

Original Research Article

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## Effect of Different Harvesting and Threshing Methods on Seed Quality of Rice Varieties

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### ABSTRACT

#### Keywords

Rice, Harvesting, Threshing, Mechanical damage, Germination, Seedling vigour.

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An experiment was conducted to find out the influence of harvesting and threshing methods on seed quality of rice varieties viz., CR1009 Sub1, IW Ponni and CO51. The treatments are manual harvesting and manual threshing, manual harvesting and mechanical threshing (axial flow thresher) and combine harvesting (with pneumatic wheel). The harvested and threshed rice seeds were evaluated in terms of moisture content, kernel to husk ratio, hardness and mechanical damage based on physical, physiological and chemical methods. The results revealed that rice seed harvested and threshed through manual method or by combine harvesting method with minimum mechanical damage did not affect the germination and seedling vigour irrespective of the varieties studied.

### Introduction

Rice is the main food of the largest population of the World. About 90 % rice in the world is grown and consumed by the population of the Asian countries which constitute 58 % population of the World. In India, it occupies an area of 43.75 mha with a production of 85.3 million tonnes. The average productivity of rice is 2.13 t/ha in India, which is far below the world's average of 3.7 t/ha (Jagtap *et al.*, 2012). In India, the demand for rice will increase because of population growth and an expected diet change. The country has to produce about 130 million tonnes of rice by 2025 to feed the ever growing population. Meeting the food demand of a rapidly increasing global population is emerging as a

big challenge to mankind. The population is expected to grow to 9.1 billion by the year 2050, and about 70% extra food production will be required to feed them (Godfray *et al.*, 2010; Hodges *et al.*, 2011; Parfitt *et al.*, 2010). The majority of this population rise is expected to be attributed mainly from developing countries, several of which are already facing issues of hunger and food insecurity.

Increasing urbanization, climate change and land use for non-food crop production, will intensify these concerns of increasing food demands. In the last few decades, most of the countries have focused on improving their

agricultural production, land use, and population control as their policies to cope with this increasing food demand. Farm mechanization in our country has the obvious advantages of reduction in human drudgery, reduction in cost of cultivation, enhancement of working efficiency and timeliness of working.

Different types of farm operations starting from land preparation to seed storage are involved in agriculture. All these operations are labour intensive and time consuming when carried out with manual labourers. Failure to complete farm operations within the stipulated time may sharply reduce the crop production. In India improved agricultural tools and equipment are estimated to contribute food production by saving in seeds (15-20%), fertilizers (15-20%), time (20-30%), and labour (20-30%) and also by increase in cropping intensity (5-20%), and productivity (10-15%). In developing countries, greater than 40% of the losses occur during postharvest and processing operations (Gustavsson *et al.*, 2011). The combine harvester, or simply combine, is a machine that "combines" the tasks of harvesting, threshing and cleaning the harvested produce. The desired result is the seed or grain (of rice, corn, soybean, black gram etc.).

For seed crops, dry weather during ripening and harvesting is essential. Harvesting rice crop using combine has been widely accepted and practiced to overcome the peak demand of farm labourers and to minimise the field losses incurred during manual harvesting. However, for reasons not known our farmers hardly use combines for rice as seed crop. With the available limited information and to verify the myth, the study was initiated to assess the effect of different harvesting and threshing methods on seed quality of rice varieties.

## Materials and Methods

An experiment was conducted at the Department of Applied Sciences and Engineering, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Kumulur, Tiruchirappalli, Tamil Nadu during *kharif*, 2016 to find out the influence of harvesting and threshing methods on seed quality of rice varieties viz., CR1009 Sub1, IW Ponni and CO51. The treatments are manual harvesting and manual threshing (T<sub>1</sub>), manual harvesting and mechanical threshing (axial flow thresher) (T<sub>2</sub>) and combine harvesting (with pneumatic wheel) (T<sub>3</sub>).

The rice crops were harvested at physiological maturity stage. The seed moisture content (%) and kernel to husk ratio were estimated at the time of harvest. The harvested and threshed seeds were sun dried to reduce the seed moisture content to 12 per cent (w.b) and processed using cleaner cum grader. The hardness tests (Viswanathan *et al.*, 1997) were conducted using hardness tester. The seeds were placed in their natural resting position on the pressing disc. In this method a screwable rod was used to press the seed against the disc while a pointer attached to the pressing disc denotes the pressure applied in kgf. As soon as the seed cracks, a red pointer moving along with the black one stays at the cracking pressure point, while the black one moves back to the resting position.

The pressure in kgf denoted by the red pointer is taken as the hardness measurement of the seeds. The mean is expressed in kgf. Treatment wise mechanical damage was evaluated through physical, physiological and chemical methods. In the physical, method visual observations were made for splits or cracks in seed coat under illumination board. The percentage of seed coat damaged seeds was calculated using the following formula:

Seed coat damaged seeds (g)  
Seed coat  
Damaged seed % = ----- X 100  
Total quantity of cleaned seed (g)

In chemical method the mechanical damage to seed was detected by ferric chloride test (Agrawal, 1995). Twenty per cent Ferric Chloride (FeCl<sub>3</sub>) solution was prepared by adding four parts of water to one part of solution FeCl<sub>3</sub>. Five replications with 100 seeds of each treatment were soaked in 20 % solution of FeCl<sub>3</sub> for fifteen minutes. Enough FeCl<sub>3</sub> solution was poured to immerse the seeds in the solution. Separation of black stained seeds was started within five minutes and completed within fifteen minutes after soaking. By counting the number of black stained seeds, mechanical damage percentage was recorded. In physiological method, germination was tested by roll towel method (ISTA, 2011) using the 4 x 100 seeds. The experiment was laid in completely randomized block design. Fourteen days after sowing, percent germination was computed. Ten seedlings from each replication were randomly taken and root and shoot lengths were measured. The seedlings were then oven dried at 85°C for 24 hours and weighed. (Abdul – Baki and Anderson, 1973)

Vigour Index = Percentage germination x  
Total seedling length (cm).

The results were subjected to statistical analysis for significant difference ( $p \leq 0.05$ ) as per Panse and Sukhatme (1995). Percentage values were transformed using arc sine values prior to statistical analysis.

## Results and Discussion

The results on influence of harvesting and threshing methods on seed quality of rice varieties revealed that the moisture content of the seed at the time of harvesting were

22.50%, 19.72% and 19.51% in CO51, CR1009 Sub 1 and improved white ponni, respectively (Table 1). Among the varieties, there was no significant difference in the percent of husk and kernel to the whole seed and its ratio (Table 2). The difference in the hardness of seeds of three varieties was not statistically significant and also it was not significantly affected by different harvesting methods (Table 3, Fig. 2). In general, seed harvested and threshed by manual method recorded higher hardness when compared to manual harvesting and mechanical threshing and combine irrespective of the varieties studied. This might probably due to manual method of threshing seeds escaped from mechanical damage, whereas mechanical threshing and combine harvesting, impact by objects or rotating drums, or impact by cylinders or rotors with rasp bars, peg teeth, or wire loops. As threshing becomes more mechanized, the rasp bar type of cylinders or rotors usually rotate with tight clearance inside a concave grate that allows a shearing action and quick release of threshed kernels to fall away from the cylinder or rotor. As the kernels are released the threshed plant material is carried away, tangential to the cylinder direction of rotation.

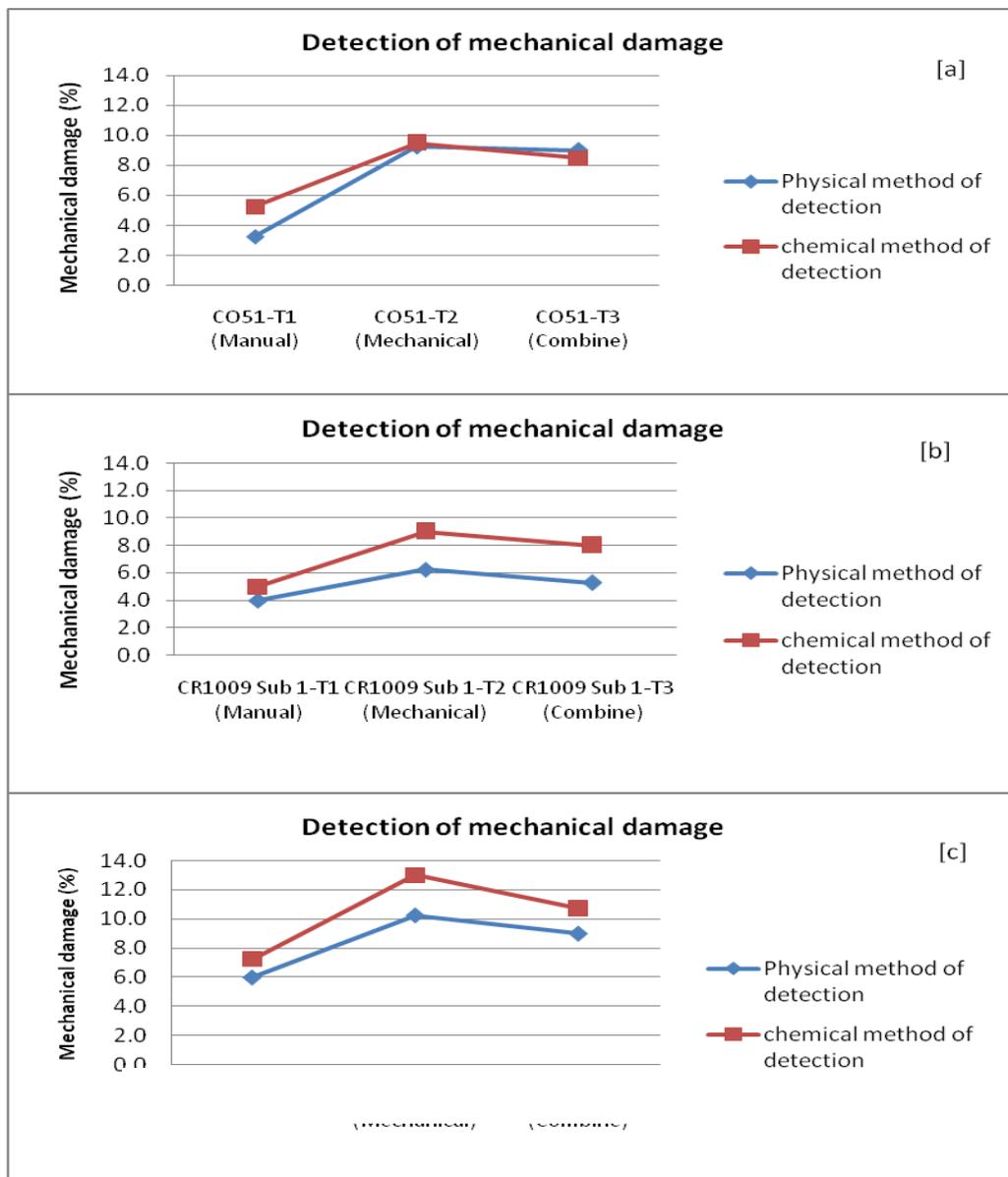
In mechanical threshing, the rotational speed which creates impact on kernels and the clearance between the cylinder and rotor to the concave are critical settings. Many studies had emphasized that moisture content during harvest decides the intensity of mechanical injury caused by the harvester and processing equipment in paddy (Arvinder *et al.*, 2001; Alizadeh and Khodabakhshpour, 2010).

Significant difference in percentage of mechanical injury were observed among the varieties and in seeds harvested by different harvesting methods. Among the varieties, physical observations shows the highest mechanical injury in improved white ponni

(8.4%) and CO51 (7.2%), which was on par with each other and the lowest mechanical damage was observed in CR1009 Sub 1 (5.2%), while chemical method of detection revealed that maximum mechanical injury in improved white ponni (10.3%), while the lowest was in CR1009 Sub 1 (7.3%) and CO51 (7.8%). Among the different harvesting and threshing methods, physical observations shows the highest mechanical injury in

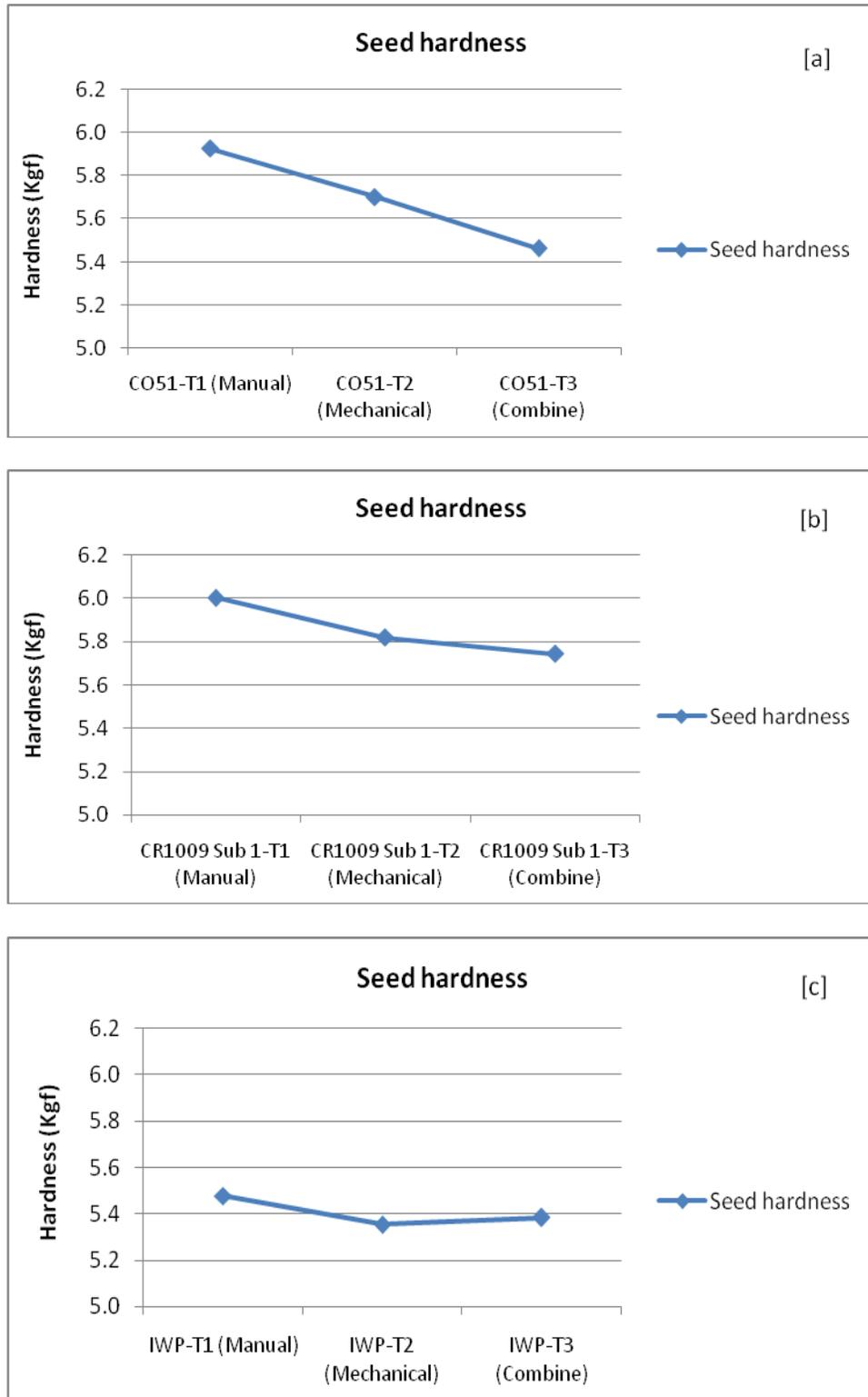
manual harvesting and mechanical threshing (8.6%) followed by combine harvesting (7.8%) which was on par with each other, while manual harvesting and threshing registered the lowest injury of 4.4%. Similar trend in mechanical injury due to different harvesting methods was also observed in chemical method of detection (Table 4, Fig. 1).

**Fig.1** Effect of different harvesting and threshing methods on mechanical damage (%) of Different rice varieties



Note: [a]-CO51, [b] - CR1009 Sub 1 and [c]-Improved white ponni

**Fig.2** Effect of different harvesting and threshing methods on hardness test (Kgf) of different rice varieties



Note: [a]-CO51, [b] - CR1009 Sub 1 and [c]-Improved white ponni

**Table.1** Moisture content (%) of different rice varieties during harvesting

Rice varieties	Moisture content (%)
CO51 (V <sub>1</sub> )	22.50 (28.32)
CR1009 Sub 1 (V <sub>2</sub> )	19.72 (26.36)
Improved white ponni (V <sub>3</sub> )	19.51 (26.21)
Mean	20.58 (26.96)
SEd	0.263
CD (P=0.05)	0.547

(Figures in parenthesis indicate arcsine value)

**Table.2** Kernel and Husk percentage and their ratio for rice varieties

Rice variety	Husk (%)	Kernel (%)	Kernel to husk ratio
CO51 (V <sub>1</sub> )	21.96(27.95)	78.04 (62.06)	3.55
CR1009 Sub 1 (V <sub>2</sub> )	22.72 (28.47)	77.28 (61.54)	3.41
Improved white ponni (V <sub>3</sub> )	21.35 (27.52)	78.65 (62.48)	3.68
Mean	22.01 (27.98)	77.99 (62.02)	3.54
SEd	0.440	0.440	0.119
CD (P=0.05)	NS	NS	NS

(Figures in parenthesis indicate arcsine value)

**Table.3** Effect of different harvesting and threshing methods on Seed hardness for rice varieties tested

Varieties (V)	T1	T2	T3	Mean
CO51 (V1)	5.926	5.701	5.463	5.697
CR1009 Sub 1 (V2)	6.003	5.820	5.743	5.855
Improved white ponni (V3)	5.478	5.354	5.383	5.405
Mean	5.802	5.625	5.529	5.652
	V	T	V×T	
SEd	0.147	0.147	0.255	
CD (P = 0.05)	NS	NS	NS	

T1-Manual harvesting and threshing, T2-Manual harvesting and mechanical threshing, T3-Combine harvesting

**Table.4** Effect of different harvesting and threshing methods on mechanical damage (%) of Different rice varieties

Treatment (T)	Mechanical damage (%)							
	Physical method				Chemical method			
Varieties (V)	T1	T2	T3	Mean	T1	T2	T3	Mean
CO51 (V1)	3.3 (10.18)	9.3 (17.65)	9.0 (17.30)	7.2 (15.04)	5.3 (13.15)	9.5 (17.92)	8.5 (16.86)	7.8 (15.98)
CR1009 Sub 1 (V2)	4.0 (11.35)	6.3 (14.43)	5.3 (13.20)	5.2 (12.99)	5.0 (12.89)	9.0 (17.45)	8.0 (16.27)	7.3 (15.54)
Improved White Ponni(V3)	6.0 (14.02)	10.3 (18.60)	9.0 (17.38)	8.4 (16.67)	7.3 (15.53)	13.0 (21.10)	10.8 (19.10)	10.3 (18.58)
Mean	4.4 (11.85)	8.6 (16.89)	7.8 (15.96)	6.9 (14.90)	5.8 (13.86)	10.5 (18.82)	9.1 (17.41)	8.5 (16.70)
	V	T	V×T		V	T	V×T	
SEd	0.886	0.886	1.535		0.722	0.722	1.251	
CD (P=0.05)	1.818	1.818	NS		1.482	1.482	NS	

(Figures in parenthesis indicate arcsine value)

T1-Manual harvesting and threshing, T2-Manual harvesting and mechanical threshing, T3-Combine harvesting

**Table.5** Effect of different harvesting and threshing methods on Germination (%), root length and Shoot length of different rice varieties

Treatment (T) Varieties (V)	Germination (%)				Root length (cm)				Shoot length (cm)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
CO51 (V1)	96 (79.41)	93 (75.06)	95 (78.19)	94.7 (87.11)	23.5	22.1	22.4	22.7	10.3	9.8	9.8	10.0
CR1009 Sub 1 (V2)	94 (76.96)	90 (72.05)	91 (72.88)	91.7 (74.18)	25.3	23.4	24.3	24.3	12.1	11.3	11.5	11.6
Improved White Ponni(V3)	97 (80.64)	91 (72.88)	94 (77.87)	94.0 (77.87)	23.8	22.7	22.9	23.1	10.4	9.9	10.0	10.1
Mean	95.7 (80.26)	91.3 (73.90)	93.3 (76.00)	93.4 (76.72)	24.2	22.7	23.2	23.4	10.9	10.3	10.4	10.6
	V	T	V×T		V	T	V×T		V	T	V×T	
SEd	2.764	2.764	4.787		0.500	0.500	0.867		0.330	0.330	0.572	
CD (P=0.05)	NS	NS	NS		NS	NS	NS		0.677	NS	NS	

(Figures in parenthesis indicate arcsine value)

T1-Manual harvesting and threshing, T2-Manual harvesting and mechanical threshing, T3-Combine harvesting

**Table.6** Effect of different harvesting and threshing methods on dry matter production and seedling vigour of different rice varieties

Treatment (T) Varieties (V)	DMP(g/10 seedling)				Vigour index			
	T1	T2	T3	Mean	T1	T2	T3	Mean
CO51 (V1)	0.079	0.078	0.079	0.079	3251	2965	3057	3091
CR1009 Sub 1 (V2)	0.107	0.105	0.106	0.106	3519	3121	3255	3298
Improved White Ponni(V3)	0.081	0.077	0.078	0.079	3317	2967	3087	3124
Mean	0.089	0.087	0.088	0.088	3362	3017	3133	3171
	V	T	V×T		V	T	V×T	
SEd	0.002	0.002	0.004		87.19	87.19	151.02	
CD (P=0.05)	0.004	NS	NS		NS	178.90	NS	

T1-Manual harvesting and threshing, T2-Manual harvesting and mechanical threshing, T3-Combine harvesting

Results on physiological quality of seeds obtained by different harvesting and threshing methods in three varieties revealed that seed germination and root length of all the three varieties were not significantly influenced by the different harvesting methods in spite of significant changes in the shoot length and dry matter production among the varieties. However, vigour index values were significantly influenced by different harvesting and threshing methods. The maximum vigour index was recorded in seeds harvested and threshed manually (3362) followed by combine harvester (3133) while the minimum was observed in seeds obtained through manual harvesting and mechanical threshing (3017) (Tables 5 and 6). The above results clearly indicated that the highest mechanical injury caused by manual harvesting and mechanical threshing. Yadav and Sharma (1998) observed that the cracked seed coats reflect poor quality of seeds as they may be prone to imbibitional and pathogenic injury during storage. Hence, reduction in vigour of the seeds may result in reduction in the shelf life of the seeds. Therefore, proper adjustment of threshing machines is necessary to minimize the mechanical damage and to obtain quality seeds. In any seed production activity, achieving high level of germination is the prime objective. As per the minimum seed certification standards, rice seed should pass 80 per cent germination. In the present study, irrespective of harvesting and threshing methods of rice varieties a germination level of above 80 per cent (91-97 per cent germination) was registered.

This study clearly indicates that the paddy crop harvested and threshed either manually or by combine was with minimum mechanical damage without out impairing the germination and seedling vigour. Both harvesting and pre-cleaning operations are done simultaneously using combine harvester. Since combine harvester is designed for

paddy harvest, necessary adjustment have to be done to the threshing drum and concave to increase the threshing efficiency and to minimize breakage. When paddy thresher or combine is used, care must be taken to thoroughly check the machinery for previous crop remnants to avoid seed admixture. Finally it could be concluded that manual/combine harvester is recommended for harvesting of rice varieties viz., CR1009 Sub1, IW Ponni and CO51 without impairing the germination and seedling vigour.

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