On-farm management and quality assessment of farmers' saved wheat seed in the western Terai, Nepal

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Abstract

A study was conducted at Pakadi Village of Kapilbastu district, western Terai, Nepal in 2005 to find out the effect of on-farm seed management on the quality status of farmers' saved wheat seed. A survey was conducted to collect required information about on-farm seed management by using pre-tested questionnaires as well as to collect wheat seed samples, which were produced under general, additional and standard management practices. Survey showed that most of the farmers fulfilled their seed demand through informal sources. Roguing was not common practices in the study site and majority of the farmers saved seed from the harvest which was used for consumption purpose as well. Also, majority of farmers used to store unknown quality of seed in local containers by adopting simple storage techniques, which were one of the major causes of seed deterioration in their condition. Except physical purity, other seed quality attributes such as germination, 1000 seed weight and genetic purity percentage were found highest in certified seed. However, vital seed quality attribute viz. germination percentage of certified seed produced under standard management practice was statistically at par with seed produced under additional management practice. Likewise, other crop mixed seed, varietal mixing; and percentage infection of diseases such as *Bipolaris sorokiniana* and *Alternaria spp*. were found minimum in certified seed produced under standard management, while those attributes were recorded in high amount for seed produced under general and additional management followed by farmers. It showed that on-farm seed management played a significant role for maintaining seed quality parameters except physical purity and weed mixture in the seed. It was concluded that high quality wheat seed could be produced under farmers' condition by adopting additional management system with treatment and processing of seed.

Key Words: Certified seed, fumigation, genetic purity, roguing, seed quality, vigor

Introduction

Wheat is the third important cereal crop of Nepal after rice and maize both in area and production. At present, wheat-sown area is about 6,69,014 ha, with a total production of nearly 1.3 million ton (CBS, 2004). The productivity has steadily increased from 1.4 to 1.88 t/ha in the last ten years (NARC, 2002). However, average productivity of wheat is very low as compare to developed countries (7.7 ton/ha in U.K. and 6.5 ton/ha in France) Joshi and Regmi (1988). Even though wheat is third important crop of Nepal, it is second important for Kapilbhastu district. It is cultivated in 27000 hectares and average productivity is 2.5 ton/ha (DADO, Kapilbastu, 2004). There are several technical constraints associated with low productivity of wheat in Nepal. Poor crop stand due to low quality seed is one of the major causes of low productivity wheat in Nepal (Mudbari *et al.*, 1998).

Quality seed is considered as the basic, critical and cheapest input for enhancing productivity (Rana, 1997). Seed is not only input but also dynamic instrument for increasing agriculture production (Jha and Rai, 2001). Use of quality seed can increase crop yield up to 15-25% (DISSPRO, 1999). Use of other inputs such as fertilizer, irrigation, plant protection, does not yield good economic return without use of quality seed (Thapa, 2005). Seed quality is judged by its genetic purity, vigour and germination,

analytical (physical) purity, freedom from seed borne diseases and higher yielding ability (Rana and Raut, 1997). Thus, Seed is biological basis of the world food security and, directly or indirectly supports the livelihood of every person on earth.

A large number of Nepalese farmers are storing wheat seed in rainy season in ambient condition, when there is high temperature and high rainfall which accelerate quality degradation of stored seed in such condition. Due to high temperature and high rainfall, most of the farmers are sowing poor quality seed, which may be one of the main causes of low productivity of wheat in Nepal (Thapa, 2005). For instances, a survey conducted by SDQCSS (now SQCC) identified germination quality status of farmers' saved wheat seed which showed that only 36% samples were within standard, whereas 64% samples were below standard (Shrestha and Mishra, 2001).

National Seed Company (NSC) is responsible for supplying cereal seed to the farmers. It is supplying only 3-5% cereal seed out of total seed requirement of the country. Not only that seed supplied by NSC is very nominal it does not fulfill the demand of the farmers, it is expensive, cannot be available in time and these are not suitable varieties as demanded by the growers. Therefore, farmers do not want to depend upon this institution for seed supply and they prefer to save the seed by themselves or exchange among farmers to farmers (Bhandari, 2002). In Nepal, formal seed sale account for only a small percentage of the actual requirement, being less than 2% incase of rice, 12% for wheat and 1% for maize (SSSP, 2003). In totality almost 90% of the seed requirement of major crops and 100% of minor crops is met by farmers' own seed production and supply system (Cromwell et al., 1993; Joshi, 1995; Baniya et al., 2000 as cited by Sthapit and Sah, 2001). Thus importance of the informal extension and supply system (farmer-to-farmer networks) is verygeneral practice in Nepal because the formal extension and seed supply system are weak (Green, 1997 cited by Sthapit and Sah, 2001).

Up to now, government, donor agencies, NGO/INGO and other institutions are focusing formal seed sector that only supply 10% of the total seed requirement of the country though seed produced by farmers is the most important seed source in the majority of developing countries (Almekinders, 2000). Hence, agricultural productivity can be increased up to 20% by maintaining the quality of farmers' seed. Farmers' seed system is not getting priority and support and very rarely included in research even though it plays significant role in food security and livelihood of the poor people. Although national seed policies and plans are in the line to encourage the private sectors in seed business, but the cereal crops are high volumes, low price commodities. So private sectors are reluctant to get involved in the cereal seed business because it is risky, needs heavy physical facilities and infrastructures and less profitable as compare to vegetables (Bhandari, 2002).

For this purpose, Crop Development Directorate (CDD)a plan was prepared "District Level Seed Self Sufficiency Program (then DISSPRO) by creating source center. Major focus was given on rice, maize and wheat seed multiplication program in farmers' group of selected districts to supply source seed and improved seed for commercial cultivation (Bhandari, 2002). But DISSPRO program is not running as per its manual (Shrestha and Mishra, 2001).

Hence, survey and quality assessment of farmers' seed are key component to assess the causes of quality deterioration of farmers' mnaged seed. It is therefore; necessary to study the on-farm seed management and quality assessment of farmers' saved wheat seed to maintain the quality of seed for increasing agriculture production through focusing informal seed system (farmers' seed system) at Pakadi village of Kapilbastu district.

Methodology

Method and techniques of data and sample collection

In order to cover wheat-growing area in the survey, two wards out of 9, were selected from lottery system in collaboration with respective service center of DADO. Name and number of households (Voter list) were obtained from respective VDCs office in Taulihawa. Selected households, where ther wer not real owner had been omitted from the list with the help of key informants and substitute farmers were selected for interview. Thus, it was necessary to select 26 and 22 farmers in ward number 3 and 4, respectively for interviewing 12 farmers in each ward to meet minimum requirement of minimum sampling i.e. 15% of real population. Out of 48 randomly selected households, study and sampling were undertaken with only 24 households by using standard pre-designed and pre-tested questionnaires. During survey, 24 wheat seed samples were collected from farmers and 6 samples of certified seed lots were also collected from National Seed Company, Bhairahawa with by following seed sampling procedures of International Seed Testing Association (ISTA) Rules, 2006.

Farmers under general management

With field survey data, farmers who adopted some common agricultural practices related to seed quality such as seed drying, seed cleaning, cleaning of seed storage, maintenance of seed storage, use of local containers (gunny bag, dehari etc.), keeping seed lot aside the wall, use of wooden plank, brick stand or any material as pallet, and time to time inspection of seed store to check the insect infestation were considered as general management.

Farmers under additional management and standard management

Including general managements, farmers who are adopting special or extra agricultural practices for seed quality such as use of separate plot for seed production, roguing of the field, use of vapor proof containers, use of local herbs and insecticide in seed and seed storage respectively, use new containers for seed storage or fumigation of old containers during seed storage. They were categorized under additional management. Six samples of certified seed produced by contract farmers of National Seed Company Bhairahawa by following strict rules of seed technology were categorized under standard management (such as use of verified seed source, use of recommended packages of practices for cultivation, adoption of proper roguing, field certification, harvesting and threshing inspection, storage inspection, pre-cleaning of seed in processing plant, complete seed test before storage, use of insecticide in seed storage, use of new container or fumigation of old container during seed storage, time to time fumigation of seed lots to control insect infestation, quality test during seed storage, seed treatment and processing, and bagging and tagging of seed (in plastic laminated gunny bags at safe moisture level)

Treatment details

Each farmer (i.e. sample) was taken as a replication and 3 types of managements of seed production under farmers' conditions were considered as 3 treatments. According to field survey data, 10 farmers (i.e. 10 replications) were adopting the general management practices (T1), 14 farmers (i.e. 14 replications) were adopting the additional management (T2), 6 certified seed samples of National Seed Company, Bhairahawa (6 replications) were produced under standard management practices (T3).

Seed Testing

For the lab experiment, Completely Randomized Design (CRD) with unequal replications was used. All seed samples were tested for parameters such as number of seeds, physical purity, germination, seed health, 1000 seed weight and phenol color test for varietal purity which were carried out in collaboration with Central Seed Testing Laboratory, Hariharbhawan, Lalitpur, Nepal. All samples were sealed in thick polythene bag and stored in deep freeze at -5^0C to avoid the change in quality of seed until tests were performed.

Data analysis

First of all, information collected from the field survey was coded, tabulated and analyzed by using Statistical Package of Social Science (SPSS). Simple descriptive statistics was used to separate the mean and standard deviation to describe the socio-economic characteristics of the respondents.

Result and discussion

Surveyed information on seed source, mode of receiving seed, quality, and seed replacement

Only 20.8% farmers of research site used seed completely obtained from formal sources and rest of the farmers met their demand of wheat seed from informal sources. Of the total farmers, about (91% purchased wheat seed for sowing. It showed that buying was popular means of receiving the seed in Pakadi village. Remaining percentage of farmers used seed grown from their own crop. More than 80 percent of farmers of research site tested seed before sowing. However, they did not send the samples in seed testing laboratory for testing **(**Annex 1). It was encouraging that majority of the farmers were aware of seed quality and all farmers replaced the seed with in 1-3 years after the first use (Annex 2). However, they were testing seed by themselves. So, it necessary to provide the seed testing training to enrich their knowledge for seed testing and seed evaluation.

On-farm seed management

It was found that majority of farmers (i.e. 95.8%) cleaned seed immediately after harvesting but few farmers also reported that they did not clean seed after harvesting. Most of the farmers of research site were (i.e. 75%) saving seed from total harvest and only one fourth of the farmers (25%) used separate plot for seed production. Around one third of farmers (29.2%) removed off type plants but they did not remove other weed plants such as *Vicia spp.*, *Chenopodium album*, *Rumex spp*. etc. and other crop plants except canary grass and oat respectively. All farmers of the village (100%) dried the seed before and during storage but some farmers were drying the seed only for 2-3 hours, which was not sufficient to reduce the seed moisture at safe level for storage. Roguing was not common practice of the research site and majority of the farmers separate seed from total harvest (Annex 3).

On-farm seed management for seed saving and storage

All farmers of research site were storing seed without seed testing. Majority of farmers (79.1%) used the earthen dehari (Bhakari) for seed storage. One third of the farmers (i.e.33.3%) used the local materials such as neem leaves, onion bulb and wheat husk as local herbs for controlling the insect infestation during storage to protect the viability of the seed. Most of the farmers were adopting the simple storage management practices such as cleaning of store (100%), maintenance of seed store and use of pallet

(90.9% of farmers in each), keeping seed lot aside the wall (73.7%) and inspection for fumigation to control insect and pests (86.4%). In case of pallet, all farmers were using the brick stand below the dehari to protect the seed from moisture of earthen floor. Only very few farmers followed the other important storage management techniques such as use of insecticide before storage and use of new containers or fumigation of old containers before use respectively. It showed that majority of the farmers were storing unknown quality seed in local containers with simple storage techniques. It was one of the major causes of seed deterioration in farmers' condition (Annex 4).

Laboratory findings

Purity

Purity percentage of seed produced by farmers under different managements was statistically at par with each other ($P<0.05$) which significant and superior to certification standards. The purity percentages were 98.68, 98.98 and 98.90 for seeds produced by farmers under general, additional and standard management, respectively. The highest purity percentage (98.98) was found for seed produced under additional management because farmers had small seed lot as compared to certified seed production management. Hence, farmers could maintain the seed properly with using local materials (Annex 5). It showed that high percentage of analytically pure seed could be produced under farmers' management condition.

Germination

The highest germination percentage viz. 88.36 was found in certified seed produced under standard management but it was statistically at par with farmers' seed produced under additional management (83.79%). It was fond that if farmers could adopt additional management practices properly, seed with good germination capacity as in certified seed production system under standard management could be produced by themselves under their condition (Annex 5).

Seed quality determination by other tests

Number of other crop seed (OCS) and other distinguishable variety (ODV) were significantly lower in certified seed than that of seed produced by farmers under generaland additional management condition. In certified seed production, farmers removed the off-types and all other crop plants during roguing due to compulsion of seed certification. Farmers also adopt rouging practice under additional management but it was not as enough as in certified seed. So, it is necessary to suggest to farmers to adopt proper rouging practice in additional management as in certified seed production for maintaining the physical and genetic purity of seed.

Farmers did not care to other weed plants except objectionable weeds such as *Convolvulus arvensis* (which is not found in Nepal) in wheat field in certified seed production. They only removed the *Phalaris minor* from field during roguing in additional management. However, in general management, farmers did not adopt roguing practices. So, number of weed seed present in seed produced under different managements was statistically at par with each each other. (Annex 6). Seed was pre-cleaned and cleaned during processing of certified seed but farmers had very small seed lot as compared to certified seed, so they might have cleaned it properly by using local materials. Due to this reasons, number of weed seed present in farmers' seed was lower than that of certified seed.

Thousand seed weight

Thousand seed weight of certified seed produced under standard management (42.40 g) was significantly higher than that of seed produced by farmers' under general (36.02 g) and additional management (37.06 g) at 5% level of significance. Certified seed was produced by adopting improved package of practices with verified seed source. In addition to this, immature and shriveled seed were also removed during processing to make the seed lot uniform, which had also positive effect on 1000 seed weight of certified seed (Annex 7).

Seed health test

The infection percentage of *Bipolaris sorokiniana and Alternaria spp*. in certified seed (i.e.0.35 and 1.48%) was found very low as compared to seeds produced by farmers under general (17.68 and 33.08%) and additional management (15.53 and 32.31%) respectively at 5 % level level of significance. It was due to the fact that certified seed was treated with vitavax during seed processing time but farmers' produced seed was untreated. So the infection percentage of *Bipolaris sorokiniana and Alternaria spp*. was low in certified seed than that of farmers' produced seed under general and additional management (Annex 8).

Phenol color test for varietal purity

Varietal purity of farmers' produced seed under general (88.27%) and additional (90.02%) management was statistically lower than that of certified seed (97.75%) seed produced under standard management at 5% level of significance. Contract farmers involved in certified seed production removed the all off type plants properly during roguing. In additional management, farmers also adopt rouging practice as well but it showed that they did not rogue the off type plants properly as in standard management. However, farmers did not adopt roguing practice under general management (Annex 9).

Conclusion

Majority of the farmers fulfilled their seed demand through informal sources. Even though farmers were aware of seed quality. They were sowing low quality seed after increasing seed rate due to inability to afford quality seed. Roguing was not common practices at research site and most of farmers saved seed from harvest which was generally used as consumption purpose. Farmers were storing unknown quality of seed in local containers by adopting simple storage techniques, which were one of the major causes of seed deterioration in on-farm condition. On-farm seed management played a significant role on maintaining seed quality parameters except seed purity and number of weed mixed in the seed. It could be concluded that high quality wheat seed could be produced under farmers' condition by adopting additional management system with treatment and processing of seed. It is also necessary to organize the Seed Quality Management training and DISSPRO program effectively in farmers' condition for strengthening farmers' seed system in Nepal.

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Annex 1. Categorization of farmers on the basis of different sources of wheat seed used at Pakadi VDC, Kapilbastu in 2005

Use of seed sources	Farmers (Farmers saving wheat seeds for sowing)	
	No.	%
Formal	5	20.8
Informal	9	37.5
Both	10	41.7
Total	**24**	**100**
Completely own source	2	8.3
Own as well as external source	9	37.5
Completely external source	13	54.2
Total	**24**	**100**
Mode of receiving seed		
Buying	20	91.0
Barter	1	4.5
Other (as a minikit from farm)	1	4.5
Total	**22**	**100**
Query for germination (if seed from external sources)		
Yes	18	81.8
No	4	18.2
Total	22	100
Seed testing before sowing (if self source)		
Yes	9	81.8
No	2	18.2
Total	**11**	**100**
Self seed testing	9	100

Annex 2. Categorization of farmers according to wheat seed replacement at Pakadi VDC, Kapilbastu in 2005

Seed replacement period	No. and percentage of farmers	
	No.	%
One year	2	8.4
Two years	14	58.3
Three years	8	33.3
Total	**24**	**100**
Reason for Seed replacement		
Due to poor genetic make up of self save seed	1	4.2
Due to good yielding ability of new seed.	23	95.8
Total	**24**	**100**

Annex 3. Categorization of farmers according to on-farm wheat seed management practices at Pakadi VDC, Kapilbastu in 2005

Seed management practicess	No. and percentage of farmers (N=24)	
	No.	%
Seed Cleaning		
Yes	23	95.8
No	1	4.2
Total	24	100
Seed drying in sun	24	100
Seed selection procedures		
Use of separate seed production plot	6	25
Use of seed from total harvest	18	75
Total	24	100
Rouging of the field		
Yes	7	29.2
No	16	66.7
Don't know	1	4.2
Total	24	100
Post harvest seed drying		
Before storage (times)		
One time	14	70
Two times	4	20
Three times	2	10
Total	20	100
After storage (times)		
One time	13	61.9
Two times	7	33.3
Three times	1	4.8
Total	21	100

Annex 4. Percentage category of farmers on the basis of different practices of wheat seed storage followed at Pakadi VDC, Kapilbastu in 2005

Activity	Percentage category of farmers (N=24)	
	No.	**%**
Seed saving for next season	24	100
Storage without seed testing	24	100
Use of Storage containers		
Earthen dehari	19	79.1
Gunny bag	3	12.5
Gunny bag with plastic lamination	1	4.2
Dehari and gunny bag	1	4.2
Total	**24**	**100**
Use of local herbs	8 (16)	33.3 (66.6)
Cleaning of seed store before seed storage	24	100
Use of insecticide before storage	2 (22)	8.3 (91.7)
Maintenance of seed storage	20 (2)	90.9 (9.1)
Fumigation of old container	1 (5.6)	17 (94.4)
Use of pallet	20 (2)	90.9 (9.1)
Keeping seed lot aside the wall	14 (5)	73.7 (26.3)
Inspection for fumigation to control insect and pests	19 (3)	86.4 (13.7)

- Figure in parentheses indicate percetage of farmers who don't follow activity given

Annex 5. Seed purity and germination as affected by different seedmanagement practiceson on farmers' saved wheat seed at Pakadi VDC, Kapilbastu in 2005

Seed management practice	Purity	Germination
1. General management	98.68 (9.934) a	67.05 (54.97) b
2. Additional management	98.98 (9.949) a	83.79 (66.26) a
3. Standard management	98.90 (9.945) a	88.36 (70.05) a
SEM	0.01195	2.720
LSD (P<0.05)	0.03468	7.894

- Figures in parentheses are arcsine transformed means
- Means in the column followed by same letter are not significantly different at 5% level by DMRT

Annex 6. Seed quality parameter as affected by different seed management practices of wheat on farmers' saved wheat seed at Pakadi VDC of Kapilbastu district in 2005

Seed management practice	No. of other crop seed (OCS)	No. of other distinguishable variety (ODV)	No. of weed seed
1. General management	91.62 (1.962) a	44.46 (1.648) a	39.90 (1.601) a
2. Additional management	89.54 (1.952) a	30.13 (1.479) a	40.64 (1.609) a
3. Standard management	7.60 (0.881) b	7.10 (0.851) b	55.72 (1.746) a
	0.09335		0.05477
SEM	0.2709	0.0676	0.1589
LSD (P<0.05)		0.1962	

- Means in the column followed by same letter are not significantly different at the 5% level by DMRT
- Figures in parentheses are log transformed means

Annex 7. 1000 seed weight as affected by different management practices on farmers' saved wheat seed at Pakadi VDC, Kapilbastu in 2005

Seed management practice	1000 seed weight mean (g)
1. General management	36.02 b
2. Additional management	37.06 b
3. Standard management	42.40 a
SEM	0.8942
LSD (P<0.05)	2.595

- Means in the column followed by same letter are not significantly different at 5% level by DMRT

Annex 8. Seed health as affected by different treatments on farmers' saved wheat seed at Pakadi VDC, Kapilbastu in 2005

Seed management practice	*Bipolaris sorokiniana*	*Alternaria spp.*
1. General management	17.68 (4.264) a	33.08 (35.11) a
2. Additional management	15.53 (4.004) a	32.31(34.64) a
3. Standard management	0.355(0.925) b	1.48 (6.98) b
SEM	0.1498	1.516
LSD (P<0.05)	0.4345	4.398

- Means in the column followed by same letter are not significantly different at 5% level by DMRT
- Figure in parentheses are transformed means (square root for *Bipolaris sorokiniana* and arcsine *Alternaria spp.*)

Annex 9. Phenol color test as affected by different seed management practices on farmers' saved wheat seed at Pakadi VDC, Kapilbastu in 2005

Seed management practice	Phenol color test mean
General management	88.27 (9.395) b
Additional management	90.02 (9.488) b
Standard management	97.75 (9.887) a
SEM	0.03485
LSD (P<0.05)	0.1011

- Means in the column followed by same letter are not significantly different at 5% level by DMRT
- The figures in parentheses are square root transformed means