Development of a Stabilized Jersey – *Bos Indicus* Cross for Tropical and Sub-Tropical Conditions

"Jersiwal"?

Issues of Pure Jerseys in Tropical and Sub-tropical Conditions

- Despite the significant advantages of introducing pure Jerseys in tropical or sub-tropical countries for milk production improvement, there are still several drawbacks
- Although the Jersey breed is the most **Heat Tolerant** of all the *Bos taurus* dairy breeds, it still suffers heat stress in hot (>32^{o}C) and humid (>80% humidity) conditions, that depresses appetite and hence milk production. This is because it does not have the density or size of sweat glands in the skin that Zebu / *Bos indicus* cattle have that enable them to sweat sufficiently to cool the body. These conditions are quite prevalent in tropical and sub-tropical countries, for at least a large portion of the year.
- The Jersey breed is also not genetically **Tick Resistant** to the cattle ticks that are prevalent in tropical and sub-tropical countries, unlike Zebu / *Bos indicus* cattle that are naturally tick resistant. Tick infestation also causes stress and has the potential to introduce parasite borne diseases, both of which depress milk production and lead to animal health and management issues.

Jersey Cross-Breeding

- These disadvantages are largely overcome if the Jersey breed is used in cross-breeding programs to upgrade local cattle (generally Zebu or *Bos indicus* cattle in Tropical and Sub-tropical areas) to have improved milk production while retaining their heat tolerance and tick resistance.
- However, in order to retain the heat tolerant and tick resistant characteristics of the Zebu / *Bos indicus* cattle, it is important not to go over 62.5% (5/8th) Jersey genetics in the cross-bred animals. This limitation was established by the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) in extensive cross-breeding research and testing from the mid 1950s to the early 1980s in tropical and sub-tropical areas of Australia, using Jersey and Sahiwal and Red Sindhi crosses (both *Bos indicus* dairy breeds from Pakistan and India). This eventually produced a stabilized Jersey-Sahiwal crossbred called the Australian Milking Zebu (AMZ) – see link below:
- https://csiropedia.csiro.au/the-australian-milking-zebu-1977/

Challenges with Progessive Cross Breeding

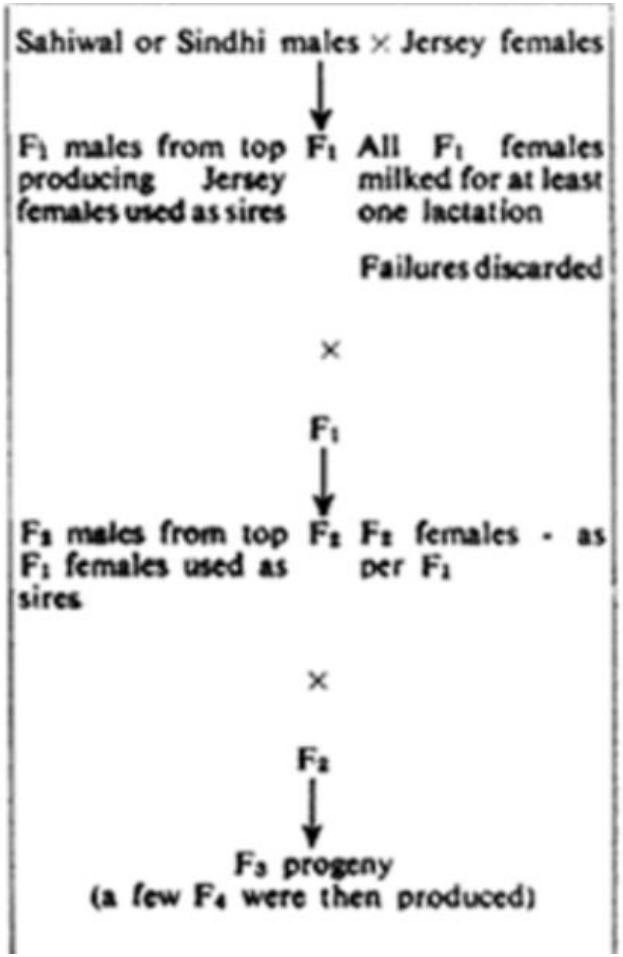
- First Cross: Jersey x local Zebu / Bos indicus breed (50% Jersey:50% Zebu) – good heat tolerance and tick resistance, improved milk production
- Second Cross: Jersey x First Cross (75% Jersey:25% Zebu) – further improved milk production but less tick resistance and heat tolerance (no longer a fully easy-care animal)
- Third Cross: Jersey x Second Cross (87.5% Jersey: 12.5% Zebu) – loses heat tolerance and has tick infestation problems (no longer a robust easy-care animal for a small holder farmer)
- Optimal animal is stabilized 62.5% (5/8th) Jersey and 37.5% (3/8th) Zebu (First Cross x Second Cross, as per above) which balances a good level of milk production from the Jersey genetics while retaining the heat / humidity tolerance and tick resistance of the Zebu genetics

1950s-1980s Development of the Australian Milking Zebu (AMZ)

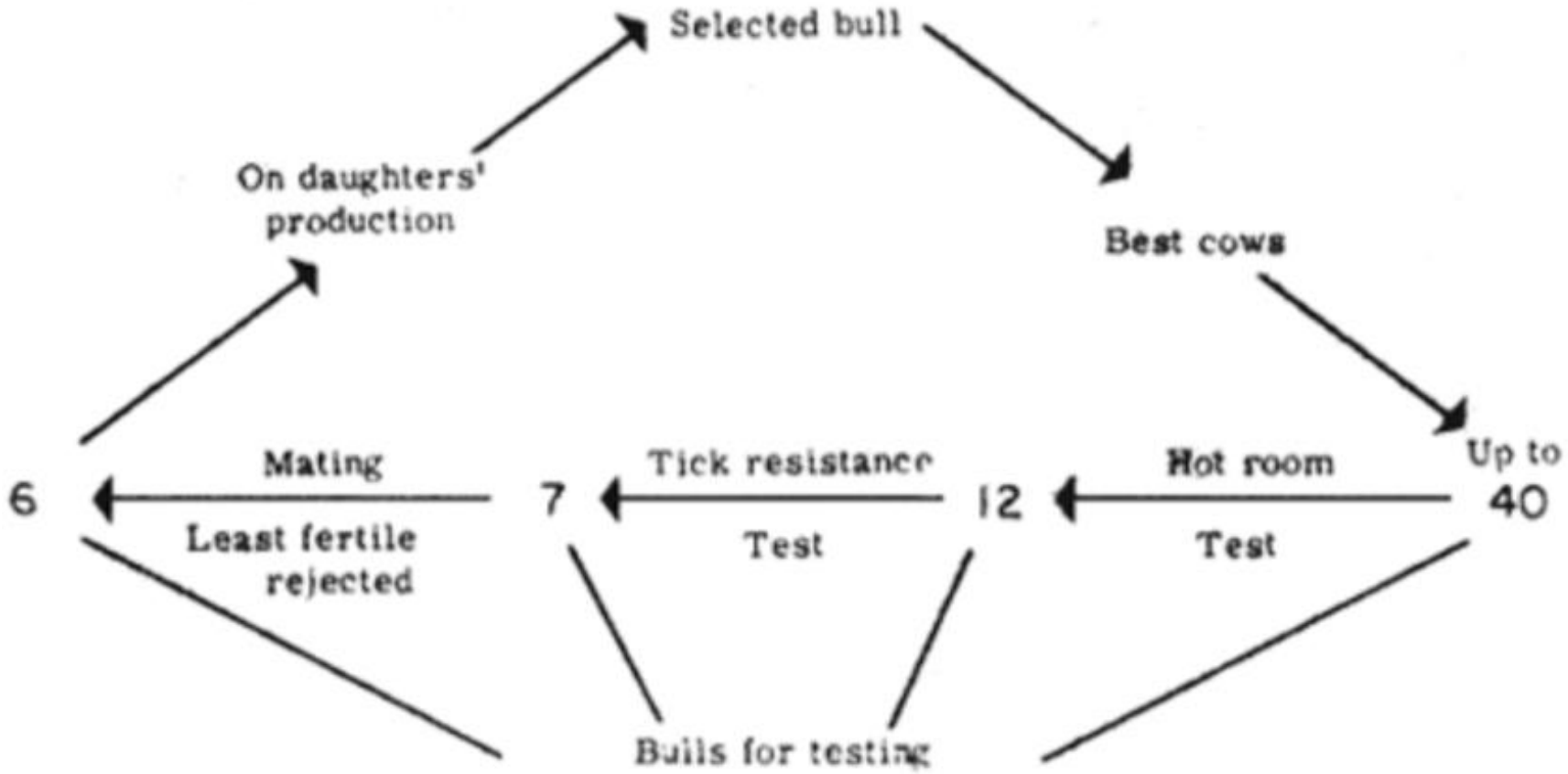
Jersey cows (3500-4600 L/lactation)
***Bos taurus* genetics (not tick resistant)**

Sahiwal bull (from Dam with 2000+L/lactation)
***Bos indicus* genetics (tick resistant)**

AMZ Breed Development 1955-1980



AMZ Testing and Selection Process



Stabilized AMZ (5/8th Jersey : 3/8th Sahiwal) cattle by 1974: Heat tolerant, tick resistant, good milk production (average 3500 L / lactation with elite up to 4,600 L /lactation)

Proven, progeny tested AMZ Bull

Australian Milking Zebu (AMZ)

- CSIRO released the AMZ to commercial dairy industry in sub-tropical and tropical areas of Australia in the 1970s and retained control of the breeding nucleus of elite animals until early 1990s, which was then was sold to a commercial artificial breeding company.
- Unfortunately, the elite genetic material of the AMZ (semen, embryos, elite bulls and cows from the nucleus herd) was all exported to Mexico by the commercial artificial breeding company and it dissipated there with no systematic breeding or maintenance. Hence it effectively dissipated and died out in Australia and Mexico and was lost globally.

Opportunity to Re-Create a Suitable Stabilized Jersey – Bos indicus Cross for Tropical and Sub-Tropical Conditions

- Both Jersey genetics and the genetics of *Bos indicus* dairy breeds have improved very significantly since the 1970s.
- Artificial breeding technology has also very significantly progressed since the 1970s:
  - Superovulation and embryo transfer
  - Embryo freezing
  - Cattle *in vitro* oocyte maturation (IVM), fertilization (IVF) and embryo production (IVP)
  - Juvenile female calves' oocyte collection and *in vitro* embryo production to shorten generation interval (JIVET)
  - Genomics to enable very early selection as juveniles
  - Use of sexed semen
- This should enable the re-creation of a suitable stabilized Jersey – Bos indicus cross much more rapidly than the 20 years needed for the AMZ (potentially within 6-8 years with the use of in vitro embryo production techniques, JIVET and genomics)

Quality Jersey Cows

Jersey Bull

Jersey Dairy Cattle

- Temperate (*Bos taurus*) dairy breed.
- Some heat tolerance (better than most *Bos taurus* breeds)
- But NOT tick resistance
- Medium size 400-450kg adult cow weight
- Very good milk production
- 1970s ~ 3000-5000 L / lactation (10 months duration)
- 2022 elite at 7000-9500 L / lactation with excellent milk solids content (fat 5+%, protein 4+%)

Sahiwal Cow and Calf

Sahiwal Bull

Sahiwal cattle

- Indigenous dairy breed from NW India / Pakistan
- Heat tolerant, tick resistant
- Medium size of 350-375kg adult cow weight
- Good milk production (9-10 months duration)
- 1970s ~ 1500-2000 L / lactation
- 2022 elite cows at NDRI 3500-4500 L / lactation (generally over 5% fat content in milk)

Reviving the AMZ: Option 1

High Genetic Merit Sahiwal Cow - modern selected genetics (4000+L/lactation, at least 5% fat content in milk)

Modern Jersey Bull (progeny tested with daughters producing at least 7500+L/lactation, >5% fat and >4% protein content in milk)

Reviving the AMZ Option 2

Jersey cows (7500+ L/lactation, >5% fat and >4% protein content)

Sahiwal bull (from Dam with 4000L+ /lactation, >5% fat content)

Reviving Stabilized Elite Jersey-Sahiwal Cross

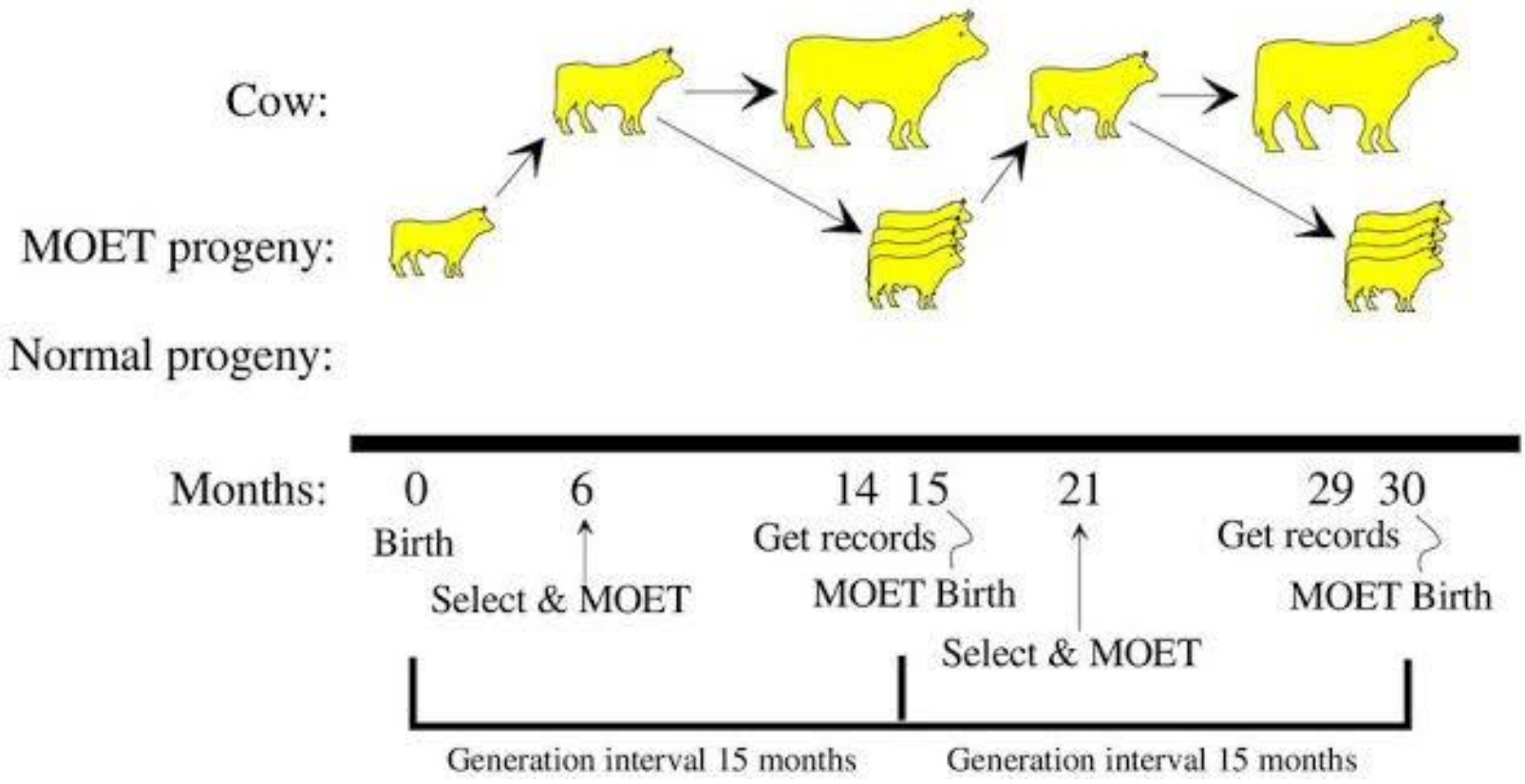
- Elite Jersey bulls (7,500-9,000 L) x Elite Sahiwal Cows (3500-4600 L) = F1 (5,500+L / Lactation)
- F1 (5,500+L) x Elite Jersey (7,500 L) = F2 (6,500+ L / lactation, 75% Jersey, 25% Sahiwal)
- F2 (6,500+L) x F1 (5,500+L) = F3 (6,000+ L / lactation, 62.5% Jersey, 37.5% Sahiwal) -> test for tick resistance & heat tolerance, select best F3 for on-breeding
- Best F3 x Best F3 ->F4 as stabilized 5/8th Jersey 3/8th Sahiwal ("Jersiwal"). Select best F4 for on-breeding and for semen widespread use and embryo production
- Need to use advanced breeding technology (JIVET, MOET, Genomics and Sexed Semen) to shorten generation interval to quickly produce a stabilized Jersey-Sahiwal breed within 4 generations (possible within 6-8 years) with proven production capacity in a high temperature / humidity and high tick pressure environment
- Production should stabilize around 6000+L/lactation level, >5% fat and >4% protein content in milk
- Maintaining a minimum of 37.5% *Bos indicus* genetics to retain high levels of heat tolerance, tick and disease resistance

Stabilized modern “Jersiwal”: Heat tolerant, tick resistant, good milk production (should be able to average 6000 L / lactation, with >5% fat and >4% protein content)

Tools to Speed Up Jersey-Sahiwal Breed Stabilization

- Shorten Generation Interval by using Juvenile in Vitro Embryo Production and Transfer (JIVET)
  - Collect immature oocytes from 1-3 month old female calves
  - Mature oocytes in culture to ovulated oocyte equivalent
  - in vitro fertilization (IVF)
  - Embryo culture to day 6 blastocyst stage, transfer into adult surrogates
  - Female side generation interval shortened to 12 months (3 months of age oocyte donors + 9 months pregnancy) rather than a 24 to 36 months in natural breeding
  - 4 generations in 4 years rather than 8-10 years

JIVET Generation Interval in Cattle



Genomics

- Assessment of key production genetic markers of animals at a very young age by DNA testing to select elite animals to enter into breeding programs
  - intensifies selection to narrow down number of males going into AI progeny testing programs
  - Intensifies selection of females for MOET or JIVET programs
- For Cattle have genomics markers for milk production characteristics

Rates of Genetic Gain

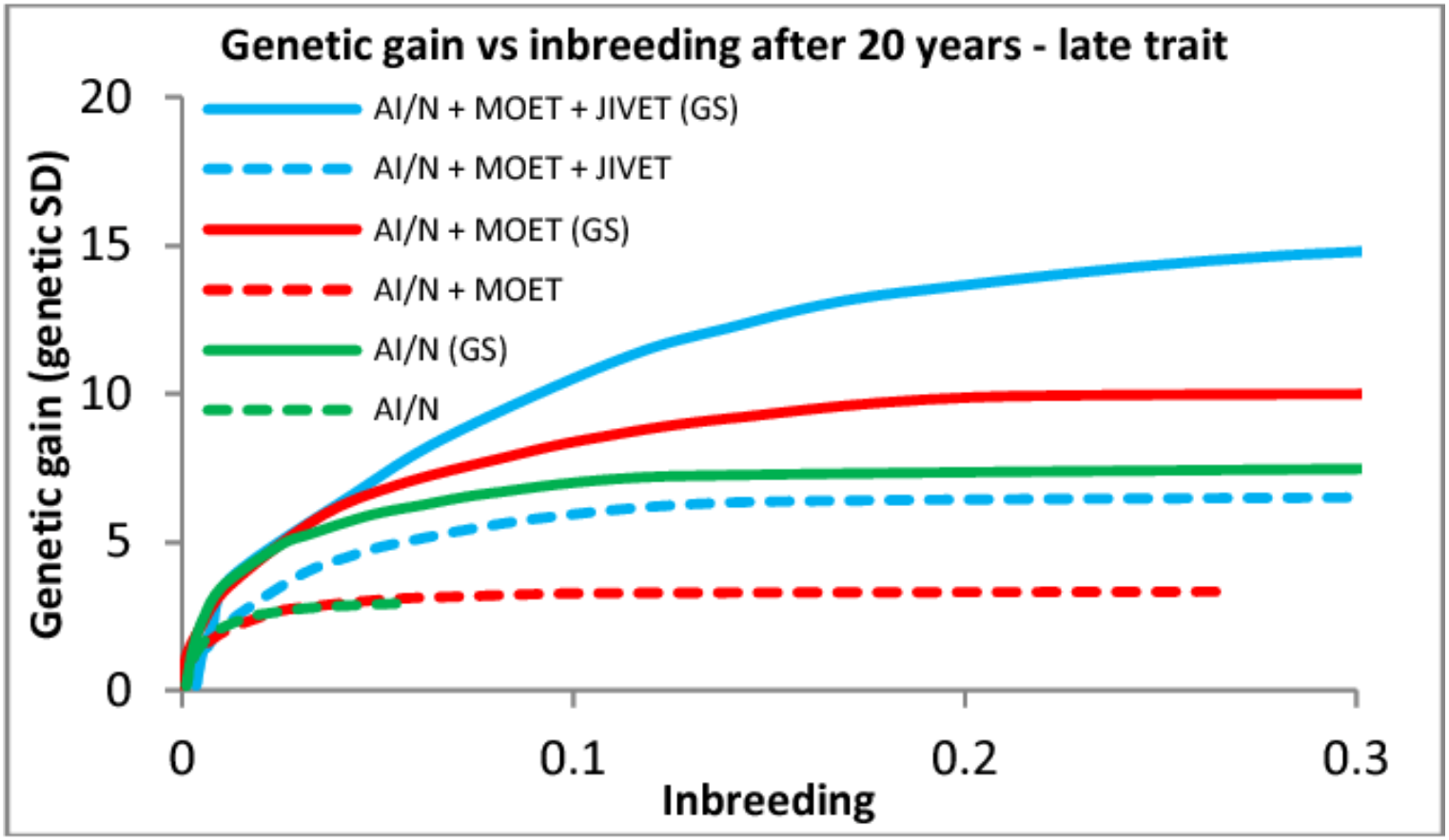


Figure 2: Genetic gain and inbreeding after 20 years in

Potential Site for Initial “Jersiwal” Development

- Best Sahiwal Genetics are available in India
- Bharatiya Agro-Industry Foundation (BAIF), based near Pune in India, has very strong experience in dairy cattle Artificial Breeding:
  - Artificial Insemination (AI; produce 12 million doses of semen / year, including sexed semen) and have AI technicians that work with over 3.7 million small holder dairy cattle farmers
  - Ultrasound guided oocyte pick-up/aspiration (OPU) followed by in vitro embryo production undertaken on a weekly basis in their embryology laboratory – oocyte collection from their elite cows to produce future bulls for AI.
- BAIF are keen to partner on this endeavor to develop a stablized “Jersiwal” and then to produce “Jersiwal” semen and embryos for export to interested countries to enable the establishment of more nucleus herds for further multiplication
- Technical and scientific support cost structures are much more affordable in India than in other western countries that have established in vitro embryo production laboratories and capacities

THANK YOU FOR YOUR ATTENTION