“Armstrong’s Folly”: the development of the Saudi Barn and evaporative cooling for the Southwest Dairy Industry

Robert Collier | University of Idaho (retired) | University of Arizona (emeritus)

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Robert J. Collier

Animal, Veterinary and Food Sciences

University of Idaho (retired)

School of Animal and Comparative Biomedical Sciences

University of Arizona (Emeritus)

Dennis Armstrong

Introduction

Dennis Armstrong, one of the greatest Dairy Extension faculty of the 20th century was born in Big Springs, Nebraska on July 1, 1935. He lived near the Ogalala Sioux reservation and spent many hours playing with the local native kids. He grew up believing he was part Sioux. After graduating High School, he attended Colorado State University and graduated with a B.S. in Animal Science in 1957. He then took a job as Assistant Herdsman, Adohr Milk Farm, Camarillo, California (2,600 cow dairy) from 1957-1959. From 1959-1960 he served as Herdsman, of the Colorado State University, Dairy in Fort Collins. He then decided to pursue an M.S. degree and from 1960-1972 he served as Dairy Farm Manager and Instructor, Dairy Science Department, Michigan State University and also earned his M.S. in Dairy Science in 1964. In 1972, he and his family moved to Tucson, Arizona to manage the Shamrock Dairy. In 1973, he was hired as an Extension Dairy Specialist and Research Scientist, Department of Animal Sciences, University of Arizona, Tucson, Arizona. It was a pivotal time in the history of the Dairy Industry of Arizona. The state population was increasing rapidly but the extreme heat made it difficult to operate a dairy which led to milk deficits in Arizona and milk was shipped into Arizona in the 70’s.

Approximately 90% of Arizona's 155 dry-lot dairy operations were located within 60 miles of Phoenix.

Dennis began his work at the U of A on milking equipment, parlor layout and parlor efficiency (Armstrong et al. 1973, Bickert et al. 1973, Armstrong and Wegner. 1983, Armstrong and Quick, 1986). These studies were pivotal in working out designs for milking systems in large dairies because the Arizona Dairy Industry was expanding in both herd size and cow numbers. As time passed, his focus changed to facility design for large dairies, particularly those in hot, dry climates (Smith et al. 1997). However, he always maintained his interest in parlor efficiency and would often be up early each morning to visit a dairy and check milking times and parlor turnovers. He teamed up with 3 key U of A faculty in those early years. They were Gary Stott, Animal Physiologist, Frank Wiersma, Agricultural Engineer and Otish Lough, Dairy Extension. One of the first things they developed was a temperature humidity index for dairy cattle shown in Figure 1. This was widely used for over 3 decades before being updated by Rosemarie Burgos Zimbelman and others due to increased milk yields of modern cows the threshold for losses in milk production was lowered from a THI of 72 to a THI of 68, Zimbelman et al. 2009.

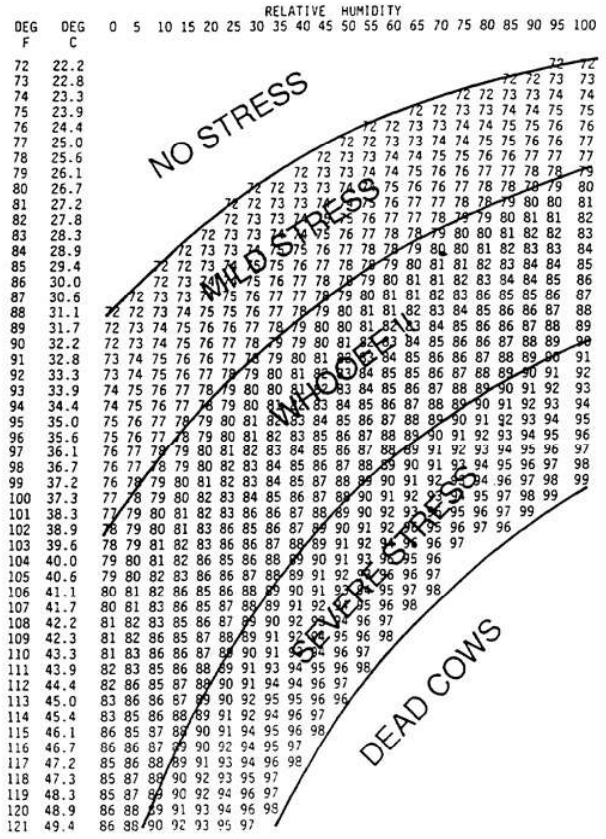


Figure 1. Temperature-humidity index table for dairy producer to estimate heat stress for dairy cows. Deg = Degrees. Relative humidity expressed as percentage. (From Frank Wiersma, 1990, Department of Agricultural Engineering, The University of Arizona, Tucson.)

Dennis then began collaborating on developing housing and cooling systems for dairy cattle in the desert southwest. What follows is an excerpt written by Dennis Armstrong for the History of the Arizona Dairy Industry.

“In the late 1970s, I took on some of the responsibility for researching and developing methods to reduce the effects of heat stress on dairy cattle. Drs. Frank Wireman and Glenn Stott developed and tested an evaporative cooling system and were experimenting with different systems on dairy farms in the Phoenix area, including those belonging to Pete Burgeon, Jim Tappan, and Sharp’s. The major effort to reduce stress on cows in Arizona at that time involved the use of fogger systems in holding pens and providing shade for milk cows. Not all milk cows had access to shade, and very few dry cows were shaded.

By 1978, Stott and Wiersma had developed a cooling system for shade in the corral, and it was installed at Sharp’s dairy. Data indicated an increase in milk production of four to five pounds of milk over the summer season. Also, the use of a spray and fan system in the holding pen and shade over the feed area were being tested. As temperatures in Arizona can vary from one summer to another, researchers require multiple years of data in order to evaluate a given cooling system.

In 1978, I had the opportunity to assist Masstock, a company from Northern Ireland that built beef-feed barns in Europe. It also had built a dairy in Saudi Arabia and had several more projects scheduled for the next few years. The Masstock dairy farms were a cross of European free-stalls, slotted-floor milk cow barns for the milking cows, and open lots and shade for the dry cows and heifers. The free-stalls were concrete with one-inch-thick rubber mat. The barn had side walls for protection from sandstorms. Very few of the cows would lie down on the free-stall mats, instead standing all day on the slotted floor and going out into the open corrals at night. Day time high temperatures from late April through October averaged 115 degrees Fahrenheit.

By 1984 in Arizona, Korral-Kool had developed a cooling system for the shades in corrals, and many dairy farms were using a spray-and-fan system in their holding pens. Arizona dairymen were not as willing to use a pen of uncooled cows as controls in the Phoenix area, and we realized that summer temperatures in Tucson only gave an opportunity to collect data for three months and were not as hot as Phoenix. I realized that the data being collected in Saudi Arabia on a year-to-year basis was more reliable, and one year’s data could be used to evaluate Arizona conditions as well.

Dairymen in Saudi Arabia were interested in maintaining the free-stall slotted floor, side-wall barns, and air conditioning was suggested as an alternative design. The estimated cost of installing a unit for a 200-cow barn was $4.5 million. I received permission from Bob Snedigar and Dennis Hakes to use Bob’s 40-cow tie stall barn as a research unit and Dennis’s cows as research subjects, and we compared the use of air conditioning with the use of Korral Kool. The results of this trial led Masstock to discontinue the idea of air conditioning and begin purchasing and employing Korral Kool—to great success.

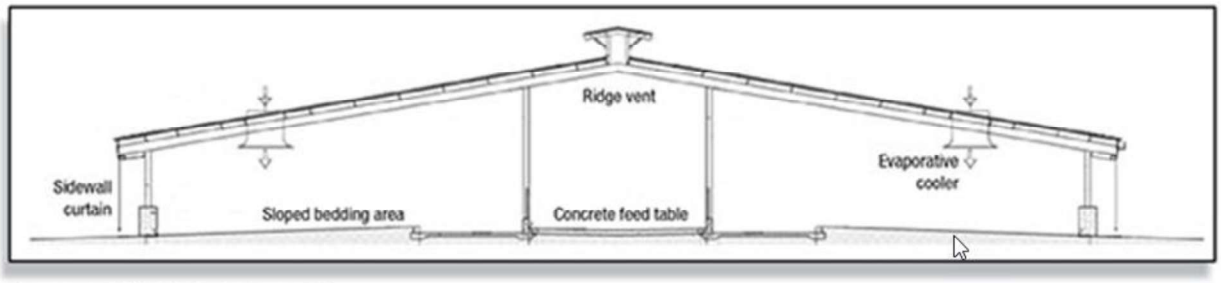
In 1986 Masstock built a 200-cow research barn with two 100-cow pens and a drive-through covered feed area. It looked just like a free-stall barn, only the area behind the cow platform was replaced with a 25-foot area of sand. Korral Kool was used to cool the cows. The first year, manure management was a disaster, with the area becoming a wet hole. During one visit to the farm, I picked up the barn plans, and at the top was the label "Armstrong's Folly," with a design to change it into smaller pens for calves from three to five months of age. After several meetings with the farm manager and staff of the new barn, we decided to remove the wet material three to four times each day when the cows were out being milked and dragged in dry sand to keep the area dry. The next year this frequency shifted from twice a day in March to four times a day in May, and the shaded area remained dry all summer. Cows lay in the shade and only went out into the corral at night. Their feed intake increased, as did milk production.

In 1987 Arizona dairymen Tom and Dennis Dugan visited Saudi Arabia. When they returned to Arizona, they not only designed a housing system similar to what they had seen on the trip but also brought back the management system necessary to make it successful.

From two countries half-way around the world from each other, we worked successfully under the same conditions for the marriage of two concepts. In the past fifteen years, the majority of new dairies built in Arizona have been the Saudi design, and the majority of cows in Saudi Arabia are cooled by coolers designed for Arizona dairymen. The message of this story is, if we had not traveled, we would never have had a chance to be a part of this story."

--Dennis Armstrong, University of Arizona

Figure 2. Example of a Saudi Barn with Korral Kool units.

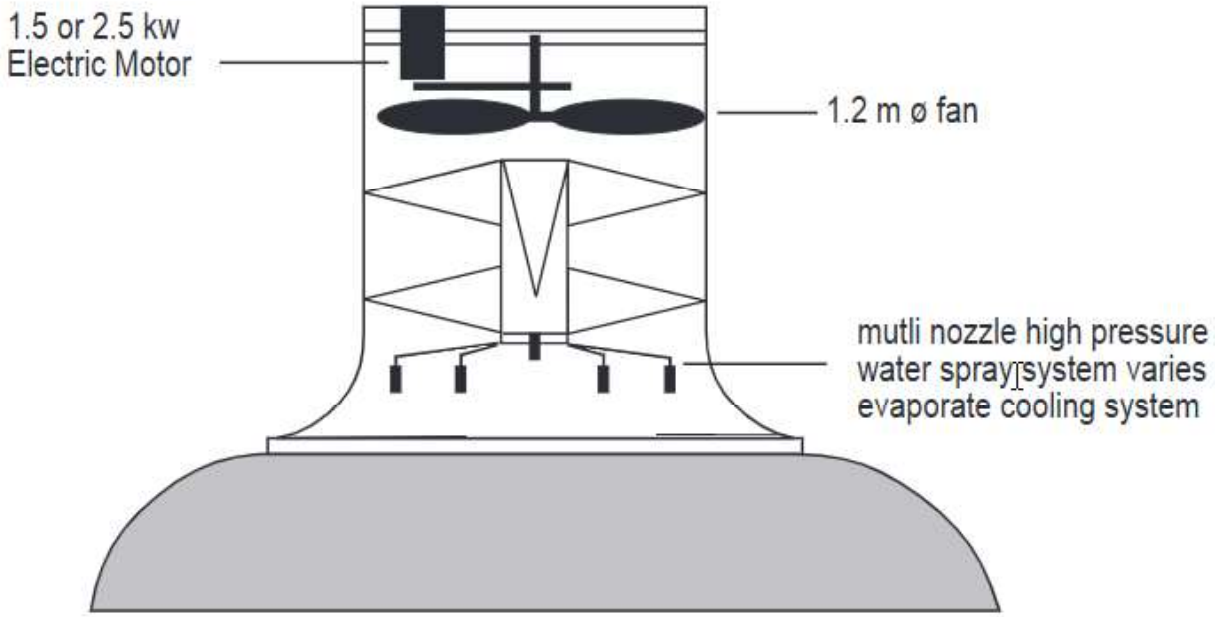


Courtesy of JGM III Dairy Design Team

Dennis collaborated with Bob and Larry Gorden of Korral Kool (KK) to evaluate the efficacy of their cooling system under Arizona conditions (Armstrong et al. 1988, Armstrong, 1994) and then in Saudi Arabia where the heat stress period is longer and more intense, (Ryan et al. 1992). The KK system (Figure 3) consists of independent reverse chimney units (1.4 m in diameter) mounted in the middle of the roof at 6-m intervals., (see Figure 2). These units release high-pressure mist (up to 8.6 L/min) into an airstream, which is ejected through metallic veins, creating a cyclonic motion of the air/mist combination. The water evaporates before hitting the ground, which decreases the air temperature. This system also uses curtains on the west side of the shade to protect cows from the radiation of the sun in the afternoon hours.

This is required because the cooling units are fixed and do not move with the shadow as the angle of sunlight changes through the day. The two main advantages of this system are that it cools cows continuously and there are 16 different settings or combinations of air flow and water injection depending on the severity of the heat stress.

Figure 3. Cross-section of Korral Kool unit.



The cooler location relative to the roof of the barn is shown in Figure 2.

The work on parlor efficiency and housing design led Dennis to getting involved in overall dairy design and in 1990, Dennis teamed up with Jake Martin to form a dairy design team. From 1990 until his death in 2024, Dennis and Jake traveled to over 30 countries and by Jake's estimation assisted in the design of close to 100 dairies. A picture of Dennis and Jake is shown in Figure 4. Another key figure during this period was John Smith who joined New Mexico State University as a Dairy Extension Specialist in 1989. He and Dennis teamed up to serve dairies in the Desert Southwest. In 1995 John joined the faculty at Kansas State University but continued his collaboration with Dennis. John and Dennis joined Michael Gamroth to form the Western Large Herd Conference in 1993. A picture of the original committee for the Large Herd Conference is shown in Figure 5. In 1985, Dennis teamed up with Arnaldo Burgos and Tal Huber to form the Southwest Nutrition Conference held each year in the Phoenix area which became a major source of information for producers, nutritionists and industry professionals and continues to this day.

Figure 4. Dennis Armstrong and Jake Martin

Figure 5. Western Large Herd Conference Organizing Committee

Dennis Armstrong, University of Arizona – Co-chairman
Mike Gamroth, Oregon State University – Co-chairman
John Smith, New Mexico State University – Co-chairman
Donald Bath, University of California-Davis
Ruth Blauwiekel, Washington State University
Ron Bowman, Utah State University
Dennis Halladay, The Western Dairyman Magazine
Donald Klingborg, University of California-Davis
Richard Norell, University of Idaho
William Wailes, Colorado State University
Chris Woelfel, Texas A&M University

Conference Organizing Committee members (kneeling and seated l-r):Chris Woelfel, Mike Gamroth, John Smith, Don Bath, Ruth Blauwiekel, Dennis Armstrong, and Richard Norell. (Standing, l-r): Donald Klingborg, Ron Bowman, and Bill Wailes.

Dennis did not stop his work on evaluating cooling strategies with the Korral Kool system. He went on to test sprinkler systems with and without fans, tunnel and cross ventilated barns, and

oscillating fan systems with and without water injection as well as different barn and milking parlor designs. All of these approaches are in use on different dairies in the southwest. Additionally, he maintained his interest in milking parlor efficiency and design. He collaborated or consulted with dairy producers, engineers, animal scientists and veterinarians all over the world to improve dairy production systems.

In summary, Dennis Armstrong was not an inventor or an engineer, but he was a master at translating science into practical solutions for on farm problems. He not only impacted the dairy industry of the southwest but through his collaborations had world-wide impacts on dairy systems in a host of different environments. He was one of a kind.

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