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On-farm validation of improved seed production methods for upland rice

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ABSTRACT

Two components of seed (rice) production system viz.; seed harvest and storage were validated through on-farm trials with an objective to fine-tune existing and/or improved techniques based on location specific requirements. Panicle harvested (PH) seed was compared with that of traditional bulk harvest (BH) using two improved upland rice varieties (Vandana and Anjali) during 2004-05. Despite average yield increase of 6.1% (Anjali) to 14.9% (Vandana) the PH method was not accepted by the farmers due to higher labour requirement of the operation. So, a less labour intensive method of 'crop area selection' was evaluated and demonstrated during 2006-07 using the variety Anjali. Improved seeds resulted in significant grain yield increase to the tune of 12.5% (2.36 t ha^{-1}) to 20.3% (2.31 t ha^{-1}) in on-farm and research station trials, respectively. Storage systems used by the farmers (locally termed as; Hatwa/Kothi/Gaza/Tokri) were comparable to hermetically sealed storage systems for seed viability, germination and seedling vigor. Based on the results and farmers' opinion, the 'crop area selection' method followed by traditional method of seed storage was recommended for adoption. However, the farmers were advised to repeat panicle harvest once in 5-6 years, to regain seed purity.

Key words: *Improved, seed production method, storage, upland rice*

Upland rice is predominantly grown under rainfed, fragile ecosystems by the resource poor, small and marginal farmers practising mostly subsistence farming. Though majority of uplands could be diversified with more suitable crops, rice continues to be cultivated in uplands to meet food requirement during lean months following monsoons. Farmers usually reserve a part of the produce for seed and occasionally exchange seeds with other farmers leading to poor seed quality in terms of seed health and purity over the years. Attempts were made in the present investigation to introduce improved seed production methods to facilitate seed production and maintenance by farmers without resorting to external sources for seed supply.

MATERIALS AND METHODS

Farmers' seed lots of panicle harvest (PH; harvesting of selected, healthy panicles and separate threshing; Mele *et al*., 2005) and bulk harvest (BH; traditional method of keeping a portion of produce as seed) were sown in villages following the farmers' method of cultivation during wet seasons (June to October) of 2004 (village Amnari of district. Hazaribag) and 2005 (village Kuchu of Ranchi). The seeds (PH and BH) used for the on-farm trials conducted during 2004 and 2005 were harvested by the co-operating, trained farmers from their own fields grown, respectively during wet seasons of 2003 (village Amnari) and 2004 (village Kuchu). The seeds were stored (November to June next year) in air tight container under farmers' condition. Farmers' cultivation method included sowing 120 kg ha^{-1} of seeds by broadcasting followed by leveling and one manual weeding at 25-30 days after sowing (DAS). The crop was fertilized with 30.0 kg P_2O_5 and 11.25 kg N ha^{-1} as basal, and top-dressed twice each with 20 kg N ha^{-1} at 25-30 DAS (just after weeding) and 45-50 DAS. Two improved upland rice varieties *viz*., Vandana (V) and Anjali (A) of 90-95 days duration were used. The two seed lots (PH and BH) of the two varieties (4 treatments; PH-V, BH-V, PH-A and BH-A) were sown in 10 replications (farmers) in each village (villages Amnari in 2004 and Kuchu in 2005) following RCB statistical design. Plant vigor (height, tiller density), yield attributing characters (panicle characteristics) and grain yield were recorded.

Based on the results and feed back of farmers, the panicle harvest method was simplified and modified 'improved seed' (IS) production method (crop area

selection method) was formulated through farmers' participation by location specific, need based fine tuning of the method described by Mele *et al*., (2005). The improved seeds (variety Anjali) were produced in two villages (Lupung and Rigatoli of District Chatra) during wet season of 2005 following the 'crop area selection' method for testing their performances in 2006 in the same villages. Its performance was compared with bulk seed (BS) in the wet season of 2006 in the research station as researcher managed trial for demonstration to visiting farmers and in villages under farmers' participatory, on-farm trials for validation. Both IS and BS were stored under traditional systems prior to sowing. The 'crop area selection' method of improved seed (IS) production involved; (1) selecting and demarcating portion of crop area with uniform, and healthiest crop stand, (2) weeding and rouging twice (at maximum tillering and maturity), (3) separately harvesting, threshing, cleaning, sun-drying of grains from the area, (4) storage under existing system. The trials were laid out in RCB design with 10 replications in each site. Similar data were recorded and were compared using paired "t" test.

The existing seed storage systems followed by the upland rice farmers were surveyed in villages during the summer months prior to the wet season of 2004 and were documented. Seeds (variety- Anjali) stored in traditional storage structures and air-tight plastic containers were sampled separately from two villages in 2004 and from three villages in 2005 during June 2nd week and were tested for seed quality (moisture content, viability, microbial contamination and cleanliness) under house hold storage conditions through farmers' training and participation. Seed moisture was recorded *in situ* by non-destructive method using grain moisture meter (Multi-grain Moisture Tester; make-DICKEY-John, USA), viability and contaminations (Benoit *et al*., 1970; Chidambaram *et al*., 1973) were recorded using the standard blotter test (Doyer, 1938) and cleanliness was examined manually. Seed cleanliness was worked out using the formula; "% clean seed = [{Total no. of seeds - (no. of discolored + spotted + unfilled + partially-filled + insect-damaged + varietal mixture seeds)/total no.} x 100]".

The seed lots were also sown in the same villages with 10 replications (each cooperating farmers sown with two seed lots were considered as replications) of minimum 200 m^2 plot size in each village in both the years. Farmers' method of cultivation was followed. Seedling vigor, plant height, panicle characteristics and grain yield were recorded and data were analyzed using paired "t" test.

RESULTS AND DISCUSION

In the wet seasons of 2004 and 2005 panicle harvested (PH) seeds of two varieties (Vandana and Anjali) were compared with that of bulk harvest. Seed health testing of the seed lots prior to wet season (WS) of 2004 revealed that overall microbial contamination was less and viability was 93% in BH seed as compared to 100% in PH seeds across variety. The seed lots had comparatively higher infection level by storage fungi (*Aspergillus* and *Penicillium*) with more infection in BH seeds (37.4%) than that of PH seeds (24.5%) in two varieties (average). Pathogenic fungal (species of *Alternaria, Helminthosporium, Pyricularia, Rynchosporium, Tilletia* and *Ustilaginoidae*) and unidentified bacterial (slimes) contaminations were observed in very few seeds. Storage insect infestation was also negligible. Slightly reduced viability in BH seeds was attributed to the higher saprophytic growth of storage fungi which, nevertheless, was within the acceptable range. The results thus revealed that harvest method did not have much influence on seed contaminations and viability which are more dependent on storage conditions. This also indicated that the farmers' existing seed storage systems were quiet satisfactory in the target ecosystem.

In the on-farm trials conducted during wet seasons of 2004 and 2005, PH seeds had increased tiller and panicle number and improved grain filling (filled grain number and panicle wt.). These led to average yield increase of 6.1 to 14.9% in Anjali and Vandana respectively the across years (Fig.1). Comparatively less moisture stress during reproductive phase (coinciding with 34 to 37th meteorological weeks (Fig. 2) in 2005 resulted in higher grain yields of Anjali over that of 2004. It also predisposed Vandana to neck blast (caused by *Pyricularia oryzae*) leading to drastic yield reduction. PH seeds, however, significantly improved filled grain number in Anjali and panicle weight in both the varieties in 2005 (Fig. 1) with figurative increase in 2004 and showed better yield advantage under neck blast stress in moderately susceptible variety Vandana with 11% yield increase (2005, WS). Varietal mixture was negligible in plots sown with both PH and

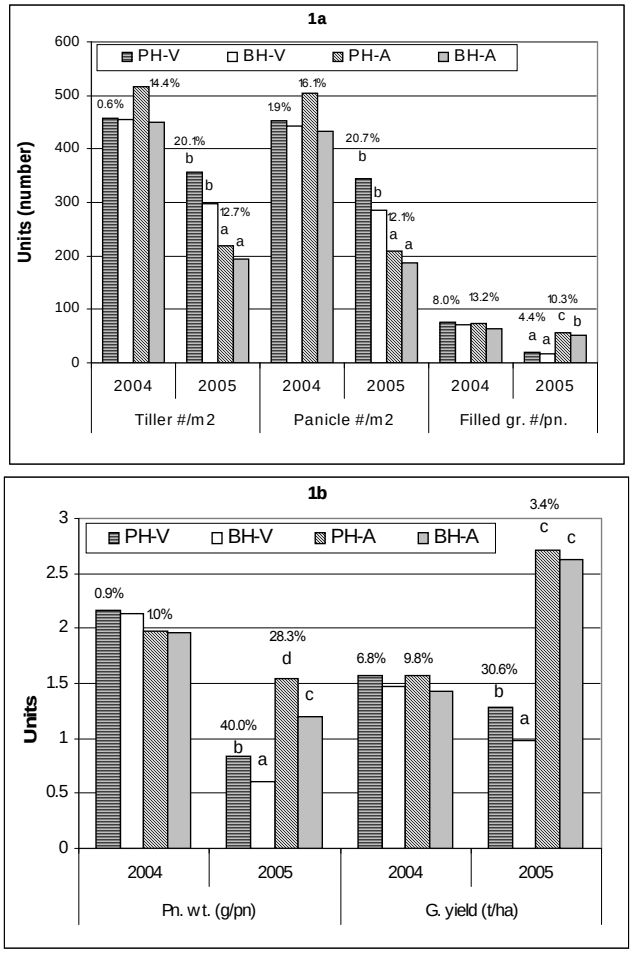

Fig. 1. Influence of panicle harvested (PH) seed on plant growth, yield attributes & grain yield of upland rice varieties in villages (on-farm trial), wet seasons 2004 & 2005 (values of bars under each parameter/year (2005) designated by different letters are significantly different at 5% level of probability by DMRT; 2004=ns; bars designated by percentage data are % gain in PH over respective BH

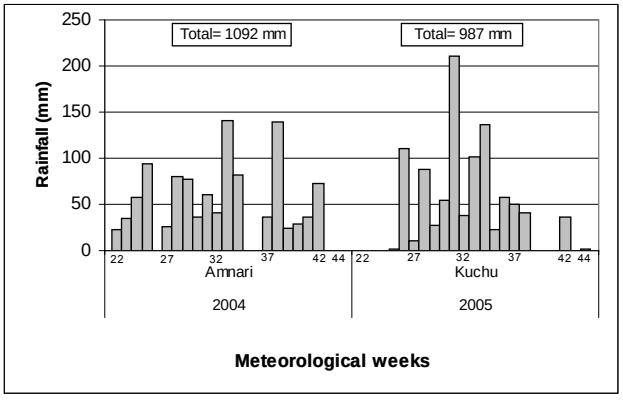

Fig. 2. Rainfall pattern (weekly total) of two on-farm trial sites (villages) during wet seasons (meteorological weeks: 22 to 44; June to October) of 2004 and 2005

BH seeds in both the villages owing to the fact that the only traditional upland rice variety (*Gora*) was completely replaced by the improved varieties (Vandana and Anjali) during previous 2 years and no other varieties of similar duration were grown even in lower topography which reduced the chances of seed mixtures during threshing and storing. The increase in tiller number and yield attributing characters in PH seeds was due to improved seed health.

Despite yield increase, farmers did not accept the panicle harvest method owing to its labour intensiveness and not commensurating with return. For this reason, a less labor intensive 'crop area selection' method (producing seed lot designated as improved seed; IS) was formulated through farmers' participation and was compared with bulk harvest (bulk seed; BS) in 2006 both under researcher managed trial in the research station and farmers' participatory on-farm trial in two villages. The farmers disliked the variety Vandana due to neck blast susceptibility and only Anjali was used in 2006 wet season.

Average viability and moisture content of the seeds (IS and BS) stored in the villages following traditional storage systems, ranged between 84.3 to 87.0% and 9.6 to 10.3%, respectively, prior to sowing (June, 2006). This supported the earlier observations that traditional storage systems of the farmers in this plateau region were good enough.

Among the parameters observed in CRURRS farm, initial plant population, aerial biomass at maturity, panicle length, panicle weight, filled grain weight and grain yield showed statistically significant increase with improved seeds over bulk seeds (Fig. 3). Other parameters, like plant height, both total and ear-bearing tiller density, filled grain number panicle^{-1}, 1000 grain weight, however, showed figurative increase in improved seeds over bulk one. The improved seeds, despite having similar viability, enhanced seedling vigor as indicated by 12.8% higher plant population and 36.4% more aerial biomass production over bulk seeds. Superior plant vigor resulted into better grain filling (12.9 % more filled grain weight) and 11.9% higher panicle weight leading to 20.3% higher grain yield (2.31 t ha^{-1}). In the villages (Lupung and Rigatoli), improved seed (IS) produced by 'crop area selection' method was compared with bulk seed (BS) under farmers' participatory, technology dissemination mode. IS resulted into significantly better grain filling which was

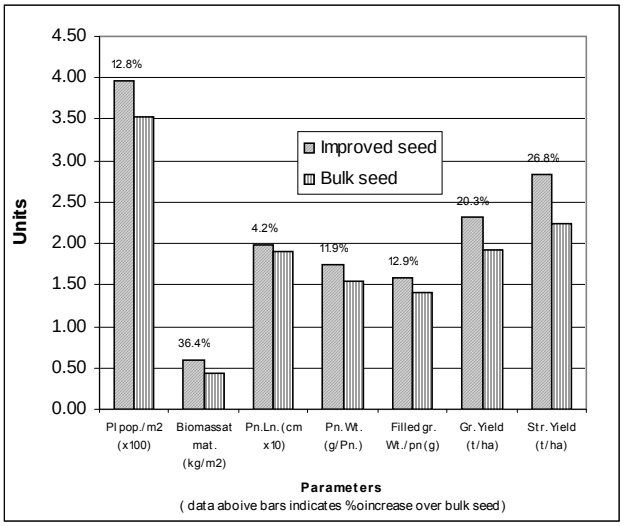

Fig. 3. Influence of improved seed on plant growth, yield attributes & grain yield of upland rice (Anjali), CRURRS, Hazaribag, wet season, 2006.

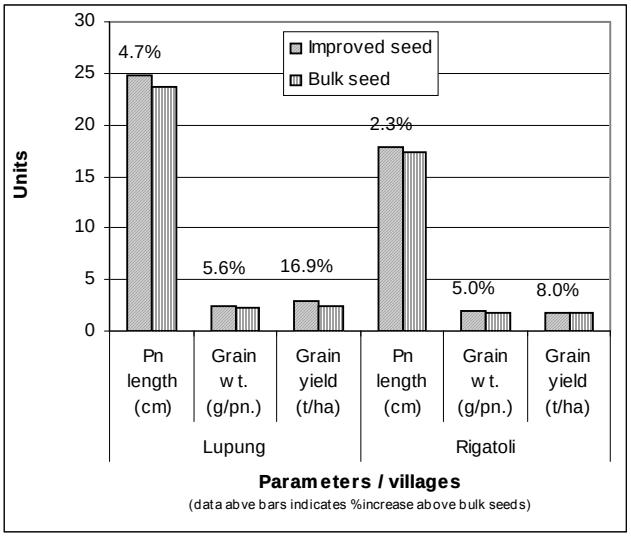

Fig. 4. Influence of improved seed on yield attributes & grain yield of upland rice (Anjali) in villages (On-farm trial), wet season, 2006.

evident from 5.0 to 5.6 % increase in filled grain weight panicle^{-1} over that of bulk seeds (Fig. 4), leading to significant enhancement in grain yield by 16.9% in Lupung (2.85 t ha^{-1}) and 8.0% in Rigatoli (1.86 t ha^{-1}). Other parameters like plant population, plant height, panicle length, filled grain number showed figurative increase in improved seeds over bulk seeds. The rogues were nominal in both the seed lots. This was due to the fact that the upland rice variety was totally replaced by Anjali during last two years (2005 and 2006) leaving no other variety of same duration group reducing the chances of mixture in threshing floor as indicated by the seeds cleanliness results obtained during May 2006 from the seed lots stored in villages. Average % clean seeds ranged between 84.3 to 87.0%. Results of both research station and on-farm trials indicated that yield increase in IS over BS was due to superior seed health of IS produced from uniformly better crop stand (previous year) leading to enhanced seedling vigor (aerial biomass) and improved yield attributing character (filled grain weight panicle^{-1}).

The advantage of improved seed of upland rice produced by 'crop area selection method' was demonstrated in 8 villages (2-4 ha in each village) as component of technology integration for low cost production system during wet season of 2007. Average yield increase to the tune of 2.87 t ha^{-1} was observed in the villages.

Mainly three types of systems were observed to be followed in the villages of Jharkhand for storage of rice seeds. The three systems differed in the storage structure sharing similar process of drying (sun drying to <10% seed moisture determined by typical sound originating from breaking the seeds with teeth), storage with bio-pesticide (dried leaves of Begonia; *Vitex negundo;* locally called *Senwar*). The storage structures/containers were (i) gunny bags; closed with rope and stored on wooden projections on the in-door walls below the thatched roof, specially constructed for the purpose, locally called *Dharan*, (ii) bamboo baskets sealed with mud and cow dung mixture, locally called *Tokri* / *Gaza* and (iii) specially fabricated earthen pots sealed with mud called *Hatwa / Kothi* (Plate 1).

Seeds stored under these containers were compared with that stored in air-tight, recycled PVC containers with similar bio-pesticides for seed quality and crop performances in field. The seed quality parameters ranged between 11.8 to 12.9% (seed moisture), 93.0 to 96.3% (seed viability), and 11.3 to 17.0% (seed discoloration) across samples irrespective of storage conditions which were well within the acceptable ranges. No significant difference in plant height, aerial biomass production, panicle characteristics and grain yield was observed between the seed lots stored under farmers' systems and air-tight PVC container. This revealed that the farmers' storage systems were good enough for proper seed storage under the comparatively drier climate of

(a) ***Dharan***

b) ***Tokri / Gaza***

(c) ***Hatwa / Kothi***

Plate 1. Traditional rice seed storage structures by upland rice farmers In Jharkhand plateau locally called (a) *Dharan*, (b) *Tokri/Gaza*, (c) *Hatwa/Kothi*

Jharkhand plateau (average minimum and maximum relative humidity during seed storage period, *i.e*. November to June next year, of 2003-04 and 2004-05 were 40.8 and 61.3%, respectively) and hence, no further intervention was required.

The cooperating and associated farmers' in the villages (10), were demonstrated with the benefits of improved seeds and were further trained (through village meetings, group discussions) during 2006 and 2007, on technique of improved seed production (crop area selection method) under the existing subsistence farming system, where farmers' mostly produce their own seed. The recommendations were to produce their seed through the demonstrated 'crop area selection' method on regular basis and to follow need based panicle harvest method after 5-6 years.

The advantage of improved seeds, produced through 'crop area selection method'. was demonstrated in 8 villages during the wet season of 2007 as a component of technology integration for low cost production method of upland rice for poor, small and marginal farmers under subsistence farming system.

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