increases cultivation cost but also causes environmental, soil, and water pollution, and is also hazardous to human health. So farmers should be aware of the ETL levels of pests and the type of weeds before going for chemical sprays, or they need to consult an agriculture specialist. Bandong *et al.* (2002) reported that most farmers rely on pesticides, leading to overuse.

The average grain yield was 6.7 t/ha, ranging from 3.5-10.0 t/ha in surveyed farmers' fields (Fig. 6). 7.1% farmers got yields ranging from 3.5-4.5 t/ha, 22.9% farmers recorded yield ranging from 4.5-5.5 t/ha, 19.0% of farmers got yields between 5.5-6.5 t/ha, 22.9% farmers recorded yield ranging from 6.5-7.5 t/ha, 5.3% got yields ranging between 7.5-8.5, 13.8% farmers recorded yield range of 8.5-9.5 t/ha and 9.0% farmers recorded yield range between 9.5-10.5 t/ha. Variation in yield was due to different crop

Table 9. Average number of pesticide applications

Particulars	Once		Two times		Not used	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Herbicides	146	69.5	5	2.4	59	28.1
Insecticides	178	84.8	0	0.0	32	15.2
Fungicides	173	82.4	0	0.0	37	17.6

Table 10. Practices of pesticide application

Particulars	Frequency	Percentage
Not using	2	1.0
After observing pests/diseases without consulting anyone	23	11.0
After observing the damage without consulting anyone	15	7.1
After observing by consulting the agriculture department or university scientists	2	1.0
After observing by consulting private dealers	157	74.8
Following neighbor	11	5.2

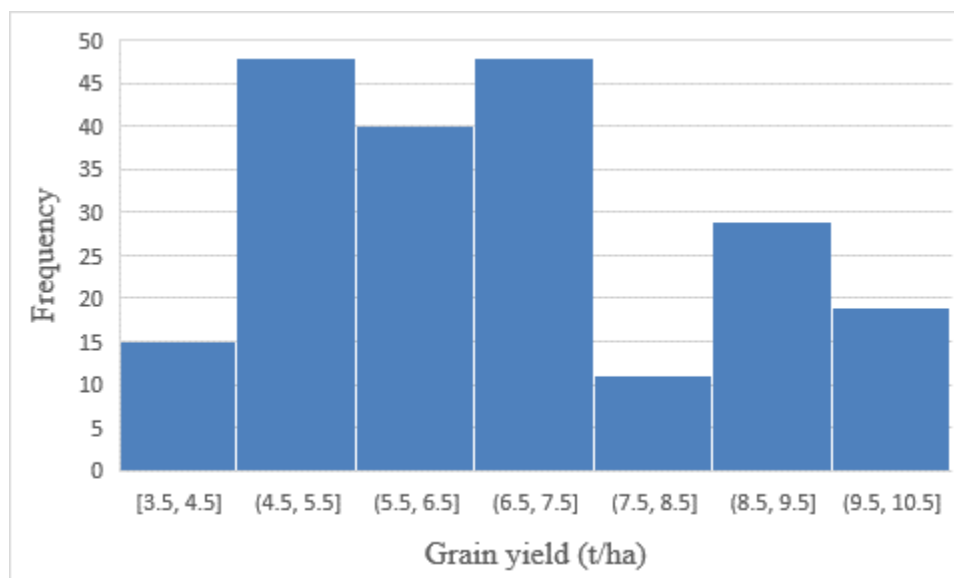


Fig 6. Histogram of rice yield

establishment methods, time of sowings/plantings, varieties, and other management practices.

Variety-wise average grain yield of rice is depicted in Fig.7. NLR 34449 recorded higher yields (8.1 t/ha), followed by NLR 9674 (7.0 t), NLR 3041 (6.7 t). NDLR 8 recorded the lowest yield of 5.6 t/ha. The survey was conducted in the southern zone, and varieties released from the southern zone are performing well in these areas compared to other varieties.

Among crop establishment methods, manual transplanting methods recorded higher yields compared to direct seeding. Yield of 7.0 t/ha was obtained manually in the Random transplanting method in puddle fields, followed by 6.6 t in the line

transplanting method. Direct seeding recorded a yield of 4.0 t/ha. Among different planting times, June transplanted Paddy recorded the highest yield of 8 t/ha, and yield reduction was observed with a delay in transplanting rice from July to August. Among different weed control methods, one-time herbicide usage and one-time hand weeding got a higher yield of 8.2 t/ha, followed by 2 hand weedings (6.3 t/ha). The lowest yield of 5.8 t/ha was obtained in 1 hand-weeded fields (Table 11).

Results indicate that proper time of plating and management practices give higher yields. Sowing in May or early June to transplant in correct time, transplanting the crop instead of direct sowing and appropriate pesticide usage will reduce cost and

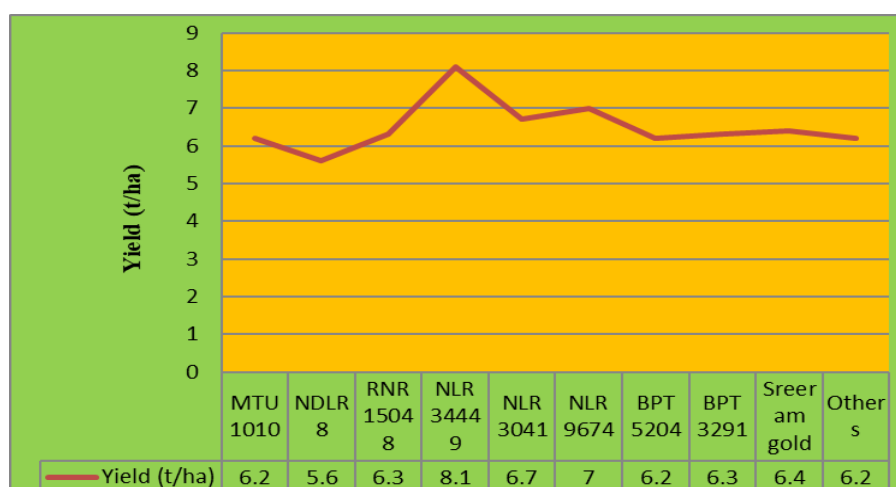


Fig 7. Average yield of different varieties

Table 11. Yield of rice as influenced by different management practices

	Grain yield (t/ha)
Crop establishment methods	
Direct Broadcasting	4.0
Random transplanting in puddle fields manually	7.0
Line transplanting in puddle fields manually	6.6
Time of transplanting	
June	8.0
July	6.1
August	5.9
Weed control methods	
1 hand weeding	5.8
2 hands weddings	6.3
1 hand weeding + one time herbicide application	8.2

Table 12. Residue burning in the field

Particulars	Frequency	Percentage
Residue burning	5	2.4
Ploughing in the field	51	24.3
Sale	10	4.8
Feed for cattle	144	68.6

give higher yields. Improper management practices not only increase cost but also pose a threat to biodiversity. The maximum yield potential of a rice crop is usually achieved when the crop is exposed to the most appropriate temperature range, which can be controlled by sowing at the proper time (A R Patel, 2019).

Burning of rice straw:

Many farmers (68.6%) are using rice straw to feed cattle. 24.3% are ploughing in the field, 4.8% are selling rice straw, and only 2.4% are burning (Table 12). Even though straw is being collected and used for different purposes, stubble in the rice field is sometimes burned, which causes pollution. The farmers were feeding rice straw to their cattle either after collecting from fields or by grazing animals in harvested fields (Praweenwong et al., 2010)

CONCLUSIONS

The socio-economic condition of the farmers is deplorable. Farmers are not taking advice from experts while purchasing seed or other agrochemicals. Excess fertilizer and pesticide usage are observed, which is not at all suitable for the environment, soil, and also hazardous to human health. Sowing the same crop

every year and season, subjecting it to more pests and diseases, which in turn increases the usage of pesticides.

Farmers should follow the recommendations given by the experts in selecting varieties, using fertilizers and other agrochemicals. It reduces the cost of cultivation and pollution and gives good yields. Farmers should be well-trained on good agricultural practices to reduce the usage of agrochemicals. The use of agrochemicals discriminately is being proposed to protect biodiversity.

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