CHAPTER 2

Literature review

Plant breeders use plant genetic resources to create new genetic variation. The genetic variation becomes the raw material for crop improvement. Therefore, genetic variation is a prerequisite for sustainable crop production. The explosion of the global population elevates the demand for crop products. Paradoxically, the world is experiencing heavy plant genetic erosion at this very time of high demand for crop products. This trend calls for the management of plant genetic resources to rescue the genetic resources that are continuously being lost.

Categories of biodiversity management systems include *in situ*, *in situ*/on-farm, and *ex situ* conservation. Farmers are already practising *in situ*/on-farm agrobiodiversity conservation at considerable economic sacrifice to the benefit of formal plant breeding systems (Swaminathan, 1997). Therefore, the access to plant genetic resources is a benefit-sharing process between the conservers and the users of agrobiodiversity. Symbiotic linkage between conservers of agrobiodiversity and the commercial industry is probably the promising pathway to the identification, collection, conservation, and sustainable utilization of plant genetic resources. Faith in this symbiotic linkage 'is the assurance of things hoped for, the conviction of unseen realities' (Hebrews 11:1) in the abolition of poverty among the disadvantaged farmers. The evaluation of the elite breeding lines of flue-cured tobacco for field and market performance was for the benefit of the tobacco growers in partial fulfilment of the requirement for the symbiotic linkage.

Increased genetic variability and gains from selection may be results of introgression of diverse germplasm into the present crop genetic base (Thompson and Nelson, 1998). Scientists postulate that *Nicotiana tabacum* L. arose as a single chance hybrid between the progenitors *Nicotiana sylvestris and*

Nicotiana tomentosiformis. A review of the commercial tobacco cultivars shows a limited germplasm base. Flue-cured tobacco cultivars show a close genetic relationship. Tobacco plant breeders have reshuffled and recombined a common base of genetic factors. Therefore, it is logical to expect that tobacco cultivars would have similar genetic backgrounds and that the genetic advance would be restricted (Keller, 1976).

Although other factors are of vital importance, yield dominates the objectives of all plant breeding programmes (Stoskopf et al., 1993; Wallace and Yan, 1998; Simmonds, 1987). Intensive investigation is focussed on cultivar structure improvement to achieve this dominant objective (Kostova and Kurteva, 1997). Conventional breeding methods have enabled tobacco researchers to develop a number of high yielding tobacco cultivars (Narayaran et al, 1998). High yields of acceptable quality are to be produced if the high initial capital outlay, farm structure maintenance and crop management costs incurred by the farmer are to be justified (Dippenaar et al., 1991).

The progress in breeding for improved tobacco yield and leaf quality has been quite difficult to assess due to the confounding effects of genetic improvement and improved production technology (Wernsman and Rufty, 1988). Large interactions between the genotype and the environment retard the progress of obtaining gains from selection (Comstock and Moll, 1963). The interactions between the genotype and the environment may constitute a limiting factor in the estimation of the variance components and in the efficiency of the selection programmes (Sprague, 1966). The narrow genetic base, in tobacco, that restricts the progress of genetic gains, compounds the difficulty of assessing the genetic advance. Therefore, it is essential for the breeder to design his testing procedures in such a way as to maximise the genetic effects relative to the environmental and interaction effects (Miller et al., 1958).

Breeders need to make selections in the environments in which the useful genetic variability is best expressed, the environmental effects on heritable characters not withstanding (Meredith, 1984). Heritability is the ratio of the genetic variance to the total variance, quantitatively expressed as $H = Vg/(Vg + Ve)$ (Allard, 1960; and Breese, 1968), where H is the heritability, Vg is the genetic variance, and Ve is the environmental variance.

Genetic variance is that part of the phenotypic variance, which can be attributed to the genotypic differences among the phenotypes. The variance of the interaction between the genotype and the environment is the part of the phenotypic variance attributable to the failure of the differences between the genotypes to be the same in the different environments (Dudley and Moll, 1969). Therefore, heritability varies with the environmental factors. This emphasises Meredith's idea that the breeders need to make selections in the environments in which the useful genetic variability is best expressed.

A slight negative relationship exists between yield and quality of flue-cured tobacco. Quality decreased when the cured-leaf yield was more than 2000 kg/ha in DH10 and 2500 kg/ha in Drava. The highest value of a DH10 crop was realized in the season when the highest yields were produced, while Drava reached its highest value in the season during which it produced the highest quality (Smalcelj, 1998).

The problem of the negative relationship between yield and quality has spurred in-depth studies of yield and quality components in other crops also. A new high-yielding cultivar of field pea (*Pisum sativum* L.), Crown, consistently yielded better than the standard cultivar, Whero, by 28.2%, because of its short stature and relatively prostrate growth habit (Jermyn and Russell, 1998). A high variance of 51.9% was detected in the yield of a common buckwheat cultivar. The effect of year was significant in characters like plant height and oil and potassium contents (Michalova et al., 1998). High yielding sugar cane cultivars, PS80-847 and PS80-960 exceeded the target yield for the area in comparison with the control cultivar, M442-51. PS80-960 gave the highest yield and sugar content (11.8%) with straight stems and large stem diameter (Mudefar and Suhardi, 1998). Photosynthesis, chlorophyll fluorescence and symbiotic nitrogen fixation were studied in soybean (*Glycine max* L.) to identify selection criteria for genetically induced cold tolerance. The objective was to enhance the yielding potential of soybean in South Africa (Van Heerden and Kruger, 1998). The drought adaptation mechanism in the tobacco cultivars TL33, CDL28, GS46, and Elsoma, could, in part, be attributed to chlorophyll ***a*** fluorescence (Van Rensburg, 1991). The chlorophyll ***a*** fluorescence values, which are good indicators of photosynthetic efficiency, showed that the more drought-tolerant cultivars, GS46 and Elsoma, had a fast initial decline in photosynthetic efficiency that stabilized as water stress became acute. The less drought-tolerant cultivars, TL33 and CDL28, showed a slow continuous decline.

In Turkish tobacco, the leaf area has the greatest positive direct effect on cured-leaf yield, followed by the number of leaves per plant (Kara and Esendal, 1996). Much as many plant breeding programmes have concentrated on dealing with genetic traits responsible for high yields in turns, a holistic approach is the best means of improving yield (Wallace and Yan, 1998). An operating system of traits is the final determinant of yield levels. It is further argued that from the physiological and genetic viewpoints, biomass accumulation is the major yield component followed by partitioning of photosynthates. Number of days to maturity is another major yield component. Therefore, improved adaptation and number of days required to reach maturity are the most advocated criteria for acceptance of new crop cultivars.

Plant breeders agree that some genotypes do well over a wide range of ecological zones, while others are environment-specific for optimum performance. Some regard the attainment of augmented and stabilized yields as the most important goal in plant breeding (Soliman and Allard, 1991). On the other hand, others employ multiple comparison experimental procedures in regional yield trials to identify genotypes well suited to particular environmental conditions (Piepho, 1995). Such procedures serve as tools for developing site-specific recommendations for particular cultivars. Suitable genotypes are those that do not differ from or are better than the currently recommended cultivar in the area. Therefore, it is important to evaluate breeding materials under the conditions, which are similar to those in which the materials will eventually be used (Allard and Bradshaw, 1964). It is ideal to breed, for every locality, the genotype that is best adapted to that environment (Hill, 1975).

The objective of this work was to evaluate the elite breeding lines of flue-cured tobacco for their field and market performance in Rustenburg. Evaluation of tobacco breeding lines needs to be done over a period of two seasons at four different locations with four replications per location and year (Wernsman and Rufty, 1998). Additionally, an adequate test for genotypic performance should cover such characters as maturity, plant height, number of leaves per plant, cured leaf yield, grade index and reducing sugar and nicotine concentrations of the leaf (Wernsman and Rufty, 1998).

However, Greeff (1986) argued that both fixed location evaluation systems (FLES) and district trial evaluation systems (DTES) are equally efficient as methods of evaluating the performance of cultivars. The genetic yielding potential is best shown with the FLES. The extra years of testing may not really be necessary and fewer trials than are normally conducted would still provide the same results (Greeff, 1986).