

Client-Oriented Breeding and Seed Supply

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Abstract

We describe our efforts to provide seed of varieties produced by client-oriented breeding (COB) for upland rice in India and for rainfed rice in the low-altitude regions of Nepal. In India, farmers adopt the new upland rice varieties once they have access to seed and grow them on a very high proportion, sometimes all, of their rice uplands after only 3 seasons. This acceptance is higher than for any previous public-sector variety such as Vandana or Kalinga III. Although the upland varieties are clearly marketable, efforts to involve the private sector in India in their seed production have not been successful because of the unprofitable nature of low yielding upland rice compared with irrigated transplanted rice. Long term seed supply may have to rely on NGOs who currently have large programmes in the supply of these varieties. In Nepal, where we have also produced acceptable varieties from COB, we have been able to catalyse groups to commercially produce large quantities of seed. However, most of this seed was of obsolete varieties. If groups are to be commercially successful as well as providing seed of newly released varieties then as much attention needs to be paid to supplying information as supplying seed.

Introduction

Most of the crop land of the world is planted to annual crops that are planted from seed. Every year farmers either obtain seed or bring it from stores of their own harvested grain. Since farmers must spend resources on seed and better quality seed often represents only a small increase in total production costs, the provision of seed with improved genetic potential can lead to considerable increases in the quantity and quality of harvests. In three countries in south Asia we have, over more than a decade, derived more participatory and innovative methods called client-oriented breeding (COB) - a term that describes better than participatory plant breeding (PPB) the reason why farmers participate (Witcombe et al., 2005). An integral component of COB is the use of participatory varietal selection (PVS) where farmers test the varieties produced in the COB programme in their own fields. These techniques produce and deliver varieties more rapidly than conventional breeding and better client orientation ensures they have traits that farmers like. Benefits include improved yield, improved quality, reduced costs and earlier harvests. We have done this in regions where conventional breeding has either not delivered varieties that farmers have adopted to any great extent e.g., in the drought prone rice uplands of India, or where the results of conventional breeding have taken decades to be adopted e.g. more productive areas of Nepal and Bangladesh where some of the varieties still in use were bred more than fifty years ago.

In this region the commercial supply of seed to farmers – by the private and public sectors – accounts for as little as 2% of the seed that is sown. The rest comes from farm saved seeds (Tripp, 1997) or from grain purchased in local markets (Frazen et al., 1996). Many development projects and agencies have attempted to introduce local seed supply systems that depend on action by local communities to provide the supply that the formal sector has failed to deliver. Tripp (1997) has pointed out that there

is no example of a sustainable local-level seed production and marketing organization as, invariably, after the support of the implementing agency was withdrawn, the group activities failed to continue.

When the NGO sector realises the importance of delivering high quality seed the common 'solution' is to set up seed banks in the villages. Typically the NGO provides a given quantity of seed free of cost to farmers with an agreement that they donate twice as much, at harvest, to a communal seed bank. This is a commonplace approach even though there is no evidence that this has worked sustainably anywhere and many reasons to fear that it will fail. There is no incentive for any farmer to return the highest quality seed to the seed bank but transaction costs are high in attempting to see that this is done. A group may undertake these efforts with enthusiastic help from NGO field workers but no longer do so once that support is withdrawn. A similar reservation applies to NGO-supported community-based seed production.

We discuss here two examples of attempting to provide a sustainable seed supply in rice in two contrasting innovation systems: the uplands of India and the more productive regions of Nepal.

India

There have been decades of conventional breeding for upland rice in India but still farmers continue to grow landraces (Virk and Witcombe, 2007). We have substantial evidence that new rice varieties bred using participatory, client-oriented methods (Virk et al., 2003) are liked by farmers and adopted by them. In villages where there have been decades of project-supported seed supply of the modern varieties Vandana and Kalinga III they never achieved the same levels of use as those of the COB-produced varieties, Ashoka 200F and Ashoka 228, only a few years after their first introduction (Figs 1 and 2). In Jharkhand, the local landrace Gora was most quickly replaced by Ashoka 228 and Ashoka 200F and the only variety grown in 2001 that was still grown to any extent in 2004 was Kalinga III (Fig. 1). In Orissa, the diversity of landraces was greater but the most popular, Asu (also called Tusku) declined from 36 to 5% of the area, and by 2004 the two new varieties occupied 80% of the area (Fig. 2). These high adoption levels were because many farmers decided to adopt them on all of their rice uplands (Table 1 and Virk and Witcombe (2007)). This provides substantial evidence that the Ashoka varieties are qualitatively different to older varieties in their acceptability caused by a combination of high yield, drought tolerance and superior grain quality.

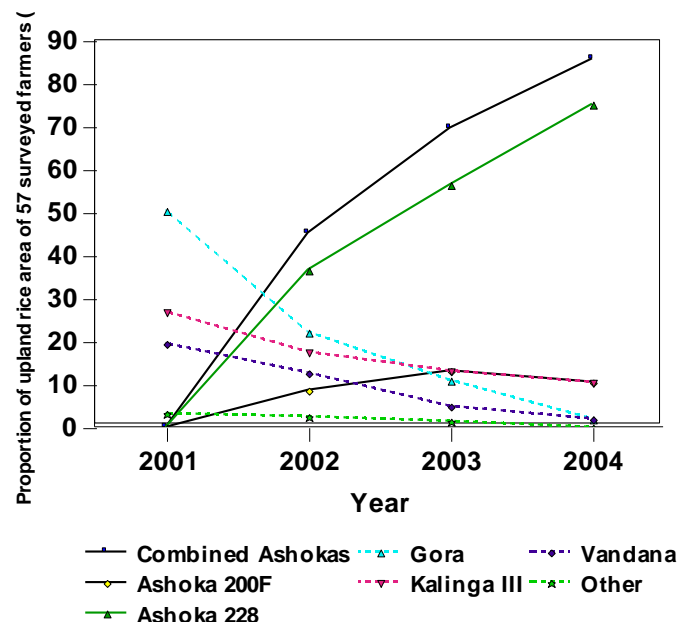


Fig. 1. Adoption of Ashoka 200F and Ashoka 228 and the replacement of existing landraces and modern varieties by 57 surveyed farmers in Jharkhand, from a survey in 2004.

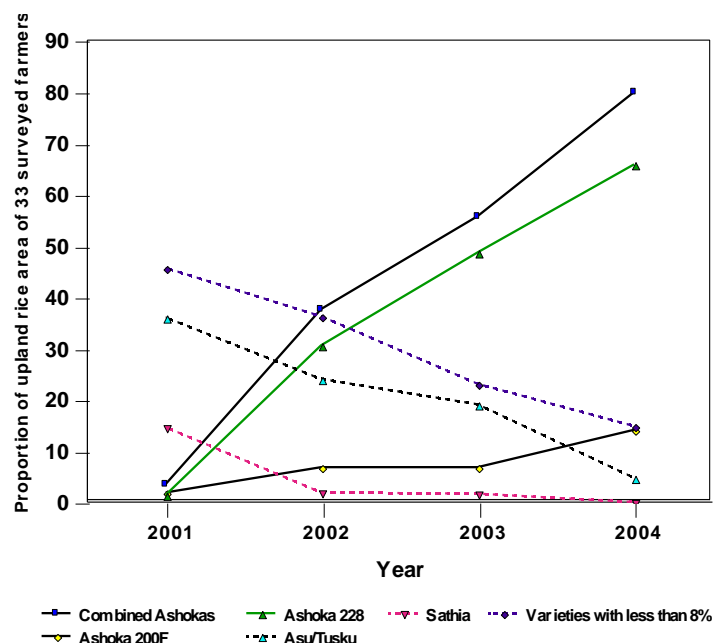


Fig. 2. Adoption of Ashoka 200F and Ashoka 228 and the replacement of existing landraces and modern varieties by 33 surveyed farmers in Orissa, from a survey in 2004.

Table 1. Adoption of Ashoka 200F and Ashoka 228 on 100% of available upland area by the interviewed farmers in 2003 and intended adoption in 2004, from a survey in 2004.

State	Households surveyed (no.)	Adoption on 100% of upland area in 2003 (number of farmers and %)	Adoption on 100% of upland area in 2004 (number of farmers and %)
Jharkhand	57	15 (26%)	39 (68%)
W. Bengal	60	38 (63%)	40 (67%)
Orissa	33	14 (42%)	21 (64%)

Given this superiority, perhaps one could rely on informal farmer to farmer networks for the varieties to spread in the farmers' rice innovation system? However, in drought years the amount of upland rice harvested falls leading to a limited supply of farm-saved seed for the sowing of the next year's crop. The farm-saved seed supply of the Ashoka varieties is reduced more than for other varieties, even though they survive drought better, as a result of two more of their positive attributes, early maturity and higher grain market price. They are the first to be eaten as they herald the end of the hunger gap. They are also more likely to be sold as they have a higher price. When, in the next year, farmers have to get seed from outside sources for the next rice crop some have to revert to obtaining seed of the currently more widely grown, lower-quality landraces. Hence, drought years, in the absence of an external seed supply, slow the rate of adoption particularly for the poorest category of farmers. Despite such difficulties, a high proportion of farmers given seed on a single occasion in 2000 had kept seed through drought years. By 2006, were continuing to grow the Ashoka varieties and did so on 100% of both their upland and medium land.

For new varieties to have a large impact in a short time frame there has to be a substantial input of project supplied seed – that is unsustainable in the long run – or preferably commercially supplied seed that will be sustainable. There have been many efforts in supplying seed by NGO-led projects and substantial quantities have been produced and supplied in nine Indian states including the four states in which they are officially recommended – Jharkhand, Gujarat, Madhya Pradesh and Rajasthan. Indeed, it may be that this could be regarded as a sustainable solution since several of these NGOs are well established institutions with a long record in rural development. As long as

farmers continue to ask for seed there will be a supply, albeit not on a scale where supply meets the need.

After a visit to eastern India it was recommended to us that it was better for an NGO not to be in the seed business as this was an onerous task that could be contracted to the private sector (Robert Tripp, pers. comm.). At the time staff of the Gramin Vikas Trust and CAZS-NR were heavily involved in the minutiae of supervising the production of seed by 'self-help' groups and its certification and distribution to other NGOs, development projects and farmer groups. We accepted this advice and attempted to involve the private sector in the seed production of our upland Ashoka varieties. We discovered that private sector players in eastern India were few and those that were active were interested in the production of hybrid seed or seed of transplanted varieties. We also found that, as a business, the production and sale of upland rice seed cannot compete with that of higher yielding transplanted varieties and it made private-sector companies reluctant even to agree to a contract to supply seed to the project. For a profitable business rice seed needs to be multiplied in irrigated fields in the dry season as this minimises the storage time between harvest and sales for sowing in the rainy season. Unfortunately, no upland variety can yield as much as transplanted varieties under irrigated conditions and the yield gap is substantial (at least 2 t ha⁻¹). Why should farmers then produce seed of lower-yielding upland varieties when the market for transplanted rice seed is far from saturated? An alternative to irrigated production is to purchase seed from upland farmers at the end of the rainy season since upland farmers have no option but to grow upland varieties. However, unlike the case for irrigated production there is an inbuilt loss of 7% in moisture when the grain is purchased at the end of the rainy season and stored during the dry season. A loss of 7% moisture results in an equivalent reduction in seed sales since seed is sold by weight and not volume.

There may be special situations in which off season production may be profitable and can form the basis for a profitable seed industry. We have reports of over 200 ha of production of Ashoka varieties by farmers in the dry season using irrigation. We do not yet know why this is done but farmers we interviewed who had adopted the same practice in the dry (spring sown *Chaita* season) in Nepal reported savings in irrigation water and an earlier harvest, even though they had a substantial reduction in yield.

Farmers have to be made aware that external seed supply cannot be relied upon and they must be empowered to maintain seed of these varieties. This empowerment is by giving advice on the simple techniques for maintaining genetic purity and reducing risk of seed loss by growing small plots specifically for seed in less drought-prone fields (e.g., in medium land with deeper soils). We are attempting to do this in villages where all households are provided with seed to ensure a more secure farmer-to-farmer network for those farmers that fail to produce sufficient seed.

Nepal

In Nepal the varieties that we have produced by client-oriented breeding are for rainfed conditions that are more favourable than those of the upland areas of India (Joshi et al., 2002). Hence, there is no inherent lack of profitability in producing seed of these varieties intended for the low altitude area bordering India (the Terai). There was already a poorly developed seed industry for varieties grown in the Terai where the producers sold seed to 'Agrovets' i.e. agricultural input suppliers. Our COB programme was conducted in Chitwan district and we realised that if there was to be seed supply on anything approaching adequate levels we had to encourage groups to produce seed. We did so by working with farmer groups that had already been established by the District Agricultural Development Offices (DADOs) for other purposes such as dairy production. When we started to facilitate seed producer groups there was only one established group in Chitwan (the Phituwa Seed Producer Group. Since 2000 five new groups have been established and the increase in total seed produced and sold is remarkable (Table 2). However, we had less success in achieving the production of seed of varieties from our participatory varietal selection and client-oriented breeding programmes. Most of the seed produced by the groups was of very old released varieties and the proportion of seed production devoted to non-project varieties was never less than about 80% of production. Moreover, of the 20% of production of project varieties about half was ordered and purchased by LI-BIRD for its programmes. By 2007, under 1% of the total production was of COB varieties produced by the groups independently of orders from LI-BIRD. However, since overall production had increased dramatically the absolute amounts sold were significant: in 2006-2007 this amounted to 119 t of seed of which 92 t

was seed of PVS varieties and 27 t of seed of COB varieties, including the released variety Barkhe 3004. About half of the seed of the COB varieties was ordered by LI-BIRD.

Table 2. Amount of seed produced and marketed by some of the community-based seed producer groups in Chitwan district of Nepal, 2002 to 2007

Name of seed producers group	Year established	No. of farmers participating in seed production	Seed production (t)				
			2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
Farmers, Pithuwa	1994	300	109	143	179	300	482
Panchakanya, Tandi	2000	50	60	100	125	150	200
Namuna, Sukranagar	2001	90	27	43	51	66	75
Devujjal, Gitanagar	2002	15	-	9	13	30	50
Shreeram, Parbatipur	2002	50	2	89	125	135	194
Unnat, Patihani	2002	99	1	38	100	137	277
Total			199	422	592	819	1277

Why this situation had arisen was not difficult to understand. The seed producer groups were responding to demands from the Agrovets who, in turn, were responding to the demands of their client farmers. Since the farmers were unaware of the new varieties they could not demand them. We were thus in the unfortunate situation that demand would not increase unless farmers could try the seed and seed would not be produced unless there was demand. We have started to turn this vicious circle into a virtuous one. For example, in the innovation network there can be unmet demand as there is insufficient flow of information between producers and potential purchasers. We have passed demand for seed of new varieties to LI-BIRD to the seed producer groups even when we knew that they have no seed available. Hence, on receiving a demand by a DADO for 10 t of Barkhe 3004, we asked Unnat, one of the producer groups, for seed. Although this could not result in an immediate supply it gave them the confidence to include Barkhe 3004 seed production in their future plans. We are also holding stakeholder meetings of seed producer groups, Agrovets, farmer groups, DADO extensionists, rice millers and other NGOs – all of the major players in the rice innovation system – to explain the growing characteristics and qualities of the new varieties to stimulate demand and increase knowledge of the new varieties. Whether this will significantly increase the rate of uptake of new varieties is yet to be seen. However, it is clear from our data on varietal portfolios that farmers grow very old varieties and so without such interventions newly released varieties typically are taking decades to become popular.

There are many factors in the rice innovation system that influence the rates of adoption and adoption decisions. Within a few kilometres of each other, on either side of the border between Nepal and India, farmers get their seed from very different sources (Fig. 3). In the case of Nepal, little seed is obtained from markets or agencies so flow of information will be vital in promoting the uptake of seed from client-oriented breeding programmes.

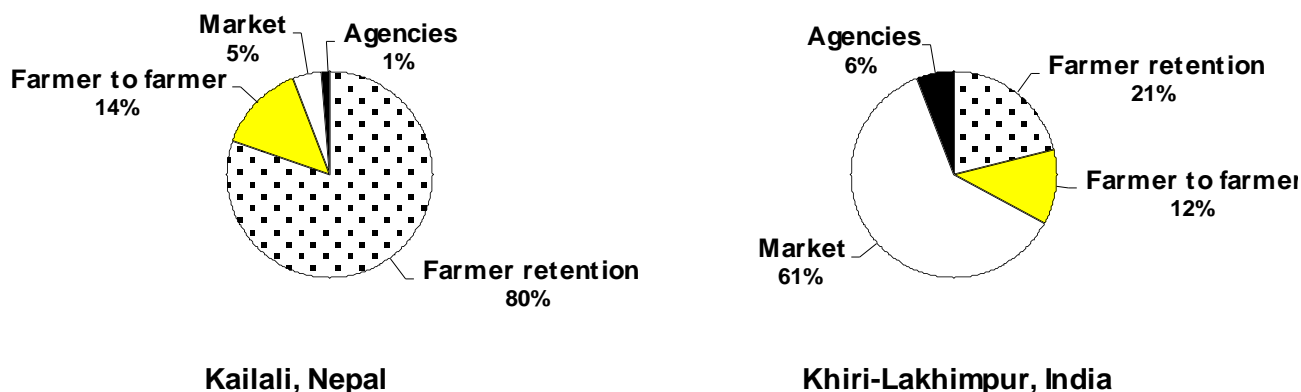


Figure 3. A comparison of source of rice seed in study villages in Kailali, Nepal and Lakhimpur Khiri, India, 2006, from a survey in 2007

Conclusions

Client-oriented breeding can more rapidly produce new varieties that stand a better chance of being used by farmers as they have desirable traits. Although seed can spread quite rapidly from farmer to farmer, for most varieties unless large-scale seed supply is implemented the adoption process will be slow. The most sustainable way to supply large quantities of seed is by commercial seed production but in less productive environments this may be difficult to achieve. Attempts in India to initiate commercially based seed production of upland rice varieties from client-oriented breeding have, so far, not been successful. For lower yielding crops, such as upland rice, that have to occupy the same land as seed production plots of higher yielding varieties perhaps the only long-term solution is government subsidy. However, in the particular case of the early maturing Ashoka upland varieties it may be possible to identify specific niches where they could be produced in the off-season, possibly because the earlier harvest they provide would benefit producers. In more favourable environments, such as the Nepal Terai, it was possible to catalyse seed producer groups to produce substantial quantities seed. However, invariably information about new varieties is poorly disseminated and this results in a lack of demand. If nascent seed industries are to best serve the needs of farmers they should provide seed of recent, not obsolete, varieties. Hence, as much attention has to be paid to information supply as to seed supply. Whatever system of large-scale seed production is employed, there are many other social and economic factors that will influence the rate of adoption of new varieties.

References

- Frazen, H., Ay P.F. Begenmann, J.A. Wadsack and H. Rudat. (1996) 'Variety improvement in the informal sector: aspect of new strategies' in P. Eyzaguirre and M. Iwanaga Eds. *Participatory plant breeding. Proceedings of a workshop on participatory plant breeding 26-29 July 1995, Wageningen, The Netherlands*. pp. 19-30. International Agricultural Research Centre, Wageningen, The Netherlands and International Plant Genetic Resource Institute, Rome, Italy.
- Joshi, K.D., Sthapit, B.R., Subedi, M. and Witcombe, J.R. (2002) 'Participatory plant breeding in rice in Nepal' in David A Cleveland & Daniela Soleri (Eds), *Farmers, Scientists and Plant Breeding: Integrating Knowledge and Practice* pp. 10:239-267. CABI, Wallingford, UK
- Tripp, R. (1997) *New Seed and Old Laws- Regulatory reform and the diversification of national seed systems*. Intermediate Technology Publications on behalf of the Overseas Development Institute, London.
- Virk, D.S., Singh, D.N., Prasad, S.C., Gangwar, J.S. & Witcombe, J.R. 2003. Collaborative and consultative participatory plant breeding or rice for the rainfed uplands of eastern India. *Euphytica* 132: 95-108.
- Virk, D.S. and Witcombe, J.R. (2007) Trade-offs between on-farm varietal diversity and highly client-oriented breeding - a case study of upland rice in India. *Genetic Resources and Crop Evolution* (on-line first). DOI 10.1007/s 10722-006-9158-5.
- Witcombe, J.R., Joshi, K.D., Gyawali, S., Musa, A. M., Johansen, C., Virk, D.S. & Sthapit B.R. (2005) Participatory Plant Breeding is Better Described as Highly Client-Oriented Plant Breeding. I. Four Indicators of Client-Orientation in Plant Breeding. *Experimental Agriculture* 41: 299-319.