AN ANALYSIS OF VARIETAL TESTING

Introduction

D.S. Virk and J.R. Witcombe

An analysis[†] of the varietal testing system in India is presented in Chapters 2 and 3 The analysis considers:

- The appropriateness of the sites used for varietal testing in terms of their geographical distribution, and in particular how the trial sites are divided into agro-ecological zones;
- How well the management of the trials reflects farmers' management practices;
- The selection strategy employed to promote entries from one trial stage to the next, and its impact on the efficiency of resource allocation across years, and
- The impact of the selection strategy on specific adaptation and on the selection for farmer relevant traits other than yield.

The trials system was studied to see if there were areas that could be improved to better meet the needs of low-resource farmers. Although this study was almost entirely restricted to India, the difficulties associated with varietal testing and popularisation that were found were shared by all of the many developing countries that we have examined. The analysis showed that:

i Limited resources and a research station infrastructure restrict the number and the location of trial sites. These prevent the locations of varietal trials from adequately representing all of the agro-ecological regions of the country.

ii The number of zones in the All-India Coordinated Crop Improvement Projects (AICCIPs) was always fewer than in the simplest agro-ecological division of India. This is unavoidable with the existing limited number of locations, as dividing the trials into more zones would result in zones with few or no trials.

iii In some crops, the more marginal areas are particularly poorly represented, because of poorer infrastructure in the marginal areas and the unreliability of trials in drought prone areas.

iv Trials were conducted under management conditions that gave much higher yields than those obtained by most farmers. The differences were extremely large. For example, in pearl millet the yields in the trials were more than 2.5 times as much as those obtained by farmers in the districts where the trials were grown. In sorghum the equivalent figure was 2.7 times. This can result in very high genotype x environment interactions and is a reason why trials may fail to identify the most appropriate varieties for the poor soils of farmers in marginal agricultural environments.

One obvious solution to the problems of too few locations, inadequate representation of all agro-ecological zones, and very different management regimes to that of farmers is to move the trial system to the farmers' fields. Farmer involvement can be used to test entries in more appropriate conditions in more locations.

The selection strategy employed in the AICCIPs studied was to concentrate on selection for yield. High selection pressures were employed that caused a rapid decline in the number of entries that were tested over a three year period. The fewer entries that were tested for a second or third year were never adequately compensated by more replicates, larger plot sizes or more trials sites. Consequently resource allocation across years was most uneven. In all cases studied the percentage

[†] The work described in Part 1 was carried out at CAZS in a joint project between ODI and CAZS that was funded by the Overseas Development Administration.

of the resources devoted to testing third year entries was less than 20% of that employed to test the first year entries. In some cases selection pressures were so high that no entries survived to the third year. This is contrary to theory which shows that an equal resource allocation over years is the most efficient selection strategy. Although there was selection for traits other than yield, they were always examples of negative selection used to eliminate a low proportion of entries that were e.g., particularly susceptible to a disease. Entries that had survived for a third year could be proposed for release on the basis of important traits other than yield, but such entries were required to yield well in the first and second years of the trial, no matter how important their other favourable attributes.

An analysis of the results of the selection on the basis of an important adaptive trait—flowering time—showed that in many trials there was strong stabilising selection for this trait, so that early or late entries were eliminated from the trials. Flowering time was used as the best documented trait to test how well the trials permitted specific adaptation to be selected. However, this would apply to other traits that impart specific adaptation. Whatever the basis of specific adaptation, specifically adapted varieties, that yield well in only a few locations and poorly in others, will be eliminated from trials that select for higher than average yield across many locations.

An improved selection strategy can be developed that eliminate or ameliorate many of the disadvantages identified in the current system. These can be divided into *design* changes and *structural* changes. The design changes would involve changes in selection strategy and trial design:

- Select for multiple traits using indices rather than yield. Obvious traits for inclusion in an index are grain yield, fodder yield, maturity (earliness) and disease resistance.
- Divide trials into different maturity classes and types. This is already done in many crops but the principle can be greatly extended.
- Alter the trial design to make resource allocation more efficient. This would involve using a "three tier" trial system in which each tier consists of the entries being tested for the first, second or third years. The more advanced the tier, the more sites replications are employed to help equalise resource allocation. A greater use of multi-site unreplicated or low-replicate trials at the initial trial stage, and improved designs (such as alpha designs) at the advanced stages would also increase efficiency.

The structural changes would involve a greater use of farmers because several of the identified weaknesses are because of a lack of farmer involvement. Increased farmer participation in the evaluation process has particular benefits at all stages of the trials:

- More trial sites on farmers' fields would allow all of the agro-ecological zones, particularly marginal ones, to be better represented.
- Trials on farmers' fields would result in a closer representation of the target environment which is farmers' fields.
- Many traits would be evaluated. Farmer evaluation could provide data on post-harvest traits such as grain quality (milling percentage, ease of dehusking, cooking quality, taste and market price) and fodder quality. To evaluate all of these without farmers' help would be beyond the capacities of even a well-funded breeding programme.
- There would be a more equal resource allocation across the tiers as farmers become progressively more involved in the second and third tiers of the trials.

Not only would the trials system be closer to optimal, but popularisation of new cultivars would be facilitated. The most acceptable cultivars would spread from farmer to farmer, and the extension services would become more aware of new material at an earlier stage.

Many of the problems identified in Part 1 and their suggested solutions are summarised in Table 1.1.

Table 1.1. A summary of problems, causes and suggested solutions to make varietal testing more efficient and more relevant to the needs of farmers

Problem	Cause	Suggested solution
Multilocational trials do not represent the crops area	trial sites are not located in accordance with the importance of area	• allocate trial sites in important areas of the crop • increase number of trial sites using extension worker and farmer participation
Multilocational trials do not represent agro-ecological zones	too few sites to represent all zones	• increase the number of test sites according to zonal importance using farmer participation • increase the number of zones
Trials do not represent farmers' field conditions	research station trials are conducted at better sites and under applied inputs	• grow trials with inputs similar to those typically used by farmers • use farmer participation in trials • do not exclude trials with mean yield less than state mean • do not exclude trials with high CV
There is an uneven resource allocation in the trials across years	Too high a selection pressure in the initial year. Inadequate increase in replication, sites, plot size in subsequent years	• revise trial design and strategy—use less replication but more sites in the first year, increase resource allocation in second and third years by using more farmer participation
Multilocational trials select against specific adaptation	breeders do not enter phenotypically extreme entries in the trials (they expect them to fail)	• create separate trials for different maturity ranges • have more trials for specific - situations, -traits, and -zones • decentralise plant breeding and have more farmer participation
Non-yield or farmer-relevant traits are not considered	yield is the primary criterion of promotion of entries in AICCIPs and many farmer-relevant traits are not recorded	• give weight to non-yield, farmer-relevant traits • use farmer evaluation (on or off station) of trials for non-yield traits
Adoption of package of practices too difficult and risky for low-resource farmers	Extension services promote package of practices, and AICCIPs conduct trials under high input packages	• conduct some AICCIP trials under low inputs • unpack package for low-resource areas, i.e., test one intervention at a time • first promote adoption of improved variety to give higher yield. Subsequent interventions are then less risky for the farmer.