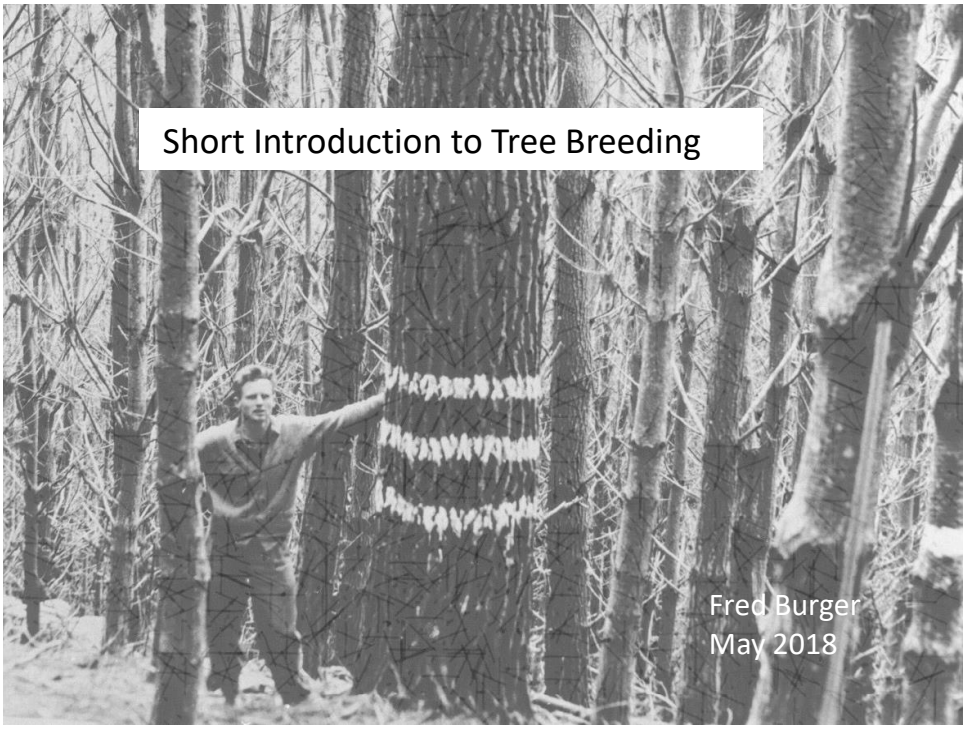

Short Introduction to Tree Breeding
Fred Burger
May 2018


Initiating the production population

Starting a tree improvement program

- What objective
- Which species
- What commitment

Quantitative and Qualitative traits

Describing a population:
mean, variance and standard deviation

Phenotype and Genotype, Heritability

Selection, General combining ability (G.C.A), breeding values, gain

Tree Breeding Cycle

Genotype by site interaction (G*E)

The *P.radiata* NZ angle

Quantitative and Qualitative traits

Quantitative: trait involves many genes, all with small effects, having an additive effect on the end trait

E.g. volume: involves genes coding for

- Leaf structure
- Disease resistance
- Root characteristics
- Metabolism
- Photosynthesis
- Transpiration

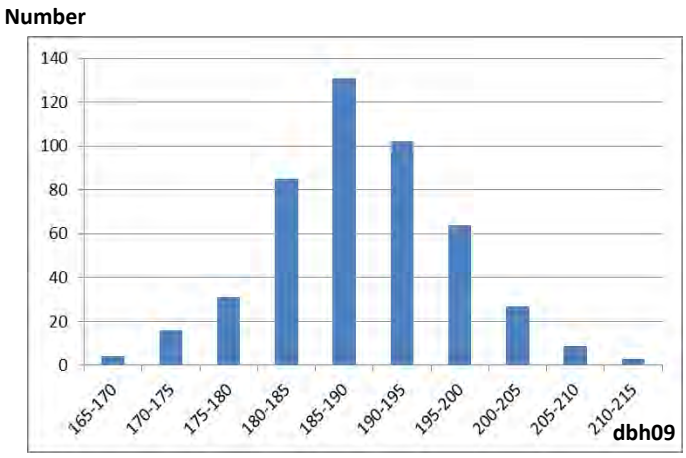
Qualitative: often few major genes involved dividing individuals into distinct types with little or no connection by intermediates

E.g. Blue eyed and Brown eyed individuals

Describing a population

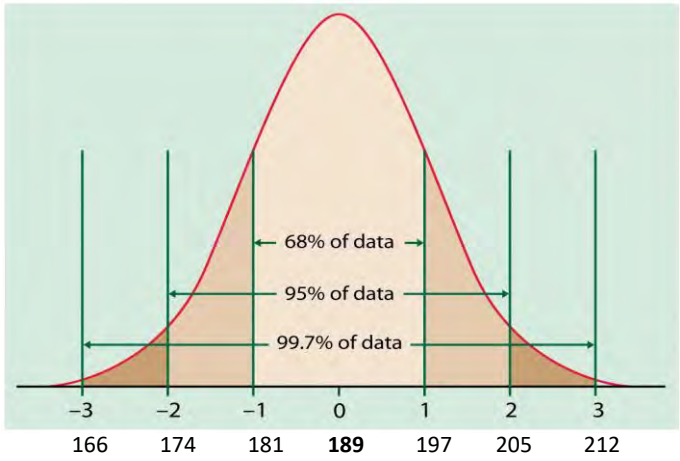
- Mean
- Variance
- Standard deviation

885 series Kaingaroa: dbh08 means of 472 families

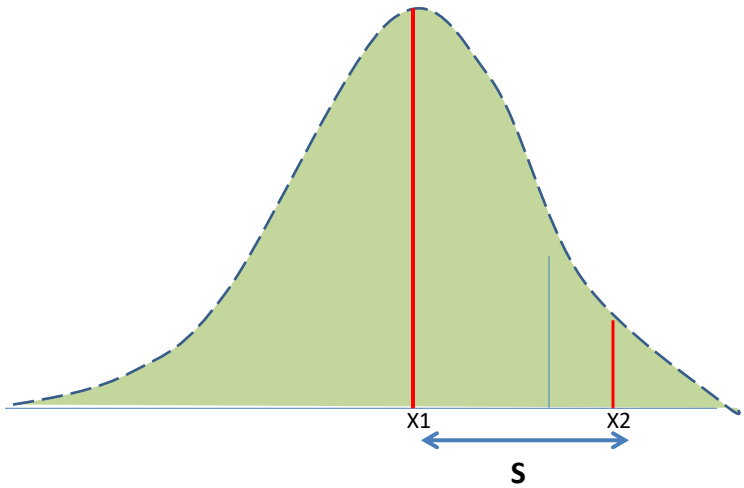


Mean = 189.1
Std = 7.7

The 68-95-99.7 Rule



Selection differential (S)



S = (mean of selected group - population mean)

Gain = h^2S

Phenotype and Genotype; Heritability

Phenotype = Genetic Factors + Environmental Factors

$$P = G + E$$

Phenotypic variance = genetic variance plus environmental variance

$$V_P = V_G + V_E$$

The genetic variance = sum of the additive genetic variance plus non-additive genetic variance.

$$V_G = V_A + V_{NA}$$

Only additive variance can be passed from a parent to its offspring.

Heritability

The degree to which parents pass their characteristics on to offspring

=

the ratio of additive variance total variance

$$h^2 = V_A/V_P$$

- Varies between 0 and 1
- Is site and population dependent

Selection, General Combining Ability, Breeding values, Gain

Genetic value of parents

expressed as

General Combining Ability (G.C.A)

Definition:

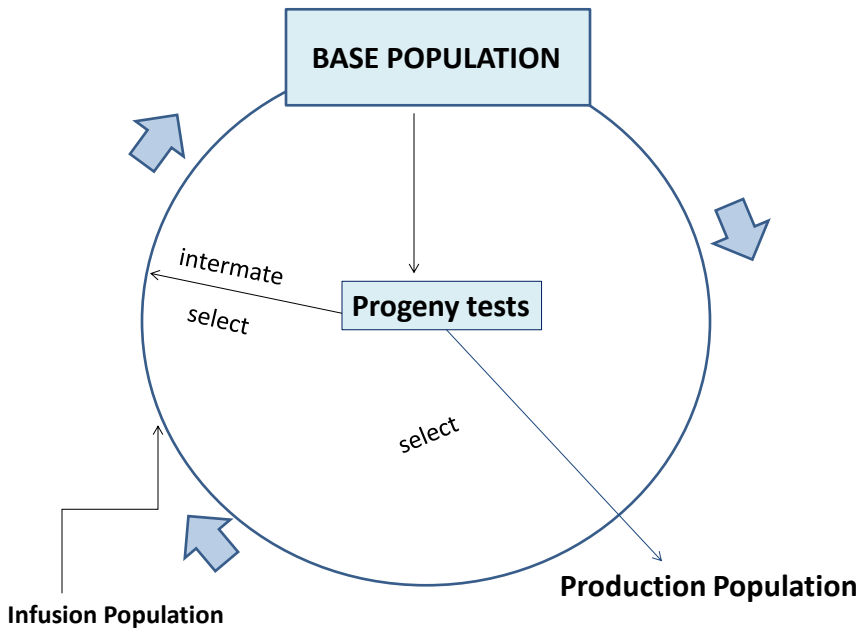
The average performance of an individual when mated to a number of other individuals in the population

Estimating G.C.A and breeding values

Female parents	Male parents a	b	c	d	Progeny ♀ means
e	9	17	12	14	**13**
f	10	16	12	10	**12**
g	11	20	10	15	**14**
h	14	15	6	17	**13**
Progeny means ♂	**11**	**17**	**10**	**14**	Test Mean **13**

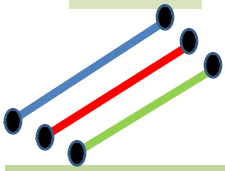
GCA parent b = 17-13 = +4; beevee parent b = 2*GCA = +8

Tree Breeding Cycle

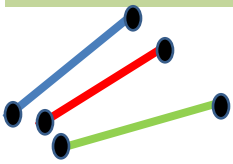


Genotype by site interaction (G*E)

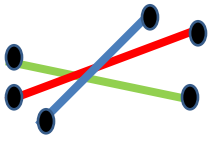
No G*E:



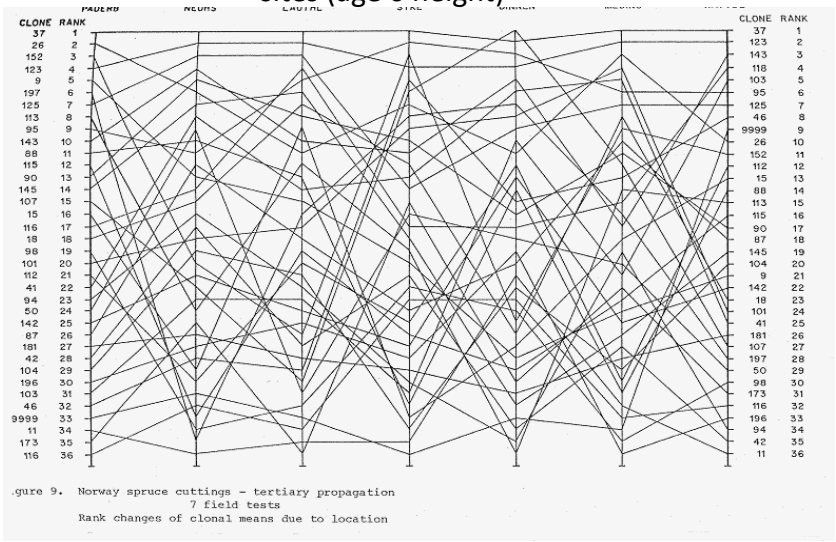
G*E due to change in scale:



G*E due to rank change:



Norway spruce, Germany; Rank changes of clonal means over 7 sites (age 6 height)



gure 9. Norway spruce cuttings - tertiary propagation
7 field tests
Rank changes of clonal means due to location

The *P.radiata* NZ angle

NZ's Breeding Strategy:

Recurrent selection for general combining ability

P.radiata provenances


40
38
36
OREGON
San Francisco
Ano Nuevo
450 ha
Monterey
5000 ha
Cambria
1200 ha
CALIFORNIA
NEVADA

Tree Breeding: Origins of radiata planting stock deployed

All germplasm currently deployed originated from 3 rounds of plus tree selections carried out in the NZ landrace:

- 850 series: 109 plus trees — 1950-1960
- 268 series: 588 plus trees — 1968
- 885/887/888 series: 1,000 trees — 1985, 1987, 1988

1978: Eldridge-Firth seed collection in native provenances followed by provenance testing in later years

Results from *P.radiata* provenance testing

- NZ landrace performed best, followed by
- Ano Nuevo and Monterey provenances

- NZ Landrace very much intermediate between Ano Nuevo and Monterey (gas-liquid chromatograph analysis of monoterpenes)

850's

676's

268's

668's

266's

880's

875's

870's

867's

887's

188's

288's

873's

869's

874's

888's

New tools in the toolbox of traditional tree breeding

- Lidar: remote sensing by means of a pulsed laser
- Moleculair genetics – genomic selection