My topic is the development of oat and plant breeding methods. I will start with a short history of important ideas and reports, laying the ground work for current oat breeding approaches. The bulk of my report will describe and discuss, in a critical way, the philosophies and approaches currently in use and the technology that may become available to the breeder in the future.

1. INTRODUCTION

Oats have been cultivated for nearly 2000 years (1). Presumably, during most of that time oat breeding efforts were limited to mass selection. Commonly, after harvest and threshing, the grain was cleaned and the heaviest grains saved to plant the next season's crop. This process produced what are referred to as land races, i.e., varieties with local adaptation. This procedure has many limitations for long term improvement, especially for self-pollinated crops. However, considering the lack of knowledge of genetics before 1900, these attempts represented a reasonable approach to plant improvement.

With the report on progeny testing by Vilromin in 1850 oat breeders acquired another option, that of plant selection within the land races (2). This approach was commonly used in the last part of the nineteenth and the early part of the twentieth century. It produced several widely grown varieties including Swedish Select and Sixty Day (3). However this procedure also has limitations, especially for crops which have insufficient outcrossing to produce new combinations of genes. Once the plant breeder identified the most productive individuals within the land race, additional selection within the progeny of a superior plant selection would not result in additional gain.

2. QUALITATIVE APPROACH

Three discoveries, all reported in the first decade of the twentieth century (2), transformed oat breeding efforts dramatically. First, the rediscovery of Mendel's work provided much needed information on how traits are passed from one generation to the next. The second, Johansen's "pure line theory", provided the explanation as to why continued plant selection would not produce additional improvement. The third was Biffen's report that genes, as described by Mendel, controlled resistance to some diseases, specifically the rusts.

The first two reports soon led oat breeders to realise that hybridisation between pure lines would produce progeny with the needed variability to allow selection to be effective. The report on genes controlling disease resistance, combined with the newly rediscovered Mendelian genetics, enabled oat breeders to devise a reliable and efficient
procedure for handling the segregating populations resulting from the crosses they were making. For nearly a half century hybridisation followed by rust screening of seedlings in the early segregating generations dominated oat breeding everywhere that rusts were a problem.

One other paper that added to this approach was the report of Barrus on the physiological races within a pathogen(2). He explained why genotypes previously resistant could, over time, lose their ability to provide protection against certain forms of a pathogen. For the first time breeders began to understand the complexities in breeding resistant varieties. The race between the pathogen and the breeder had started.

The emphasis on selection for disease resistance in the early segregating generations worked well during this time. Some disease epidemics occurred, but many others were prevented by growing resistant varieties. Thus, this defensive approach resulted in valuable contributions to crop production mainly by reducing or eliminating potential losses. However, productivity increases in spring oats due to genetic improvement in the absence of diseases, at least in the midwestern United States, were minimal. This lack of gain in productivity among new cultivars is evidenced by the fact that until recently 'Gopher', the long term check in the American Uniform Midseason Oat Performance Nursery coordinated by the USDA, was exceeded in yield by few newer selections(4).

3. QUANTITATIVE APPROACH

Complementing the discoveries on simply inherited traits such as disease resistance were important early contributions to the understanding of the inheritance of traits controlled by multiple loci(2). Following a report by Nilsson-Ehle on multiple loci affecting oat kernel colour was the classical report by C.E.M. East in 1916 on the genetics of corolla length in tobacco. Several years later, R.A. Fischer wrote two paper(5,6) which also had considerable impact on plant research, genetics and breeding. One of these described correlations among relatives and the other dealt with statistical methods. The first of these two Fischer papers, along with the East paper, was the beginning of quantitative and population genetics on which oat breeders rely today. The second Fischer paper was the forerunner of the Analysis of Variance and various other experimental design concepts. Together these papers helped form the beginnings of the quantitative approach to oat breeding. This approach ultimately would encourage emphasis on the productive potential of the crop rather than merely protecting the crop from disease, i.e. an offensive as well as a defensive effort.

Another major contribution to the quantitative approach to plant breeding was Hull's (1945) idea of cyclic or recurrent selection(7). Initially this procedure was confined to cross-pollinated crops, but recently it has also been more commonly used in self-pollinated species including oats. Further, many oat breeders use cyclic crossing in their breeding programmes even if they do not use recurrent selection systematically.

The classical work of Dr J.E. Grafius made another important contribution to the quantitative approach to oat breeding. His delineation of the components of yield, number of panicles, seeds per panicle, and seed weight as well as their interrelationships provided much needed information on how best to manipulate the oat plant at this component level(8). A related proposal, that of the ideal ideotype by C.M. Donald, went beyond yield components(9). Based on known or presumed relationships between individual plant parts and grain yield, Donald described in