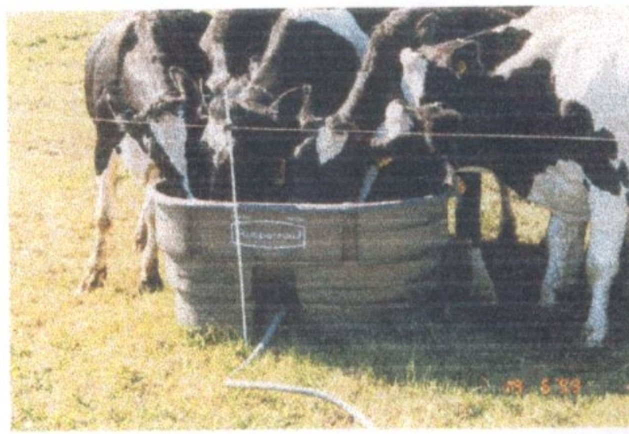
USDA Northeast Region Sustainable Agriculture Research & Education Program
1999 Farmer/Grower Research Project

FINAL REPORT

29 May 2000



Project Title: **Dietary Water Needs of Lactating Dairy Cows on Management Intensive Grazing**

Project Number: FNE 99-235

Project Leader: Dan & Ann Carey
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Groton, NY13073

GOAL:

In the conceptual stages of this study, as minimum we set out *to quantify the actual volume of water lactating dairy cows consume thorough a trough on pasture* where 1) management intensive grazing is being correctly practiced, 2) ample quantity of high quality water is provided in close proximity to grazing activity, 3) no shade is available; *and estimate relative contributions of water from pasture forage*. Upon further contemplation, additional goals were included:

- Determining which residency period (i.e., day or night) contributes most to overall dietary water intake at the pasture.
- Estimate the quantity of pasture forage intake by the herd during each residency period.
- Measure pasture forage quality.
- Identify degree of heat stress experienced throughout the grazing season.
- Determine the influence, if any, water temperatures in pasture trough may have on actual draw by cows.
- Identify any patterns that may exist in the instantaneous consumption of water by cows from pasture trough during two residency periods.

SETTING:

Only one significant change occurred in our operation between the time we applied for the SARE grant and its conclusion. The main laneway servicing the primary pasture land was slightly realigned in 1999 to provide more balance of the acreage on either side of it.

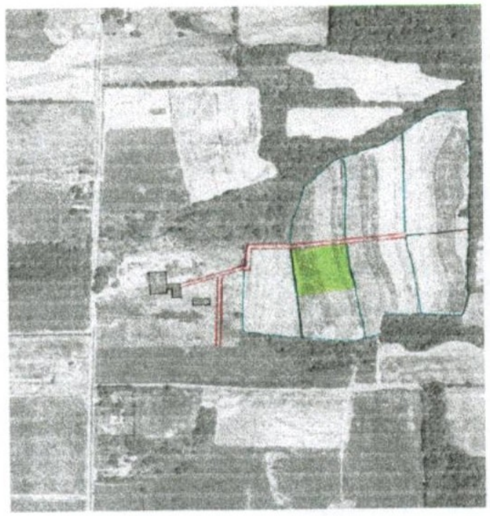

Figure 1. Management Unit I (i.e., primary pasture) of the grazing system for the lactating cows showing the location of the study paddocks in light green. The main laneway leading from the freestall barn & milking parlor is illustrated by the double red lines. Dark green lines on the inside establish major subdivisions. North is to the top of the aerial photograph.

Enterprise:	Full-time dairy cattle farmers located in Tompkins County, NY who have been actively producing quality raw milk for over 23 years.
Land Base:	Our farm currently consists of 620 owned acres and 18 rented acres.
Land Use:	Approximately 150 acres are devoted to the grazing system for the milking string of which roughly half (i.e., 75 acres) has the first cut taken off as haylage for stored roughage. The rest of the open ground is allocated to either hayland or cropland where corn silage is grown as an annual crop and rotated with hay. Other land is a either woods, traditional pasture, or farmstead.
Livestock:	180 Holstein cows (lactating + dry), 160 Holstein heifers (open + bred), 16 Holstein calves. The number of youngstock varies throughout the year due to fluctuations in freshening of cows at different seasons. Live weights of milkers ranges from a low of 1050 to a high of 1500, but averages about 1300 pounds per head.
Soil Type:	The soil which predominates on the area of the grazing system where the study took place is Bath/Valois channery silt loam.

Figure 2. Drilled well serving as water source for milking cow grazing system and freestall.

Figure 3. Improved section of main laneway leading from milking parlor.

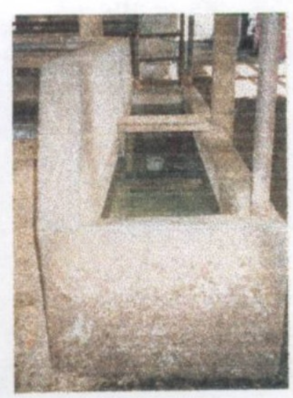

Figure 4. One of seven water troughs located in freestall barn.

Figure 5. The distribution system leading from the well at the farmstead consists of 1.25" diameter black high density polyethylene pipe laid above ground at the toe of laneway fencing. Thicker walled 160 PSI pipe was actually used.

Figure 6. An overview of study paddock # 1 looking downhill past water trough towards the farmstead. Large white fiberglass post in foreground is the top corner of this paddock.

Figure 7. The study paddocks contain strips of two different types of sod. On the left is a 1997 seeding of orchardgrass and ladino white clover, while on the right is a much older sod originally seeded down to alfalfa, red clover, and timothy.

COOPERATORS/COLLABORATORS:

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- TECHNICAL ADVISOR
- develop experimental design
- procure & install instruments to take & record measurements
- collect most data/samples
- evaluate results & draw findings
- generate reports & graphs
- incorporate into slide presentations
- develop traveling display
- disseminate information/reports/news releases

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- review experimental design
- assist in evaluating results & drawing findings
- disseminate information from project

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- review experimental design
- assist in evaluating results & drawing findings
- provide perspective from ruminant nutrition standpoint
- disseminate information from project

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- review experimental design
- assist in evaluating results
- disseminate information from project
- recommend possible revisions of NRCS technical guidance criteria

Other persons not originally identified in the proposal did actively and significantly contribute to the study. These include:

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- backup data/sample collector

Mark Ramos, Entomologist
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- provide meteorological data from the H.C. Thompson Research Farm weather station

EXPERIMENTAL DESIGN:

FACILITIES - The livestock watering system consists of a drilled well with a submersible pump as the source, a distribution network of above ground 1.25 inch diameter plastic pipe (ASTM D 2239) for the main trunks and 1.0 inch diameter pipes for lateral lines, watering connection points incorporating 0.75 inch ball valve and 0.75 inch diameter commercial grade rubber hose, and a dispensing facility consisting of a portable 100 gallon plastic water trough equipped with a "full-flow" water level control device.

Figure 8. Water dispensing facility consisting of portable 100 gallon plastic trough, 0.75 inch diameter commercial grade rubber hose, and full flow water level control device.

Figure 9. Watering connection point at the main distribution pipe serving the study paddocks. A 0.75 inch Neptune water meter has been inserted at this site for the project.

EQUIPMENT/INSTRUMENTATION/SERVICES:

(1 ea.) Neptune 0.75 inch diameter port T-10 manual read water meter
(1 ea.) Neptune 1.0 inch diameter port T-10 manual read water meter
(2 ea.) insulated white plastic water meter covers
(1 ea.) Rubbermaid 100 gallon black plastic water trough equipped with full-flow water level control device
(1 ea.) 50 foot length 0.75 inch diameter commercial grade rubber hose
(1 ea.) 0.75 inch diameter metal ball valve
(1 ea.) 3.0 inch long 0.75 inch diameter steel pipe
(1 ea.) 0.75 inch MNH x MNPT brass adapter
(1 ea.) HOBO -20°C to +70°C temperature data logger with submersible case
(1 ea.) HOBO ProSeries -30°C to +70°C temperature and 0to100%relative humidity data logger
(1 ea.) solar radiation shield and associated mounting hardware
(1 ea.) BoxCar Pro version 3.51 software
(1 ea.) interface cable
(1 ea.) laptop personal computer with Windows operating system
(1 ea.) 2 qt. empty plastic maple syrup jug
(1 ea.) weight consisting of 0.75 inch diameter steel 6.0" long nipple, Tee, & cross connector
(3 ft.) 3/16 inch diameter nylon braided cord
(1 ea.) 1/4 inch diameter eye bolt w/fender washers and nuts
(2 oz.) silicone caulking
(1 ea.) 5/8 inch brass rigid eye snap
(26 ea.) 10 inch long nylon cable ties
(1 ea.) 5.0 inch capacity rain gauge
(1 ea.) 0.96 ft^2 metal forage sampling frame
(1 ea.) grass hand shears
(1 ea.) 500 gram precision spring scale
(2 ea.) 6 foot long fence posts
(15 ft.) temporary electric twine fencing
(27 ea.) 1.0 gallon plastic freezer bags
(18 ea.) NEDHIA NIR basic forage analysis
(1 ea.) small plastic cooler
(6 ea.) frozen blue cubes
(1 ea.) Buck Environmental Labs 16 parameter water analysis
(2 ea.) NEDHIA Lab 7 parameter water analysis

Figure 10. A small weather station is located within 80 feet of where water is dispensed in study paddocks.

Figure 11. Fabricated solar radiation shield for air temperature/relative humidity data logger in weather station.

Figure 12. Rain gauge and sun shield for backup air temperature data logger.

Figure 13. Temperature data logger for water trough shown in open capsule.

PROCEDURE: Initial facility preparation will include a number of steps, which include the following:

1. Conduct site investigation to evaluate which two adjoining paddocks would best suit the needs of the study. Selection would be based on such criteria as shade (none), proximity to nearest watering connection point (<300'), distance from farmstead (<1200'), forage composition (orchardgrass & ladino white clover), soil fertility (generally medium to high), exposure to prevailing wind (unprotected), and aspect (south and/or west). Document specific conditions of chosen paddocks. Collect soil samples, as needed, and submit for analysis.
2. Insert both water meters at the appropriate locations in the water system serving the pasture. Place the 0.75" unit between the rubber hose from the trough and the valve at the watering connection point, and the 1.0" unit at the barn where the main pipe for the pasture connects with the farmstead water supply. Place water meter covers over units.
3. Conduct a yield test to determine trough water recovery rate and pressure at both ends of the submersible pump cycle. Minimum flow should be eight gallons per minute (8 GPM).
4. Thoroughly flush out built up residues and contaminants from pipeline that may have accumulated during last growing season or over winter. Collect initial water sample directly from trough float valve outlet and submit to Buck Environmental Labs for comprehensive analysis of parameters outlined in the Natural Resource, Agriculture, & Engineering Service's *Private Drinking Water Supplies: Quality, Testing, and Options for Problem Waters* publication.
5. Load "BoxCar" software onto laptop & desktop PC, and program all data loggers to continuously register readings at 15 minute intervals.
6. Set posts near water trough, attach rain gauge, solar radiation shield, and air temperature/relative humidity data logger. Enclose site with temporary fencing to protect instrumentation from livestock.
7. Affix temperature data logger sealed in submersible case to a securely anchored buoy in trough to position logger approximately 2.0 inches below water surface.

Once the apparatus is in place and verified as properly functioning, then the study paddocks will be ready for research to begin. When the milking cows start grazing in the early spring, every time they reach the two paddocks identified in the study, the following tasks will be undertaken:

Figure 14. Full flow water level control device on left and float assembly for trough water temperature data logger on right.

1. Record the date and time the herd enters and leaves either study paddock for every rotation.

2. Document water meter readouts at the water dispensing site (i.e. trough) immediately prior to and after each residency period. On those occasions when more frequent monitoring is done on a 15 minute interval, also record readings of meter at farmstead.

3. Estimate herbage consumed by cows by measuring forage mass pre- and post-grazing. Clip forage in two fractions (0.5-2.0 inch and 2.0+ inch height) for pre-graze conditions, and a single fraction (0.5+ inch height) for post-graze conditions. Composite nine (9) subsamples to attain a representative sample.

Figure 15. Tools used for collecting forage samples and estimating forage availability/intake.

Figure 16. Pasture clipping conducted immediately before cows entered and after exiting the study paddocks for each of the rotations.

4. Retain a small portion of composite sample obtained from forage mass estimation procedure and place immediately in cooler with frozen cubes. Deliver to NEDHIA forage testing lab within 3.0 hours for qualitative analysis.

Figure 17. Top fractions (2.0+") of forage samples collected where kept in a cooler with frozen 'blue cubes' and delivered the same day to Northeastern Dairy Herd Improvement Association's forage lab or frozen until open for the next business day.

5. Record accumulation and approximate time frame of any rainfall events.
6. Record number of cows utilizing pasture.
7. Record average milk production over the two residency periods.

8. Record 1.0 inch water meter reading at the beginning of each rotation.
9. Measure perimeter dimensions of study paddock #1 for pre-graze visits and study paddocks # 1+ 2 for post-graze conditions.

Figure 18. Since paddock size changes between each rotation and residency periods, taking accurate measurements of paddock perimeters was essential to calculating actual area available to the herd.

Periodically throughout the study, other tasks need to be done as required. These are enumerated below:

1. Bring laptop PC every two (2) weeks out to the field to download on-site ambient air temperature, relative humidity, and water trough temperature data temporarily stored in both data loggers.
2. Collect water sample directly from trough and submit to NEDHIA forage lab for basic analysis once in late June and again in early September.
3. Obtain each month solar radiation, air temperature, relative humidity, precipitation, and evaporation recorded at the H. C. Thompson Research Farm located in Freeville, NY (approximately 3.7 miles away) from Mark Ramos of USDA ARS stationed at Cornell University.
4. Calculate water intake from barn ration by determining average daily ration intake and component moisture content. Monitor and note significant changes in feed program throughout grazing season

Figure 19. Digital data generated by field instruments was retrieved and transferred via a laptop PC to the office for storage, reduction, and later analysis.

METHODOLOGY: Water meter readings will be reduced to find net flow through the line feeding the water trough. For those times when more frequent readings are recorded, start and end figures at both the trough and farmstead meters will be compared to confirm no bias is caused from other influences, such as leaks in other parts of the water distribution network. These figures will be divided by the number of livestock served by the trough to calculate the average gallons drawn per head at each residency period studied. Data derived from the more frequent recordings will be plotted to determine peak needs and time frames when this occurs. The data on water consumption from the trough in this study will be compared with values listed in published literature and technical guidance. The high range will be of special interest as this is likely to determine peak flow requirements of livestock watering systems if they are to meet the minimum needs of cows on MIG. An appraisal of the pasture forage's contribution to the cows total daily water needs will also be calculated based on values obtained from forage DM analysis and consumption estimations. The trough water temperatures, air temperatures, humidity, plant water ingested through grazing forage, and herd production will all be evaluated for possible correlation with trough water consumption.

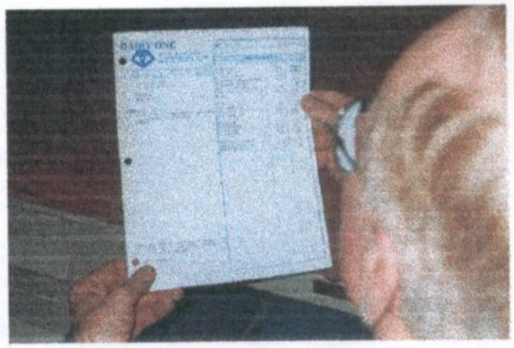

Figure 20. Results of the qualitative analysis was sent to the farm and technical advisor for each rotation through the study paddocks.

DISCUSSION:

The site chosen for the study which best met the selection criteria mentioned previously in step # 1 of the procedure section are located in management unit I (i.e., primary pasture) of the grazing system. This slightly sloping area is due east of the principal farmstead. Prior to implementing management intensive grazing for the milking string, this area was strip cropped on the contour. As a consequence, each paddock covers both a new (1997) seeding of late maturing orchard grass & ladino white clover and an older hay seeding of alfalfa, red clover, and timothy. The two study paddocks are contained within a major subdivision which is approximately aligned with the contour. In 1999 this subdivision supported an average of four paddocks, but that number fluctuated from a low of two to a high of five.

Soil samples were collected according to prior management of contour strips. Thus two composite samples were submitted for analysis to Cornell Nutrient Analysis Laboratories; one for the old hay strip and another for the new (1997) seeding. Results indicated high levels for soil P, K, Mg, & Ca on both strips. The pH was 6.7 and 7.0, respectively.

No shade whatsoever was available to cows while on either study paddock, even at twilight periods when long shadows would normally be cast by a proximate corner of a hedgerow (owing to distance and aspect with respect to arc of the sun).

The cows travel a one-way distance of just under one-thousand feet (<1000') up a partially improved laneway to reach the gate immediately accessing study paddock # 1. Most of the slope in this stretch is 5% with one short section significantly flatter (1%). Once all the cows had entered whichever paddock was allocated to them after milking, they were then confined to that site by locking the gate behind them until the following milking period.

The distribution pipe, which runs along the surface at the base of the laneway fence, is 1264 feet from its tie in with a frost-free hydrant at the farmstead to the watering connection point serving the study paddocks. This reach consists entirely of 1.25 inch diameter black plastic pipe. Dynamic flow measurements at the watering connection point yielded between 7.0 and 9.3

gallons/minute, which represents the start and end of the well pump cycles. Static pressure readings ranged from 33 to 43 PSI, also at the aforementioned watering connection point.

Although not measured, there usually was at least a mild breeze at the study paddocks as a consequence of its open exposure and relatively high position on the landscape. The site has a predominantly western aspect.

Water was collected for lab analysis on three (3) separate occasions (late April, late July, and early October) directly from the water level control device (i.e., float valve) port in the trough. Results of all samples indicated no contaminants for which tests were run were of a concentration above thresholds for lactating dairy cattle based on current guidelines and research literature.

At the 5th rotation, a fresh sample of total mixed ration (TMR) was collected and submitted to NEDHIA for qualitative analysis. The results indicated moisture content ran 44.8%. Being fed out at rate of 60.7 pounds/cow/day, this would have contributed 3.3 gallons towards the cow's daily water needs. There was also a token amount (1.5 pounds/cow/day) of dry hay (assumed moisture level to be 10%) fed out that supplied a negligible 0.018 gallons per head. Only considering this source (i.e., excluding any water drank from the troughs in the freestall barn) plus what volume the cows drank directly out of the pasture trough and the contributions of the consumed pasture forage, barn supplementation provided 18.3% of that part of the cow's water intake at this instance. This was the only time in 1999 when the impact of barn supplementation on water intake was evaluated.

In all but the 6th, and 9th rotation, study paddock # 1 was grazed during the day and paddock # 2 was used for night pasture. This sequence was interposed for the 6th rotation and both paddocks were grazed consecutive days (i.e., kept in the freestall during the intervening night) for the 9th rotation.

While data was collected for a total of nine (9) rotations during the 1999 grazing season, the herd was allowed to return to the study paddocks on one more (i.e., tenth) occasion in late fall primarily to keep them off the concrete of the freestall barn a little longer, expedite tasks in that facility, and extend the period the herd had in a open, cleaner environment. Because the growth of the pasture forage had for all practical purposes ceased and the herd had gleaned whatever feed was available from this area during the ninth rotation, there was no significant feed value left at this time. Hence the herd was only there for a brief duration each day.

A number of complications arose early in the project as preparation took place to start the grazing season. The original metal stock tank that was retrofitted for this project was found to have a leak shortly before the cows reached the study paddocks for the first rotation. In hast, a standard black plastic water trough was substituted and has continued to serve for dispensing water to the cows for the entire season. Unfortunately the combination air temperature/relative humidity data logger that was intended to be employed did not arrive until after the first rotation due to a back order. Thankfully, a single parameter unit already on hand at least captured air temperature for that first go around.

With the very low ground and air temperatures experienced in the early grazing season, the water distribution network and dispensing facilities locked up solid on a number of occasions. During the evening of first rotation through the study paddocks, the pipeline, rubber hose, and float valve all ceased to function due to ice in the lines. On the morning of 24 April, the water trough was found on its side pushed into the laneway with a small pool of frozen water partially covering the float valve. The water trough data logger was stomped into the previously soft ground at the original site for the trough. An unknown quantity of water was lost from the trough during the night and it is hard to determine what reduction in water intake resulted from the trough being inoperative and inaccessible. Thankfully, no permanent damage was inflicted on the instrumentation or facilities.

In the course of collecting forage samples and making estimations of forage utilization, it became evident that exterior moisture, in whatever form, on the surface of the plants could potentially contribute significant amounts of water to the cow's diet. This became an immediate concern when a steady mild rain fell during the data collection on the first rotation. In the process of collecting forage samples, most (but not all) of the rain adhering to the foliage drained off. There were only four rotations with precipitation while cows were grazing. The rainfall was scant (<0.1") during two of those rotations, and the other two each received ≤ 0.3" of rain.

Latter on in the season, dew or frost became the primary source of external moisture. Just as with the rain, most was removed from samples merely in the collection process. In mid-season during the daytime use of pastures, the cows did not have much opportunity to draw on that form of water since the dew had typically dried off that fraction of the sward they would have consumed by the time they were on pasture in the mid-morning. Hence, whatever the moisture levels of the samples collected under those circumstances were would not represent the true dry matter of the pasture forage actually consumed by the herd. However, the question of how much more moisture is unknown. The assumption is lab results from NEDHIA would tend to indicate slightly higher water content in the samples submitted for analysis. In an effort to accurately estimate both the volume and quality of pasture forage available to and ingested by the cows, clipping and sample collection always took place <u>immediately</u> (i.e., within 2.5 hours) before the herd entered the study paddocks. Partially due to this tight schedule, occasions arose when the herd had to be held back at the barn for a brief period until all the samples were obtained.

During soft ground conditions (early spring & early fall), collecting the post-graze forage mass was sometimes very difficult due to hoof trampling. Consequently, it is likely a small portion of the residual forage normally higher than 0.5 inches when erect was not collected. This would be especially true of short stems that tend to be mixed into the topsoil under heavy animal traffic conditions. Some of the post-graze forage that did make it into the samples were slightly contaminated by soil and/or manure. This would appear to influence both mass and qualitative measurements.

Another related issue was how to deal with those occasions when the sampling frame landed on a freshly manured spot. Besides the obvious matter of a messy sample, how does the data collector account for the forage just under the manure pile that was available to the herd immediately prior to deposition within the same residency period? Whenever the frame enclosed fresh manure, the frame was moved away so the new sampling site was one frame length away from the original landing site.

While from a statistical standpoint, completely random tosses of the sampling frame should encompass an accurate representation of the each whole paddock, the reality is that it is difficult, if not impossible, to capture the edge of the paddocks. In such instances that the frame hits the perimeter, there is almost always part of the area enclosed by the frame that is out of the paddock. As every experienced grazier has observed, livestock are inclined to graze fence lines much more aggressively and thoroughly than the interior. This is further complicated by the fact that livestock also graze as significantly beyond the fence line, depending partly on the type, design, and condition of the fence. By not having at least some sampling sites at the edge of the paddocks, the estimation of pasture forage intake may be lower.

Since there was no back fence used once the cows have access to new paddocks ahead of them, there was the possibility that some consumption of the pasture on study paddocks # 1 & 2 may occur after utilization measurements have already been made. Such activity may cause the data to further underestimate the actual overall consumption. Casual observations by data collectors, however, suggest that very little grazing of previous areas occurs at least early in the day as long as more palatable forage is offered. Cows appear to be well conditioned to expect fresh pasture immediately in front of the forward portable fence.

Preferential grazing appeared to occur in each paddock throughout the study due to two different seeding strips. This behavior to some degree determined the sampling protocol to help insure less bias was introduced into the data set as it was collected. Essentially, the number of samples collected in the new and old forage strips was approximately proportional to the area each strip contributed to the total area for each study paddock. The respective number of samples for each strip was consistent for both pre-graze to post-graze estimations within each rotation through.

Since a water line which feeds the large capacity water troughs in the freestall barn drastically reduces pressure in the pasture watering system due to sharing a common well, latter in the season flow was temporarily reduced at the pasture trough as cows first entered the study paddocks. This deficiency was rectified by placing a timer circuit on the solenoid valve which controls the pipeline serving the freestall troughs so they would be refilled after initial peak demand has abated.

Occasionally separation of the polyethylene water pipe occurred at fittings, most often at a "Tee" which serves as a watering connection point for troughs. A combination of factors may have contributed to this recurring problem. The thicker wall of this 160 PSI rated pipe makes it harder for the hose clamps to force the polyethylene of the pipe to bite deep into the barbs of the hard plastic fittings. One of the troublesome reaches of pipe is on a slope. When full with water, it has considerable weight to it. Couple this fact with a smooth outer surface and there is the chance it would slide downhill, especially when the ground and sod are wet, putting significant strain on certain fittings. Another factor may have been the great expansion/contraction thermal coefficient of this material. The alignment of the pipe was relatively straight so perhaps not enough slack was available when it shrunk on cool nights and mornings. Given the widest difference in temperature of 69°F over the whole season, a thousand foot run of this pipe would change 7.6 feet in length.

The large initial draw by the cows upon first entering the study paddocks may possibly be attributable to the last one or two groups of cows exiting the milking parlor having only a relatively limited time afterwards to drink from the freestall water troughs before the entire herd was moved out to pasture. Personal observations at the study paddocks shortly after let out from the freestall appears to substantiate this possibility since only about ten to twenty cows made a beeline to the pasture water trough immediately on reaching the paddock. Unfortunately, the identity of the cows comprising the last few groups out of the milking parlor was not recorded to see if these same individuals hit up the pasture trough early on.

Data collectors often noticed that a few cows would initiate drinking at the pasture water trough by extending their tongue out and sweeping the surface of the water almost as if they were trying to lick it. In the process, some of the water was splashed out of the trough and thus lost but not consumed. After a brief period of this motion (typically less than 90 seconds), these cows would drink by the more conventional means of suction. The volume of water spilled by this activity is assumed to be negligible.

A severe drought hit much of the Northeastern US over the 1999 growing season. As recorded at the Cornell University's H.C. Thompson Research Farm nearby, rainfall during the months of April through October was 19.53 inches. This was 4.66 inches (19.3%) below the norm (30 year mean between 1961 and 1990) for this site. On September 17th Hurricane Floyd arrived in this area and dumped 2.90 inches of the 3.12 inches above the norm for that month. As a consequence of the intensity of this single rainfall event, most of this precipitation on sloping ground was "lost" to runoff instead of being absorbed into the soil profile by infiltration. Thus if the month of September is omitted from this period, then the adjusted rainfall deficit now totals 7.78 inches or 37.8 % below the norm.

In an attempt to provide the targeted mass of pasture forage to the herd under the drought conditions in the summer of 1999, the size of the paddocks were setup considerably bigger than usual, especially during the 4th, 5th, and 6th rotations. The largest, smallest, and average areas of study paddocks # 1 and # 2 were 2.60, 1.24, 1.76 and 2.69, 1.24, 1.82 acres, respectively. The differences in paddock size within the same rotation ranged from 0% to 57.4%, though for most (7 out of 9) rotations, the discrepancy remained less than 14.0 %. This variation in size is likely due to a combination of changes in assorted factors; environmental comfort, volume of total mixed ration offered at the freestall bunk, and difficulty in judging the quantity of available pasture forage. These larger dimensions caused the cows to travel much more (i.e., a total of 632 feet in the 5th rotation) than the design criteria of 300 foot maximum established for the study when they were grazing the far corners of paddock # 2. While this far reach was certainly not the usual situation for paddock # 1, there were some rotations where the corners extended somewhat greater than 300 feet.

There was one short span of 1.4 hours at the beginning of the 7th rotation on study paddock # 1 when the data logger suspended in the pasture water trough did not capture the temperatures experienced. This occurred due a combination of an oversight and unexpected delay in downloading and then relaunching the logger after the start of this rotation. This gap represents a loss of 21.3 % in the full potential data set for this particular residency period.

Due to our vendor's inventory of the combination temperature/relative humidity data logger being exhausted at the time of gathering/ordering necessary instrumentation and tools to initiate the study, no humidity data was measured or recorded on this farm for the first full rotation through the study paddocks. However, a single channel data logger was in place and operational to track air temperature on site during that and subsequent rotations. In addition, meteorological data (including humidity) was secured for the H.C. Thompson Research Farm in Freeville, NY. Relative humidity data is principally relied upon to determine the heat stress indices and according to the chart the cows would not experience heat stress at any relative humidity level as long as the air temperature kept below 71°F. Since this is the case for the first rotation, the incompleteness of this particular data set does not detract from the soundness of the findings and results.

Unlike smaller bulk tanks which have a precisely calibrated dip stick to readily measure the volume of the milk it holds, the unit on this farm employs a different design based on an external sight glass/tube. Normally milk is excluded from this glass/tube by means of a set of valves except when the milk truck arrives for pickup. When it is used to make measurements between pickups, it is very difficult to completely clean this part of the bulk tank, and thus there is a real risk of contaminating the rest of the milk. As a consequence of these concerns regarding sanitation, the milk inspector fronds on this practice. And since the milk truck does not arrive after each milking, only an approximation (assume 55% of the day's milk comes from morning milking) of each residency period's contribution to milk production can be made.

Shortly before the normal time when the major subdivision gate was opened to allow the cows access to the laneway for returning to the milking parlor and freestall barn, they congregated in a tight bunch in the corner by the gate. This behavior started up earlier in the day during hot humid weather. As a consequence of this continual trampling, the vegetation experienced severe stress to the point of dying out. By the end of the grazing season, an area of approximately three-thousand eight-hundred eighty-five square feet (3885 ft^2) entirely within the boundaries for study paddock # 1 became devoid of any significant sod.

FINDINGS:

A mean, maximum, and minimum of 5.21, 7.86, and 0.25 gallons/cow/day of water were consumed from pasture water trough over the course of nine (9) rotations during the 1999 growing season. In six out of eight rotations, more water from pasture trough was drank during the day than night residency periods. Monitoring of water consumption from pasture trough at 15 minute revealed 51.5%, 46.2%, and 73.0% of all the water drank during the 8th rotation first and second residency periods, and the 9th rotation first residency period, respectively, was done so within the first 60 minutes upon the cows entering those paddocks. A smaller peak (37.2 %) took place between 12 noon and 1:45 PM during the 8th rotation first residency period. Consumption was a little more evenly distributed during the evening (i.e., second residency period) of the 8th rotation. Similar to what was recorded during the day, a second period of drinking activity (between 10:15 PM and 10:45 PM) occurred almost midway through this night residency period. Instantaneous peak draw were 6.4, 5.3, and 7.3 gallons per minute for 8th rotation study paddock 1 (148 cows), 8th rotation study paddock 2 (148 cows), and 9th rotation study paddock 1 (145 cows), respectively.

Although widely variable throughout the grazing season, water derived from consumed pasture forage contributed on average 30.9% more water than cows obtained through the pasture trough. Water fraction of the pasture forage consumed (as eaten basis) averaged 79.5%. Mean values for crude protein, neutral detergent fiber, acid detergent fiber, and net energy of lactation (on dry matter basis) was 23.7%, 46.3%, 24.8%, and 0.66 Mcal/lb, respectively. Due partially to drought conditions experienced during the study, pasture forage production was depressed, and consequently only an average of 14.4 lbs/cow/day of pasture forage dry matter contributed to the herd's diet.

Average time herd spent on the pasture was 6.4 hours for the day and 11.2 hours for the night. As a percentage of time over the course of the entire grazing season heat stress indices were none (85.7%), mild (11.0%), and distressed (3.3%). During five of the rotations, no heat stress was experienced whatsoever. Temperatures of water in the trough can at times get quite high. As an example, the highest recorded reading was 103.4 °F in the daytime. However, this and other maximum temperatures were usually only experienced for brief periods of time. To put this in perspective, the overall average for both study paddocks over the course of the entire grazing season was 64.7 °F. During every rotation the peak water temperature in the pasture trough exceeded maximum air temperature recorded. Relative humidity also crept up to 98.6% at times (excluding rainfall events).

Based on calculations employing average precipitation, mean lake evaporative loss figures for this area during the growing season, and the surface area of trough water exposed to the atmosphere, it was estimated a net loss of 6.4 gallons of water took place over the course of the 1999 grazing season. This constitutes only 0.087% of the 7344.7 gallons metered to the pasture water trough for all nine rotations in the study paddocks. Hence neither rainfall or evaporation significantly influenced the water consumption data.

Employing USDA NRCS Grassland Technical Reference # 8 to calculate two scenarios, one based on a conservative estimate of water trough requirements on pasture (minimum 15.10 gallons/minute) and the other using a more liberal approach (minimum 7.55 gallons/minute), the data from this study indicates the lower flow requirement may be more consistent with actual conditions that are similar to those encountered on the Carey farm in 1999. However, this Reference's higher estimation (6 versus 3 cows simultaneously at the trough) of access requirements are more in line with anecdotal observations from the study.

The Animal Management section of the publication *Prescribed Grazing and Feeding Management for Lactating Dairy Cows* states that 4.5 to 5.0 pounds of water are necessary for every pound of milk produced. Applying this correlation to the approximate production records for this herd during the grazing season, total estimated dietary water requirements averaged 32.2

gallons/cow/day. Water obtained from the trough on pasture contributed an average of 16.6 % towards this estimated required daily intake. When trough water was combined with that obtained from consumed pasture forage, this contributed an average of 38.1 % of the estimated required daily intake.

LIMITATIONS:

While most of the outcome of this study should benefit diary producers, particularly in the Northeastern US, this needs to be viewed in the context of the project. Bear in mind the following qualifiers in extrapolating the results and findings:

- The data set covers only one full grazing season.
- Only two (2) paddocks out of sixty-one (61) were included in the study.
- Each paddocks consisted of two heterogenous strips of forage.
- Paddocks aligned on the contour.
- No shade whatsoever was provided or available.
- Relatively short distance and only modest slope from barn/milking parlor to paddocks.
- Free choice water was available from a trough in close proximity to grazing activity.
- High refill capability of pasture trough.
- Good quality water provided.
- High fertility of soil.
- Proper management of pasture forage.

Although desirable, other significant sources of dietary water (freestall barn water troughs & TMR at the feed bunk) were generally not accounted for. As far as the freestall barn troughs this is partly a consequence of the rather complicated plumbing arrangement. With regards to supplementation, to properly gather the requisite data throughout the entire grazing season would have entailed more disruptive measurements and burdensome documentation than present farm labor or agency staff could handle.

Due to the severity of the drought in 1999, the level of supplementation with TMR was higher than normally desired.

ECONOMIC IMPACT:

While no detailed attempt was made to determine the specific financial effect on this dairy enterprise as a consequence of undertaking the study, there are broad implications for other diary farmers who are either contemplating initiating a management intensive grazing system for their lactating cows or those already having such a system in place but who anticipate upgrading a currently deficient watering system. Now that there is at least some evidence of lower demands by cows of a watering system supporting a MIG operation, there is the opportunity for USDA Natural Resources Conservation Service (NRCS) design criteria for such systems to be revised accordingly. This anticipated change not only offers the potential to reduce overall capital expenses on watering systems but should focus limited available dollars on those water components where the greatest return on investment would accrue.

NEXT STEP:

As is often the case, an early investigation into a topic to gain a greater understanding inevitably leads to identifying more questions. This is no less the case with this study. They include the following:

1. As suggested by other published research, the initial large draw from the pasture water trough is postulated to be caused by the last one or two groups of cows going through the milking parlor having only limited time to access the freestall barn water troughs immediately post-milking before the entire herd is moved up the laneway into the pasture paddocks. Validating or repudiating this hypothesis would be very helpful in further explaining the observed flows of the 8th and 9th rotations in 1999.
2. Despite both paddocks having different forage species composition in the two strips contained in each, in 1999 forage samples were composited for qualitative analysis and quantitative estimations. It appeared the cows grazed these two strips differently. Further separating out the samples within each study paddock would permit a more detailed evaluation of any possible preference by the herd.
3. Also in 1999 only the top (2.0+ inch height) fraction of the sward in the pre-graze data collection farm visits was analyzed for dry matter. The assumption was that the top and bottom (0.5 - 2.0 inch height) fraction were essentially at the same moisture level. In retrospect, perhaps this was an erroneous presumption. Keeping these two fractions separate in the lab would permit tracking how closely they correlate.
4. Owing in part to concerns of the severe drought, late last summer a new pond was constructed near the farmstead for the primary purpose of replacing the drilled well as the source of water for the grazing system. The pond is expected to have different levels of constituents in the water. If this is true, what effect will this new source have on water intake at the pasture trough?

To address the above unresolved questions, the study started in 1999 with SARE funding will continue another year with ongoing support of all those listed in the collaborator/cooperator section of this report. Other reasons driving the extension/expansion of this effort include:

1. When the concept for this SARE proposal was first envisioned, it was anticipated that some device would be available which could automatically and continuously water flow in a digital form for later retrieval. This device would have to be rugged enough to operate with minimal protection from the weather and draw it's power from a DC source of electricity. An extensive search resulted in finding just such a device that would aptly meet the requirements for the study. Unfortunately, this particular unit referred to as the *Meter Master*7 manufactured by F.S. Brainard & Company was quoted at approximately $6700. At this time there appears to be no other known devices or options that offer comparable capabilities and features. This is why for two of the rotations towards the end

of the 1999 grazing season monitoring and recording of instantaneous water flow to the study paddocks was performed manually by one individual. Albeit effective, this approach introduces the potential for uneven time intervals, error in documenting readings, and fatigue the person responsible for recording.

In following up on some of the information gathered from last year's search for a cost-effective device, a municipality (City of Binghamton) in the region had been identified that recently procured a model 100EL *Meter Master*7 for their Water Meter Department's leak detection efforts. Contacting the appropriate staff there revealed their willingness to briefly loan out this device for the continuation of this study in 2000. While it has not yet been utilized, it is expected to offer great advantages to last year's approach.

There are many dairy farmers who have implemented management intensive grazing for their milking string, but do not yet have the optimum watering system to serve their pasture. Some of them may even question the value of improving their watering system, especially when it entails dispensing ample quantity to the herd within a maximum of 300 feet away from the paddock in active use. By continuing to record instantaneous water flow into the trough as the herd moves beyond the second study paddock (i.e., further away from the water trough) any change in drinking pattern will become evident. This information should be helpful in convincing dairy farmers to take prudent steps at upgrading their watering system.

2. Throughout this study, the farm family and the project's technical advisor have been able to observe first hand the interesting and revealing drinking behavior of the cows. In an effort to better observe this activity, remove any possible distraction caused by human presence, and document it for later presentation to an audience, two videotape recorders will be setup on the periphery of the study paddocks. One unit at the top will have a wide angle view of most of the two paddocks in addition to the laneway and gate. The second unit will be tightly focused on whatever activity occurs at the pasture water trough. To preclude altering the cows behavior by this equipment when the recordings are done, the tripods alone will be deployed a couple of days earlier in hopes of at least partially acclimating them to these novel additions to their environment.

3. Since every grazing year is different from others, continuing this study into 2000 will build upon the first year's data set to expand the foundation of information and thus provide greater validity for the results, findings, and conclusions.

To avoid a freeze up problem similar to the one encountered early on in April 1999, a device marketed by the trade name *Ice Preventor* will be temporarily installed at the terminus of the main water line which feeds the connection point serving the study paddocks. Basically, this device is simply a mechanical thermostat physically linked to a small valve. When the environment around the coil of copper tubing drops close to 32°F (once the unit is calibrated), it starts to release a small trickle so there is some movement of water through the entire length of pipe. Once the air warms up, the unit senses this and shuts off this small flow automatically. Because the water meter at the study paddocks is inserted beyond the watering connection point, this draw to avoid freeze up will not affect readings.

Another improvement made this year was to replace the rigid 3.0 inch section of 0.75 inch diameter steel pipe at the watering connection point with 1.0 inch diameter flexible EPDM rubber hose to permit limited movement of the HDPE main pipeline without causing uncoupling at the fittings. Also hard plastic “Tee” was replaced with an all metal assembly. The groves in the barbed adapter, it was hoped, would dig deeper into the HDPE pipe, thus further abating seporation.

A parallel study, though not as sophisticated or elaborate nor directly related with this SARE project, was undertaken at another farm located in Chenango County which raises dairy replacement heifers and relies on management intensive grazing to supply forage for these livestock during the growing season. A bar graph illustrating the results investigating the water consumption of dairy replacement heifers is included for further information.

PRACTICE CONTINUANCE:

Almost all aspects of this method of providing water to the milking herd while on management intensive grazing will be continued as was practiced in the course of the study. In fact more water troughs and full-flow valves of the same design employed in the study have been purchased for other watering connection points in the system. The only alteration planned will be switching of the source from ground water to surface water. The existing drilled well will be disconnected from the distribution pipes. Once a pump and associated plumbing is finished, a new pond will be hooked up to the those pipes.

PROJECT OUTREACH:

What other farmers hear directly from the Carey’s when discussion turns to this project and its outcome is an overview of the SARE Program, the importance of providing lots of water to the cows and not making them walk so far to obtain it, the ability to use watering as a management tool, the extent of water that succulent pasture forage contributes to the herds water needs, and the relatively low volume of water drawn from the pasture trough.

Formal outreach activities which have already taken place include:

1. Developing a color slide presentation solely focused on this project, its background, results, and findings.
2. Incorporating the major conclusions of the project into an existing general slide presentation on watering systems for grazing operations.
3. Assembling two (2) copies of a miniature photo album to aid in describing the project setting, equipment, instrumentation, and conditions to individuals and small groups. One album was retained by the Careys, while the other was given to NRCS.
4. Producing a traveling display comprised of 20 foam core panels for header, photos, captions, graphs, credits.

5. Writing a news release on the outcome of this project.
6. Composing various interim reports as the project has progressed over the year.

Specific events where this study was presented/exhibited are as follows:

NYSGLCI Pasture Walk on Johnes Disease@ Dan & Ann Carey; Groton, NY
26 July 1999
interim reports
attendance: 25+

CCE/NYSGLCI Pasture Water Walk @ Dan & Ann Carey; Groton, NY
08 October 1999
interim reports
attendance: 25+

Oneida County Grazier Gathering; Orsikany, NY
19 January 2000
long slide presentation, mini-album, interim reports
attendance: 10

Great Lakes International Grazing Conference; Shipshewana, IN
14 & 15 February 2000
mini-album, interim reports
attendance: 450

New York Pasture Association Annual Conference; Geneva, NY
18 & 19 February 2000
display, mini-album, interim reports
attendance: 97

Rhode Island Grassland Initiative Year 2000 Workshop; Warwick, RI
22 February 2000
short slide presentation, mini-album, interim reports
attendance: 32

Northwest Pennsylvania Grazing Conference; Clarion, PA
28 February 2000
short slide presentation, display, mini-album, interim reports
attendance: 129

Franklin County (NYSGLCI) Grazing Mini-Conference; Malone, NY
01 March 2000
mini-album, short slide presentation, interim reports
attendance: 18

St. Lawrence County (NYSGLCI) Grazing Mini-Conference; Ogdensburg, NY
02 March 2000
mini-album, short slide presentation, interim reports
attendance: 14

NYSGLCI Forum: Grazing as a Viable Production Method; Norwich, NY
07 March 2000
short & long slide presentation, display, mini-album, interim reports
attendance: 33

Herkimer County (NYSGLCI) Grazing Mini-Conference; Middleville, NY
08 March 2000
mini-album, short slide presentation, interim reports
attendance: 4

Lewis County (NYSGLCI) Grazing Mini-Conference; Constableville, NY
09 March 2000
mini-album, short slide presentation, interim reports
attendance: 17

Cornell Cooperative Extension of CCTTS Grazier's Workshop; Dryden, NY
10 March 2000
display, mini-album, interim reports
attendance: 56

2000 Water Quality Symposium/NYSCDEA Annual Training Session; Auburn, NY
14-17 March 2000
display, interim reports
attendance: 350

Round House Mill Nutrition Seminar; Cortland, NY
21 March 2000
display, interim reports
attendance: 52

Clinton-Essex County (NYSGLCI) Grazing Mini-Conference; Plattsburg, NY
23 March 2000
short slide presentation, interim reports
attendance: 14

Broome County (GRAZE NY) Pasture Design & Layout Workshop: Maine, NY
25 March 2000
mini-album, short slide presentation, interim reports
attendance: 25

Finger Lakes (NYSGLCI) Grazing Conference; Himrod, NY
28 March 2000
mini-album, short slide presentation, interim reports
attendance: 54

Tompkins County (GRAZE NY) Pasture Design & Layout Workshop; Ithaca, NY
29 March 2000
short slide presentation, interim reports
attendance:5

Farm Diversity Conference 2000; Norwich, NY
01 April 2000
display, mini-album, interim reports
attendance: 97

Cayuga County (GRAZE NY) Grazing Workshop; Auburn, NY
04 April 2000
mini-album, short slide presentation, interim reports
attendance: 27

NYSGLCI Spring Pasture Walk @ Jeff & Locke: Oxford, NY
17 April 2000
graphs
attendance:10

NRCS Area III Staff Meeting; Auburn, NY
13 April 2000
long slide presentation, interim reports
attendance: 37+

SUNY Morrisville Ag & Tech College Ruminant Nutrition Class; Morrisville, NY
24 April 2000
short slide presentation, graphs
attendance:20+

Graze Connecticut Workshop; (University of Connecticut) Storrs, CT
06 May 2000
short slide presentation, mini-album, graphs
attendance: 25+

In summary, approximately 524 people heard firsthand some form of the SARE study presentation and another 1102 people had the opportunity to learn about it by means of a staffed display and/or offering of interim reports.

Through the print media, four (4) articles have appeared in newspapers to date. A greater distribution of the news release will be take place in the coming month, however.

Additional outreach opportunities planned in the future include:

1. Having the SARE study display and project collaborators at Tompkins County's Farm-City Day this August which is being hosted by the Carey family at their farm.
2. Participating in the poster paper session of the National Conference on Grazing Lands scheduled for 05-08 December 2000 in Las Vegas, Nevada. This will essentially be the current SARE study display updated with the data collected during the 2000 grazing season. Written acknowledgment has already been received by the Program Committee Chair that the submitted abstract has been accepted and will be included in the conference agenda and proceedings.

Wednesday, 18 August 1999
(Vol. 109, No. 192)

page 11

THE EVENING SUN, NORWICH NY 13815

Study examines dietary water needs of dairy cows

By Jerry Weaver
Sun Farm Writer

SECOND CUTTINGS

NORWICH – Water (and the lack of it in rainfall) is much on the minds of area farmers this summer - the lack of ample rain affecting crops, drying-up small streams, and threatening the water level in wells and springs.

And then there's the matter of providing drinking water for dairy animals. Especially dietary water needs of lactating dairy cows on management intensive grazing. The latter is the subject of the 1999 SARE Farmer/Grower Research Project. The project study was started prior to this summer's drought.

Robert DeClue, Natural Resources Conservation Service Area 3 Grazing Specialist and Conservation Planner with the Chenango County Soil and Water Conservation District, is the technical advisor for the project.

The study is being conducted on the 620-acre dairy farm of Dan and Ann Carey of Groton in Tompkins County. They have been producing milk for more than 22 years and are using intensive rotational grazing for their Holstein cows.

DeClue says the objective of the study is to qualify the actual volume of water lactating dairy cows consume through a trough on pasture where 1) management intensive grazing is being correctly practiced, 2) ample quantity of high-quality water is being provided in close proximity, and 3) no shade is available; and estimate approximate contributions of water from pasture forage.

Backgrounding the project, DeClue says that figures on dietary watering needs for lactating diary cattle appear to be based upon either confinement conditions or at best where pasture supplies only a token amount of the animals' ration. Such recommendations may not be transferable to dairy operations which rely heavily on management intensive grazing (MIG) to provide the bulk of their dry matter intake.

Where pasture forage is well managed to consistently maintain a highly succulent nutritious sward, a substantial quantity of plant-derived water is consumed in the process of grazing. this source of dietary water, in addition to dew which may form at times on the exterior of the top-growth and water obtained from the milking facility, may substantially reduce the amount of water needed out of pasture to balance-out the animals' daily requirements.

Recent research and anecdotal observations indicate that placement of watering facilities in relation to allocated forage sources on pasture can markedly influence manure distribution, harvest efficiency, water uptake, size of group traveling to water, and ultimately, animal performance. As a consequence, great emphasis is now given to offering water in close proximity to livestock, especially lactating dairy cows, wherever they are directed to graze in the system.

In a review of current data taken from DeClue's interim report, it appears that a relatively small average quantity of water is utilized by lactating cows while on high-quality succulent pasture; from a low of 0.25 to a high of 7.86 gallons of water per cow per day. The question still remains, says DeClue, what their instantaneous demand is throughout the grazing events and season. With the exception of the first rotation (paddock to paddock), most of the water consumption occurs during the daylight hours.

The above is a small segment of DeClue's interim report with a full report expected at the conclusion of the study. The technical advisor points out that generating essential empirical data and findings will enable educators and technical assistance advisors to better inform and guide farmers interested in properly developing or upgrading their watering infrastructure that support well-managed grazing systems.

Study examines drinking habits of dairy cows

By Jerry Weaver
Sun Farm Writer

(Editor's note: This is the second and final installment dealing with water consumption of dairy cows on management intensive grazing according to initial report of a U.S. Department of Agriculture SARE Farmer/Grower grant project, conducted during the 1999 grazing season).

NORWICH – To track water usage in the project system, a water meter was inserted at the watering connection point serving the two study paddocks and another at the beginning of the distribution network by the milking parlor. Weather instruments were also placed adjacent to the study paddocks which continuously recorded air temperature and relative humidity. A simple rain gauge captured what little precipitation fell last year.

To determine the temperature of the water drank by the cows, a data logger positioned in a watertight capsule 2.0 inches below the water surface of the watering trough in the paddock continuously measured temperatures. Immediately before and after each rotation, the quantity of pasture forage was estimated by random frame clippings to ascertain total amount of available forage and the fraction actually consumed by the herd. A portion of the sample collected directly from the float valve at three different times (before, middle, and late season) were sent in for lab analysis. Results showed no significant levels of contaminants which would affect herd health or water consumption.

Findings of the overall study proved enlightening, according to the initial report. A mean, maximum, and minimum of 5.21, 7.86, and 0.25 gallons/cow/day of water were consumed from pasture water trough over the course of nine rotations during the 1999 season. In 75 percent of the rotations, more water from pasture trough was drank during the day than night residency periods. Monitoring of water consumption from pasture trough was 15 minutes revealed 51.5 percent, 46.2 percent, and 73 percent of all the water drank during the 8th rotation first and second residency periods, and the 9th rotation first residency period, respectively, was done so within the first 60 minutes upon the cows entering those paddocks.

Although widely variable throughout the grazing season, water derived from consumed pasture forage contributed on average 30.9 percent more water than cows obtained through the pasture trough. And water fraction of the pasture forage consumed (as eaten basis) averaged 79.5 percent. Mean values for crude protein, neutral detergent fiber, acid detergent fiber, and net energy of lactation (on dry matter basis) was 23.7 percent, 46.3 percent, 24.8 percent, and 0.66 percent Mcal/lb respectively. Due partially to drought conditions experienced during the study, pasture forage production was depressed, the study report showed, and consequently an average of only 14.4 lbs/cow/day of pasture forage dry matter contributed to the herd's diet.

During the study period, the average time the herd spent on the pasture was 6.4 hours for the day and 11.2 hours for the night. Whenever the herd was on either of the two study paddocks, heat stress indices were done (85.7 percent), mild (11.0 percent), and distressed (3.3 percent). During five of the rotations, no heat stress was experienced whatsoever, the report showed. However, for all rotations the peak water temperature in the pasture trough exceeded maximum air temperature recorded.

Copies of the complete report including a more detailed description of the study, most of the data collected, graphical presentation of important information, and discussion of findings and conclusions are available by Contacting Robert DeClue at the Chenango County Soil and Water Conservation District, via traditional mail: 99 North Broad Street Norwich, N.Y. 13815-1387; e-mail: ccswcd@norwich.net, or by phone: (607) 334-8634 ext. 108 or 1-800-472-0399.

The Evening Sun Wednesday, 17 May 2000
(Vol. 110, No. 44)

Vol. 110, No. 39 Wednesday, 10 May 2000

Dairy grazing raises several important questions

BY JERRY WEAVER
Sun Farm Writer

NORWICH – The fact that intensive grazing by lactating dairy cows promotes milk production and cuts down on feed costs is well established, but along with the plentiful green grasses, the cows must also have an adequate supply of clean drinking water to manufacture milk.

And this poses a few questions: Exactly how much water do those milkers drink while on premium pasture? What contribution does lush, succulent pasture forage make to the cow's water intake? How hot does the water get in the trough as the sun beats down on it and the pipeline all day?

These are the types of questions that concern and perplex many dairy graziers, says Rob DeClue of the Chenango County Soil and Water Conservation District, and Natural Resources Conservation Service (NRCS) area grazing specialist. And they (the grazier dairymen) recognize that the bulk tank will quickly show if their milking string does not obtain sufficient water during the day for whatever reason, says DeClue. And while anecdotal observations suggest some possible answers, little if any solid information clearly sheds light on these issues, says the specialist.

Dan and Ann Carey are dairy farmers in Groton, where they provide summer forage for their milking herd by the intensive grazing system. Becoming intrigued by the water intake of their grazing herd and the effect it had on their cows' milk production, the Careys decided to participate in the USDA Sustainable Agriculture and Education (SARE) Farmer/Grower grant project to address these and other related questions during the 1999 grazing season.

DeClue, who worked with the Careys on the project, said the farm couples' objective was two-fold: 1) to quantify the actual volume of water lactating dairy cows consume from a trough located on pasture when management intensive grazing is being correctly practiced, ample quantity of clean water is provided within approximately 300 feet of where the cows are grazing and no shade is available, and 2) estimate what contribution pasture forage-derived water makes the cow's water intake.

(Working with the Careys in this investigation were a variety of technical people, including staff from USDA NRCS, Tompkins County SWCD, GRAZE NY Project, NYS Grazing Lands Conservation Initiative, and Cornell Cooperative Extension).

The Careys started grazing their 180-cow milking herd in 1998 on 150 acres, providing a new section of fresh pasture (a paddock) after each milking (2X/day).

DeClue says in his initial project report that Bath/Valois silt loam that predominates on the Carey hill-farm grazing acreage. Their watering system consists of a drilled well at the farm stead as a source, a distribution network of mostly 1.25-inch diameter black plastic pipe laid on top of the ground by fence lines, and dispensing facilities in the paddocks consisting of a 100-gallon black plastic trough, 3/4-inch rubber hose, and a full-flow float valve. This arrangement assured a flow of between 7.0 and 9.3 gallons/minute and a static pressure of 33 to 43 PSI at the trough hookup.

Just two paddocks which met the criteria mentioned in the objectives were selected for monitoring during the entire grazing season. These study paddocks ranged in size from 1.2 to 2.7 acres, depending on the growth rate. A 1999 soil analysis revealed medium to high fertility level. And since this part of the grazing system was previously strip-cropped, there were sections of both paddocks with an old alfalfa-grass hay and a 1997 seeding of orchard grass-ladino white clover.

(The second and final segment of DeClue's initial study report will appear on the Farm Page in the May 17 issue of The Evening Sun. It will include findings of the overall study gleaned from the project investigation.)

NEW YORK STATE GRAZING LANDS CONSERVATION INITIATIVE
USDA Natural Resources Conservation Service

...working to develop and sustain productive grazing lands in harmony with the environment

99 North Broad Street, Norwich, NY 13815-1387 • Phone: 607-334-8634 • FAX: 607-336-2918

Paper Submitted for
National Conference on Grazing Lands, 5-8 December 2000

Title: **Pasture Water Consumption of Lactating Dairy Cattle on Management Intensive Grazing**

Presentation: Poster

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ABSTRACT

Between 145 and 173 lactating Holstein cows in Central New York State on Management Intensive Grazing (MIG) were monitored for water consumption through a water trough located in two (2) of the more than fifty paddocks available for selection on this farm. In addition, air temperature, relative humidity, and trough water temperature 2.0 inches below the water surface were also recorded at the site in an effort to quantify the actual volume of water drawn by dairy cattle when ❶ ample supply of good caliber water is offered within 300 feet of grazing activity, ❷ no shade exists, and ❸ sufficient quantities of high quality pasture forage is present.

A mean, maximum, and minimum of 5.21, 7.86, and 0.25 gallons/cow/day of water were consumed from pasture water trough over the course of nine (9) rotations during the 1999 growing season. In 75% of the rotations, more water from pasture trough was drank during the day than night residency periods. Monitoring of water consumption from pasture trough at 15 minute revealed 51.5%, 46.2%, and 73.0% of all the water drank during the 8th rotation first and second residency periods, and the 9th rotation first residency period, respectively, was done so within the first 60 minutes upon the cows entering those paddocks.

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Average time herd spent on the pasture was 6.4 hours for the day and 11.2 hours for the night. Whenever the herd was on either of the two study paddocks, heat stress indices were none (85.7%), mild (11.0%), and distressed (3.3%). During five of the rotations, no heat stress was experienced whatsoever. However, for all rotations the peak water temperature in the pasture trough exceeded maximum air temperature recorded.

This study was partially funded by a USDA Northeast Region SARE Farmer/Grower grant and lead by dairy farmers Dan & Ann Carey of Groton, NY.

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Dear Robert,

Congratulations! The conference program planning committee has accepted the poster paper abstract you submitted for the ***First National Conference on Grazing Lands***. The conference will be held at Bally's Las Vegas, December 5-8, 2000. Posters may be set up on Tuesday, Dec. 5th, 2000, starting at 1:00 PM. Additional information will be found in the conference registration packets, which will be mailed in a month or so. We look forward to including your poster in the conference agenda, and publishing the poster abstract in the conference proceedings. The proceedings will be prepared and mailed after the conference ends.

All the conference continental breakfasts and breaks will be held in the area where the poster papers and exhibits are displayed. We would ask that you try and be near your poster during those times, to talk with people interested in your story. We anticipate having over 40 poster papers on display. They will be of interest to all in attendance.

As was mentioned in the call for papers, presenters are responsible for providing their own conference travel, registration and other expenses. Poster paper presenters need only pay the individual conference registration fee. Poster boards will be available for you on site; you just need your material. All registered attendees will receive a copy of the conference proceedings when they become available. Co-authors will be also be credited in the proceedings.

The title of your poster presentation as we have it, is shown below. If it is not accurate, or if you have changed it, please let NCGL Program Manager John Peterson know no later than Oct. 1st. John can be reached at the address and numbers above. Please contact him if you have questions.

Sincerely,

Jack R. Cutshall

Jack R. Cutshall
NCGL Program Committee Chair
Home address: Rafter J. Ranch, P.O. Box 1702, Glenmora, LA 71433, tel. 318-748-8855

Abstract title: Pasture water consumption of lactating dairy cattle on management intensive grazing.

New York State
Forage & Grasslands Council

Country Folks
Forage & Grasslands Special

Presidents Report
April, 2000

Organic Product Made From Corn—A Solution To the Problem

Recent reports indicate MTBE is a "frequent and widespread contaminant". Ethanol proponents see an excellent opportunity for ethanol to replace MTBE and help people get clean air and still be assured of having clean water. MTBE is methyl tertiary butyl ether, a synthetic chemical added to gasoline to improve air quality as part of the Federal Clean Air Act. Limited quantities have been used in gasoline through the nation since the 1970s. In 1992, oil companies began using it extensively in California to meet reformulated gas requirements of the state Air Resources Board.

A recent study by the Lawrence Livermore National Library concluded that MTBE is a "frequent and widespread contaminant" in ground water throughout California

Bradd

and does not degrade significantly once it is there. The study estimated that MTBE has contaminated groundwater at over 10,000 shallow monitoring sites in California.

Hundreds of drinking water wells could be affected if the contamination moves into deeper groundwater basins. Nationally, a recent study by the US Geological Survey found MTBE in 14 percent of the urban drinking water wells it sampled. (It has also been found in the ground water in our state of New York). There is currently no cost-effective treatment technology available to remove MTBE from drinking water. Experts believe treatment costs could exceed $1 million per drinking water well, based on research findings to date. According to the UC report released in November 1998, the cost of treating MTBE-contaminated water is 40 percent to 80 percent higher than treating water contaminated only with other hydrocarbons.

Ethanol in itself is a completely safe organic product made from corn and it biodegrades very rapidly and it causes no threat to our ground water supply.

Some EPA officials doubt that enough ethanol can be produced to replace MTBE. It actually takes almost twice as much MTBE to add the same amount of oxygen as ethanol, so we have, in terms of an oxygenate, a component in ethanol that has more oxygen than MTBE.

Trevor Guthmiller of the American Coalition For Ethanol, says "we can build new production, it's whether we have the markets to sell into that is really what drives the growth to this industry."

EPA has yet to decide whether or not to grant ethanol a carbon monoxide credit, which will allow its use year-round in markets where summertime heat makes evaporative emissions an issue. The National Academy of Sciences has concluded that about 20 percent of the ozone, or smog, produced in highly polluted areas is caused by carbon monoxide. Ethanol has been shown to cut carbon monoxide emissions by up to 25 percent.

We have seen fuel prices escalate as we anxiously await any announcement that oil-producing nations will increase production, thereby lowering prices. EPA has the authority to immediately accept ethanol to be used year-round as part of Phase II of the Reformulated Gasoline program.

Getting rid of the clean fuel requirements isn't the solution, getting rid of the MTBE is and we've got a product made right here in the US that can help them meet their clean air requirements while, at the same time, not contribute to ground water pollution.

Once again, Government regulatory agencies and so-called environmentalists attempt to solve a problem, which could have been rectified by the true environmentalists - the American Farmer & Rancher.

HAVE A GREAT SPRING AND HAPPY PLANTING!

If you wish to get in touch with the New York State Forage & Grassland Council via e-mail, you can use either one of the following e-mail addresses:

Executive Secretary, Rainy Collins-Vickers :fb@norwich.net.

President, Bradd Vickers: braddv@hotmail.com.

Grazing Technicians Offer Free Help for Livestock Producers

The Adirondack North Country Association (ANCA) is working in cooperation with the New York State Grazing Lands Conservation Initiative and the USDA Natural Resources Conservation Service to make Grazing Technicians available to northern New York livestock producers in a fourteen county region. Karen Smith of Paul Smiths, New York is available to provide services in Essex, Clinton, Jefferson, Lewis, Franklin and St. Lawrence counties. Lee Wilson, of Fort Ann, NY is available to provide services in Washington, Warren, Saratoga, Hamilton, Herkimer, Oswego, Oneida and Fulton counties. The technicians are trained to develop rotational grazing systems, prepare on-farm natural resource evaluations, and plan grazing and hayland management systems. The program has been developed to sustain grazing lands in the ANCA region in harmony with the environment and for the economic and educational benefits to regional producers.

Grazing Technicians Smith and Wilson are available to do farm visits and on-site pasture walks. They are available to develop a comprehensive technical plan for implementing rotational grazing systems on farms containing livestock. This free service has already resulted in the development of rotational grazing systems for over 2,000 acres of farmland in the ANCA region.

Producers interested in obtaining the use of these valuable services or who would like more information on rotational grazing systems are urged to contact the ANCA office (518) 891-6200, anca@northnet.org or by calling Grazing Technicians Karen Smith (518) 327-3686 or Lee Wilson (518) 632-5421.

ANCA's partnership with the New York State Grazing Lands Conservation Initiative and the USDA Natural Resources Conservation Service was developed as part of ANCA's Agriculture Committee's commitment, under the chairmanship of Robert Boice of Watertown, to provide services that result in economic and quality of life improvements for regional farm producers.

Study Documents Water Consumption of Dairy Cows On Management Intensive Grazing

Exactly how much water do those milkers drink while on premium pasture? What contributions does lush, succulent pasture forage make to cow's water intake? How hot does the water get in the trough as the sun beats down on it and the pipeline all day? These are the type if questions that concern and perplex many dairy grazers. They recognize the bulk tank will quickly show if their milking string does not obtain sufficient water during the day for whatever reason. And while anecdotal observations suggest some possible answers, little if any solid information clearly sheds light on these issues. Dairy farmers Dan & Ann Carey from Groton, NY were so intrigued they decided to participate in a USDA Sustainable Agriculture Research & Education SARE) Farmer/Grower grant project to address these and other related questions during the 1999 grazing season. Their objective was two-fold: 1) quantify the actual volume of water lactating dairy cows consume from a trough located on pasture when management intensive grazing is being correctly practiced, ample quantity of clean water is provided within approximately 300 feet of where the cows are grazing, and no shade is available, and 2) estimate what contribution pasture forage derived water makes it to the cow's water intake. To conduct this investigation, the Carey's worked with a variety of technical people, including staff from USDA Natural Resources & Conserva-tion Service, Tompkins County Soil & Water Conservation District, GRAZE NY Project, New York State Grazing Lands Conservation Initiative, and Cornell Cooperative Extension.

The Carey's started grazing their 180 cow milking herd in 1998 on 150 acres, providing a new section of fresh pasture (ie. a paddock) after each milking*(2X/day).

(cont. on pg. A-10)

American Forage and Grasslands National Conference

It is time to make plans for the next American Forage & Grasslands Conference. The AFGC sponsors an annual conference which is attended by forage and livestock producers, agribusiness, and research, extension, and teaching faculty in crop and animal sciences, agricultural engineering, and other affiliated disipines. The conference includes Invited Speakers, Volunteer Papers, Posters, and Emerging Scientists Program, Producer Papers, a Hay Show Contest, a Photography Contest, Vendor Displays, and an Awards Banquet, Attendance in recent years has been over 300.

Some of these contests require time to prepare, and it is time well spent.

American Forage and Grassland Council and the North American Alfalfa Improvement Conference. The annual meeting will be held July 16-19, 2000 at the Marriott Madison West Hotel, 1313 John Q. Hammons Drive, Middleton (Madison), WI 53562. For more information contact: Dana Tucker at The Management Group, PO Box 94, Georgetown, TX 78627. Telephone: (800) 994-2342 Facsimile: (512) 238-0703 Email: dtrucker@io.com URL: http://www.forages.css.orst.edu/Organizations/Forage/AFGC/.

Table 1. DATES, TIMES, NUMBER OF COWS GRAZED, & STUDY PADDOCKS SIZE.

Rotation (#)	Dates (day month)	Study Paddock # 1					Study Paddock # 2				
		Enter (time)	Leave (time)	Duration (hrs)	Cows (#)	Paddock Size (Ac)	Enter (time)	Leave (time)	Duration (hrs)	Cows (#)	Paddock Size (Ac)
1st	23 & 24 April	10:15 AM	1:45 PM	3.5	173	1.24	6:00 PM	5:30 AM	11.5	173	1.24
2nd	11 & 12 May	9:30 AM	4:05 PM	6.6	170	1.26	6:30 PM	?	11.0?	170	1.43
3rd	24 & 25 May	9:00 AM	3:55 PM	6.9	169	1.69	6:30 PM	5:30 AM	11.0	169	1.82
4th	07 & 08 June	9:10 AM	3:50 PM	6.7	164	1.69	6:20 PM	5:30 AM	11.2	164	2.66
5th	18 & 19 June	9:00 AM	4:00 PM	7.0	160	2.60	6:15 PM	5:30 AM	11.3	160	2.69
6th	15 & 16 July	6:30 PM	5:30 AM	11.0	156	2.22	9:30 AM	2:30 PM	5.0	156	1.60
7th	14 & 15 Aug	9:20 AM	3:55 PM	6.6	154	1.82	6:15 PM	5:30 AM	11.3	158	1.75
8th	13 &14 Sept	9:15 AM	4:00 PM	6.8	148	1.86	6:20 PM	5:30 AM	11.2	148	1.72
9th	17 &18 Oct	9:14 AM	4:10 PM	6.9	145	1.50	8:20 AM	4:06 PM	7.8	145	1.53

Table 2. WATER CONSUMED FROM TROUGH LOCATED WITHIN STUDY PADDOCKS.

Rotation	Study Paddock # 1			Study Paddock # 2			Study Paddocks # 1+ 2
	Avg. Draw During Residency Period (gal/cow)	Avg. Hourly Draw (gal/cow/hr)	Fraction of 24 Hr Draw (%)	Avg. Draw During Residency Period (gal/cow)	Avg. Hourly Draw (gal/cow/hr)	Fraction of 24 Hr Draw (%)	Avg. Draw in 24 Hr. Period (gal/cow)
1st	0.07	0.021	29.4	0.18	0.015	70.6	0.25
2nd	5.39	0.830	68.6	2.46	0.224	31.4	7.86
3rd	2.31	0.334	57.4	2.78	0.252	42.6	5.09
4th	4.24	0.637	62.8	2.44	0.218	37.2	6.76
5th	4.31	0.615	67.7	2.06	0.183	32.3	6.37
6th	3.67	0.330	49.4	3.77	0.750	50.6	7.44
7th	2.41	0.365	53.7	2.02	0.180	46.3	4.42
8th	2.53	0.375	54.8	2.09	0.187	45.2	4.60
9th	2.59	0.376	60.3	1.70	0.218	39.7	4.30

Table 3. METEOROLOGICAL CONDITIONS WHILE COWS GRAZED STUDY PADDOCKS.

Rotation	Rainfall During Residency Period (inches)	Study Paddock # 1			Study Paddock # 2		
		Max. Air Temp. (°F)	Max Rel. Humidity (%)	Max. Water Trough Temp. (° F)	Max. Air Temp. (°F)	Max Rel. Humidity (%)	Max. Water Trough Temp. (° F)
1st	rained; no inst.	43.9	NA	46.8	42.5	NA	46.8
2nd	0.0	63.5	58.4	90.2	61.5	93.0	78.8
3rd	0.3	67.7	93.8	70.4	52.5	93.8	64.9
4th	0.0	89.5	76.1	100.2	83.0	91.0	92.5
5th	0.0	69.7	81.3	85.1	68.3	98.6	79.5
6th	0.0	86.6	98.3	87.3	89.5	62.0	103.4
7th	0.0	72.5	97.9	73.9	64.9	96.1	71.8
8th	0.1	78.7	56.3	94.8	71.8	90.6	80.9
9th	<0.02	62.9	93.8	66.3	46.1	91.4	50.4

Table 4. ESTIMATED DRY MATTER & HERBAGE WATER INTAKE FROM PASTURE.

Rotation	Study Paddock # 1			Study Paddock # 2			Study Paddocks # 1 + 2	
	Forage Intake (lbs DM/cow)	Forage Intake (lbs DM/Ac)	Plant Tissue Water Intake (gal/cow)	Forage Intake (lbs DM/cow)	Forage Intake (lbs DM/Ac)	Plant Tissue Water Intake (gal/cow)	Forage Intake (lbs DM/cow)	Plant Tissue Water Intake (gal/cow)
1st	6.5	906.9	4.2	9.1	1269.6	5.7	15.6	9.9
2nd	9.4	1268.3	7.0	8.6	1022.4	5.4	18.0	12.4
3rd	1.6	160.0	0.7	3.9	362.1	1.8	5.5	2.5
4th	2.9	281.4	1.2	12.0	739.8	5.2	14.9	6.4
5th	11.3	695.4	6.3	5.7	339.0	2.0	17.0	8.3
6th	8.4	590.3	3.0	6.2	604.5	2.1	14.6	5.1
7th	10.2	863.1	3.5	9.8	884.8	3.8	20.0	7.3
8th	4.6	366.0	2.1	3.1	266.7	1.2	7.7	3.3
9th	8.6	831.3	4.8	8.0	758.2	4.7	16.6	9.5

Table 5. PASTURE FORAGE QUALITY.

Rotation (#)	Study Paddock (#)	Dry Matter (%)	Crude Protein (%)*	Acid Detergent Fiber (%)*	Neutral Detergent Fiber (%)*	Net Energy of Lactation (Mcal/lb)*	Nonstructural Carbohydrates (%)*	Total Digestible Nutients (%)*
1st	1	15.6	29.6	23.2	40.1	0.69	19.5	66
	2	16.1	30.1	20.9	39.7	0.70	19.4	66
2nd	1	13.8	24.8	22.3	37.4	0.71	27.0	67
	2	16.1	26.3	20.7	36.9	0.71	26.0	67
3rd	1	NA	NA	NA	NA	NA	NA	NA
	2	20.2	23.3	26.4	45.8	0.66	20.1	65
4th	1	22.4	14.8	16.6	32.5	0.73	41.9	68
	2	21.6	20.4	23.4	42.0	0.68	26.8	65
5th	1	17.8	19.6	31.8	58.7	0.56	10.9	61
	2	25.0	19.6	31.9	56.1	0.58	13.5	62
6th	1	24.8	24.0	24.0	42.4	0.68	22.8	65
	2	25.7	22.7	25.4	48.8	0.64	17.7	64
7th	1	25.8	18.2	26.3	51.7	0.67	14.4	67
	2	23.7	19.4	28.1	51.9	0.64	9.2	65
8th	1	20.9	25.3	28.9	56.7	0.61	6.8	64
	2	24.0	25.1	25.4	51.4	0.68	8.5	67
9th	1	17.7	28.5	24.1	47.6	0.65	13.1	64
	2	16.9	32.1	20.9	47.6	0.65	9.5	64

* These values are calculated on a dry matter basis.

Table 6. HEAT STRESS.

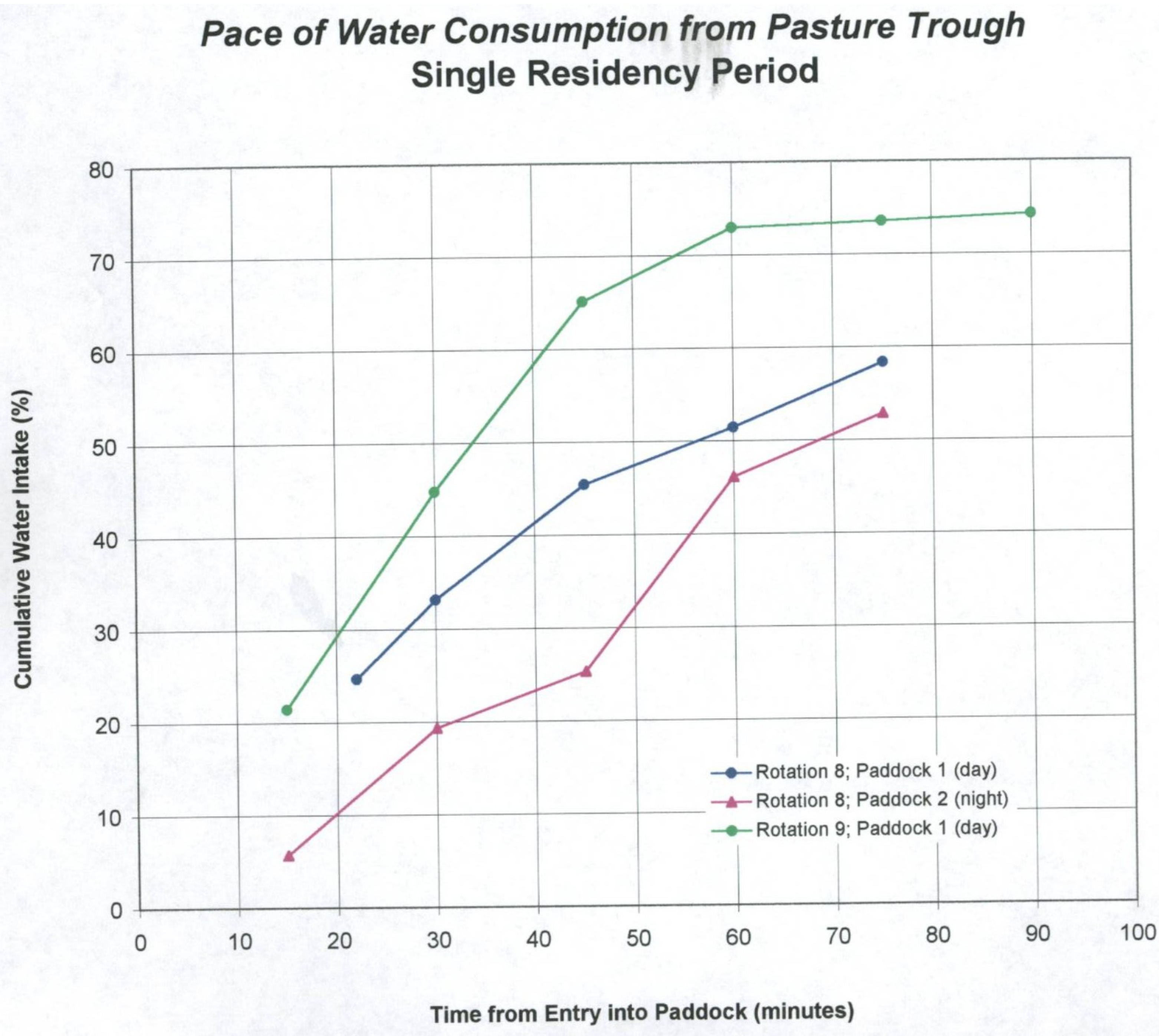
Rotation (#)	Study Paddock (#)	Heat Stress Index									
		None		Mild		Distressed		Severe		Fatal	
		Portion of Residency Period (%)	Time (hours)	Portion of Residency Period (%)	Time (hours)	Portion of Residency Period (%)	Time (hours)	Portion of Residency Period (%)	Time (hours)	Portion of Residency Period (%)	Time (hours)
1st	1	100.0	3.5	0	0	0	0	0	0	0	0
	2	100.0	11.5	0	0	0	0	0	0	0	0
2nd	1	100.0	6.6	0	0	0	0	0	0	0	0
	2	100.0	11.0	0	0	0	0	0	0	0	0
3rd	1	100.0	6.9	0	0	0	0	0	0	0	0
	2	100.0	11.0	0	0	0	0	0	0	0	0
4th	1	0.0	0	46.2	3.1	53.8	3.6	0	0	0	0
	2	68.9	7.7	31.1	3.5	0	0	0	0	0	0
5th	1	100.0	7.0	0	0	0	0	0	0	0	0
	2	100.0	11.3	0	0	0	0	0	0	0	0
6th	1	68.2	7.5	31.8	3.5	0	0	0	0	0	0
	2	0	0	70.0	3.5	30.0	1.5	0	0	0	0
7th	1	66.7	4.4	33.3	2.2	0	0	0	0	0	0
	2	100.0	11.3	0	0	0	0	0	0	0	0
8th	1	85.2	5.8	14.8	1.0	0	0	0	0	0	0
	2	100.0	11.2	0	0	0	0	0	0	0	0
9th	1	100.0	6.9	0	0	0	0	0	0	0	0
	2	100.0	7.8	0	0	0	0	0	0	0	0

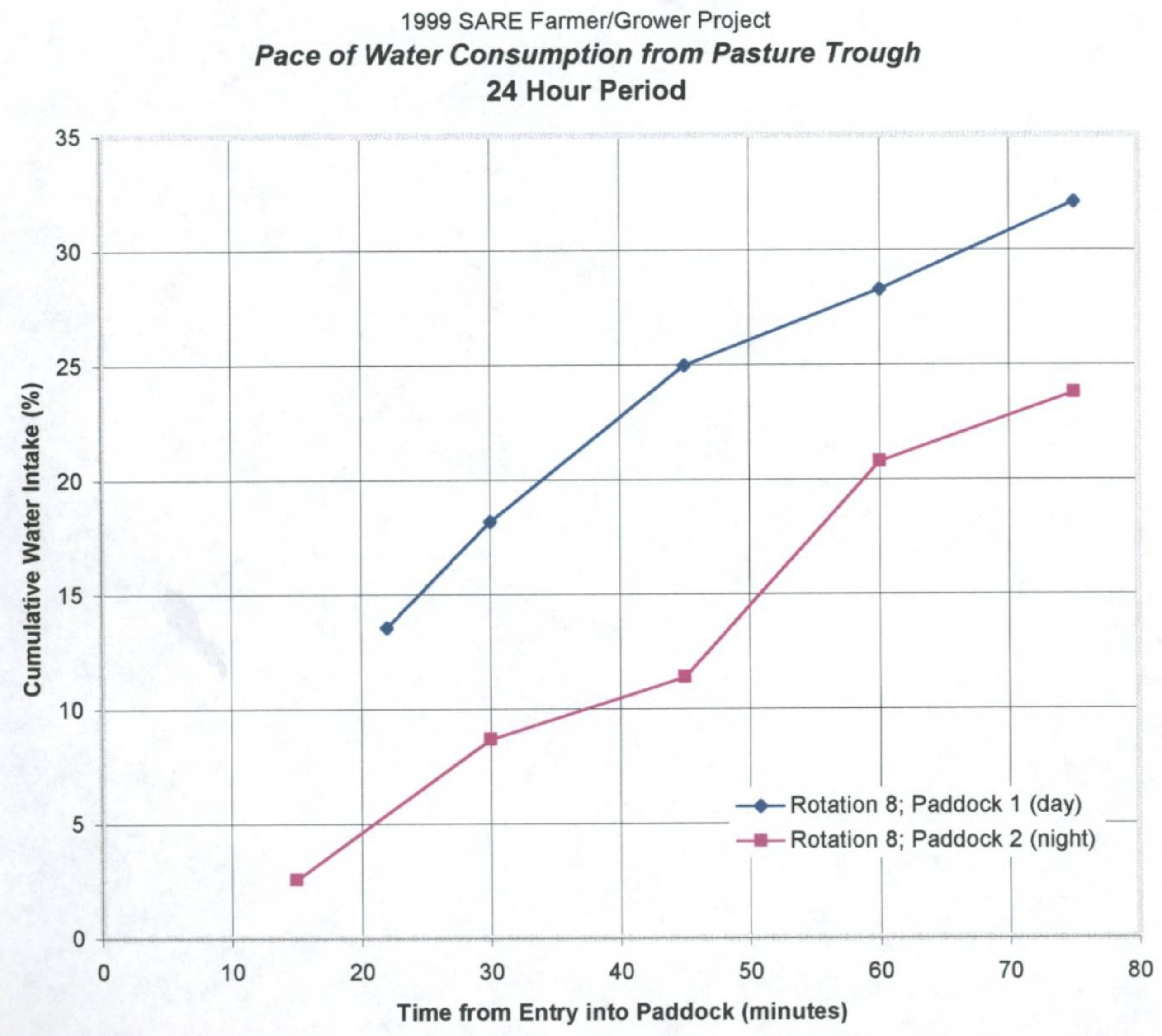
Table 7. MILK PRODUCTION & MINIMUM WATER INTAKE.

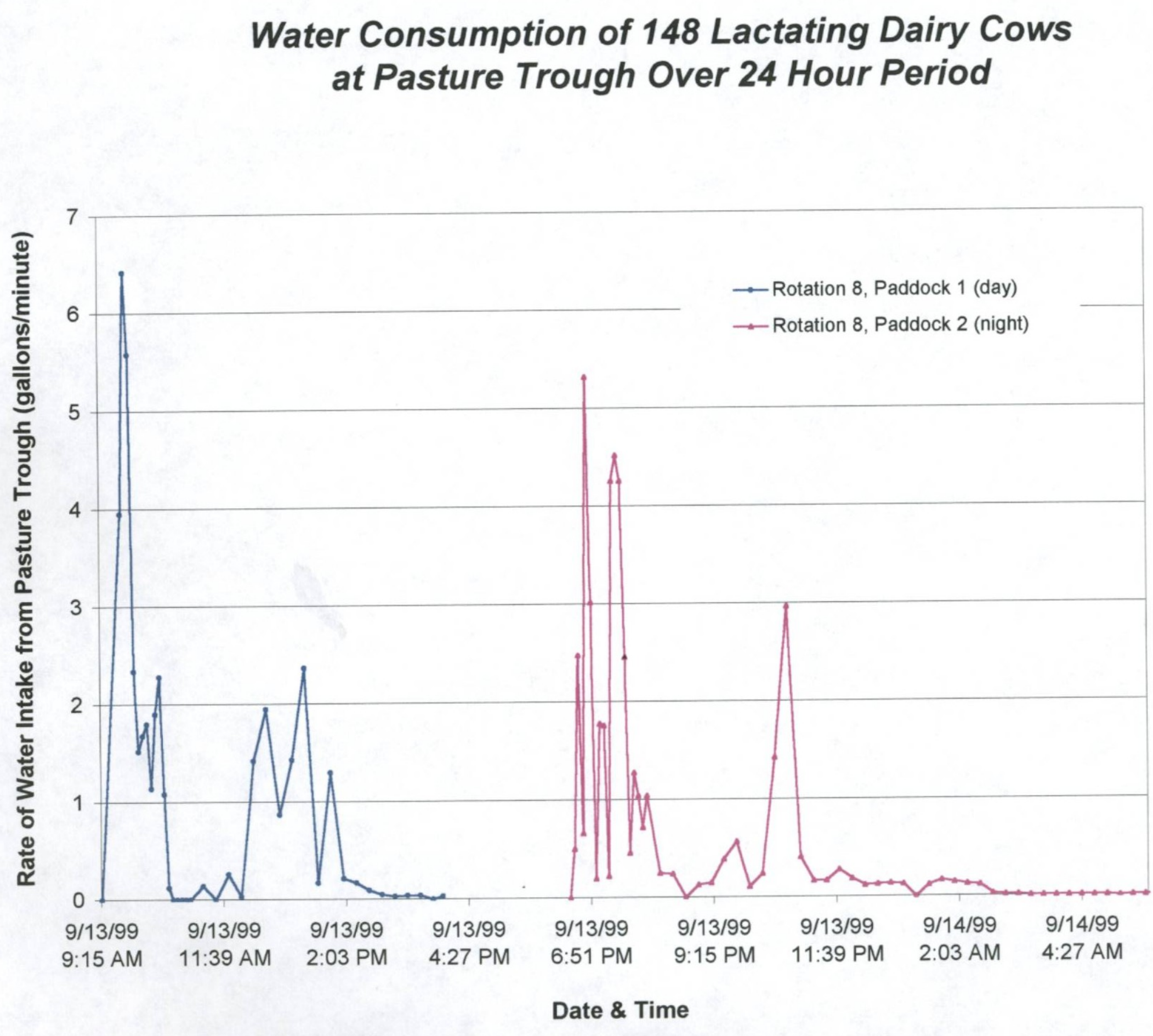
Rotation (#)	Milk Production of Study Paddocks # 1+ 2 (pounds/cow/day)	Water Consumption from Trough + Pasture Forage (gallons/cow/day)
1st	59.5	10.2
2nd	61.1	20.3
3rd	56.5	7.6
4th	56.3	13.2
5th	58.3	14.7
6th	55.0	12.5
7th	53.4	11.7
8th	54.8	7.9
9th	24.4**	13.8***

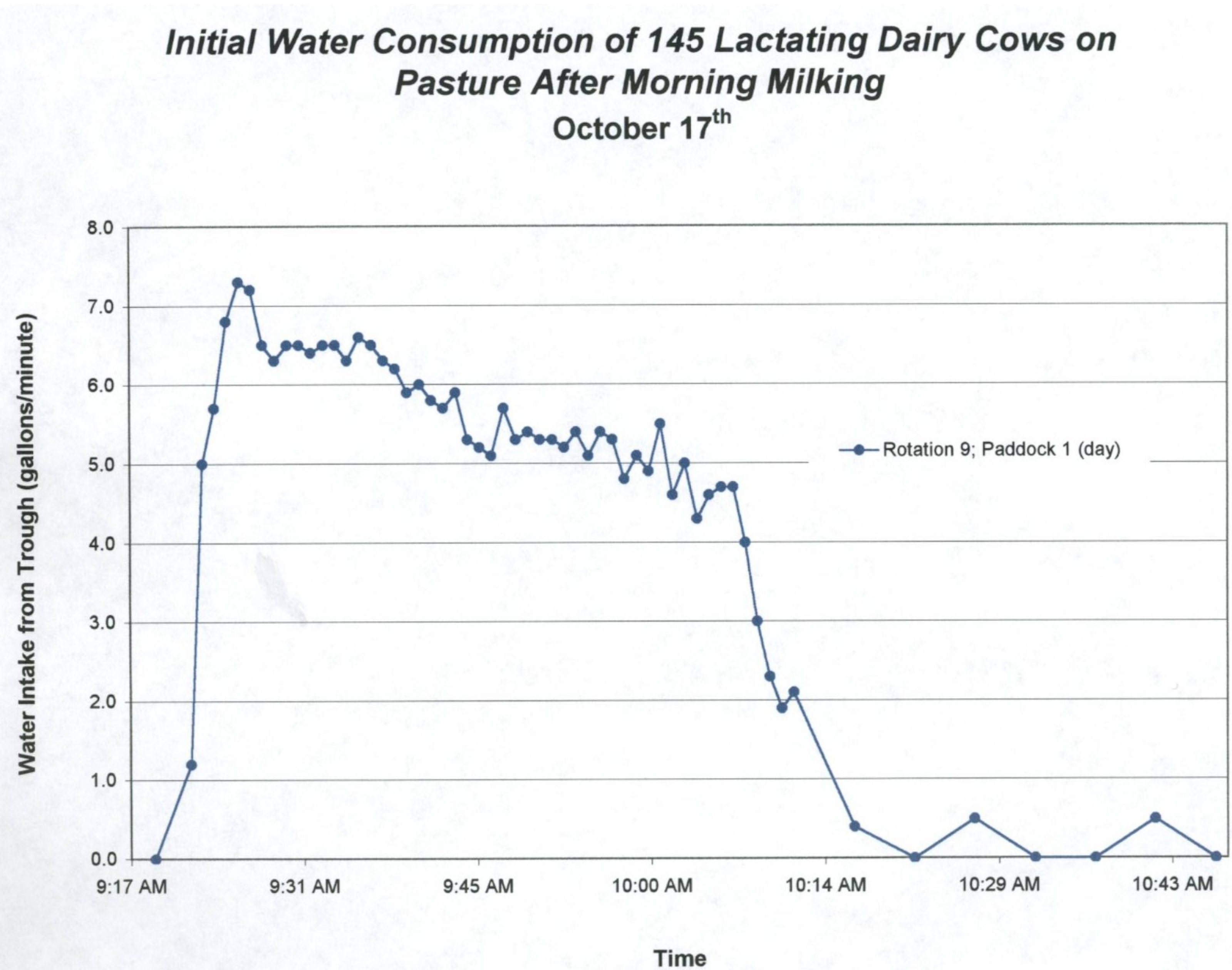
** Calculated only on first milking.

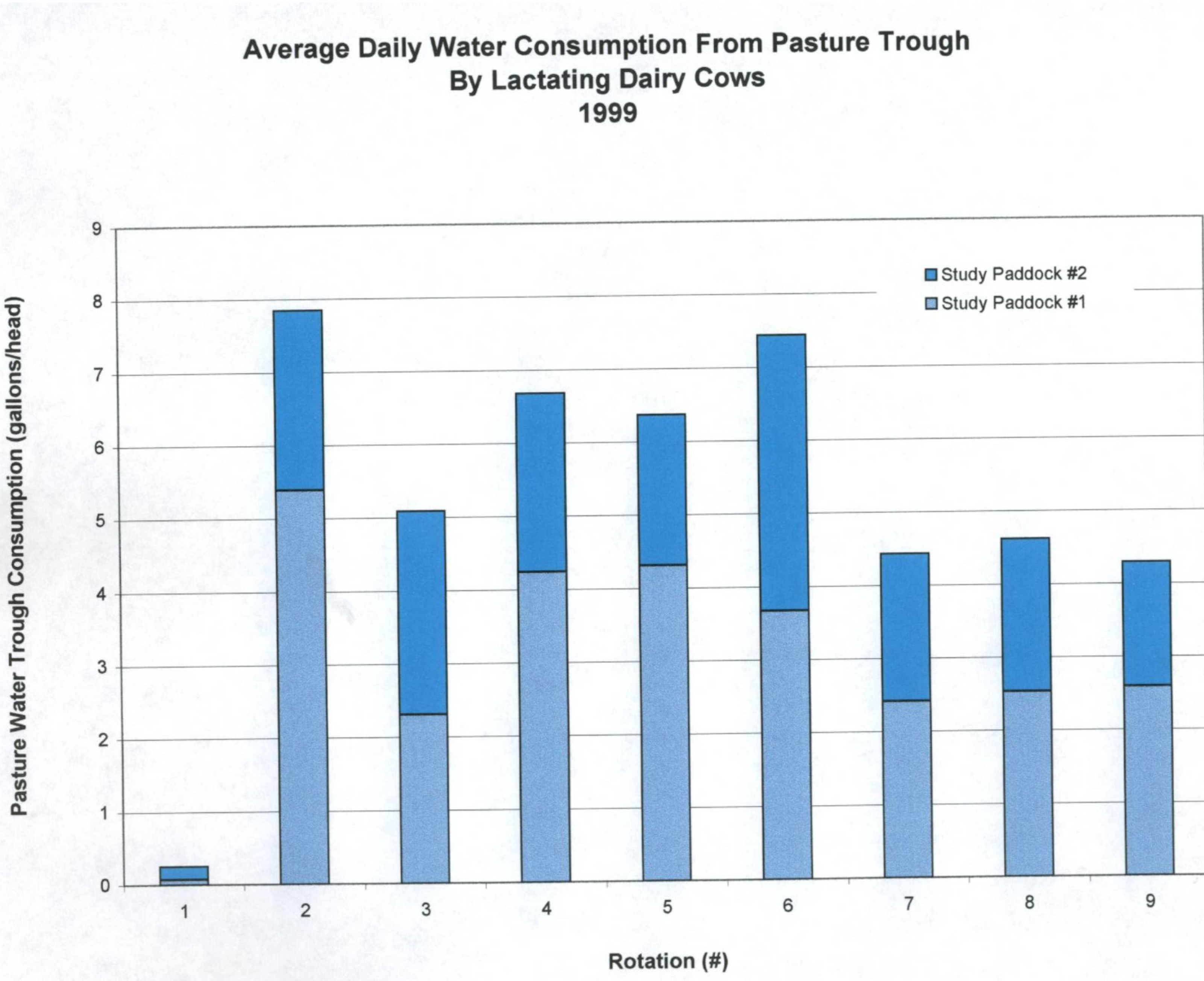
*** Estimated on two consecutive morning milkings.


Pace of Water Consumption from Pasture Trough
Single Residency Period
Cumulative Water Intake (%)
Time from Entry into Paddock (minutes)
0
10
20
30
40
50
60
70
80
90
100
Rotation 8; Paddock 1 (day)
Rotation 8; Paddock 2 (night)
Rotation 9; Paddock 1 (day)

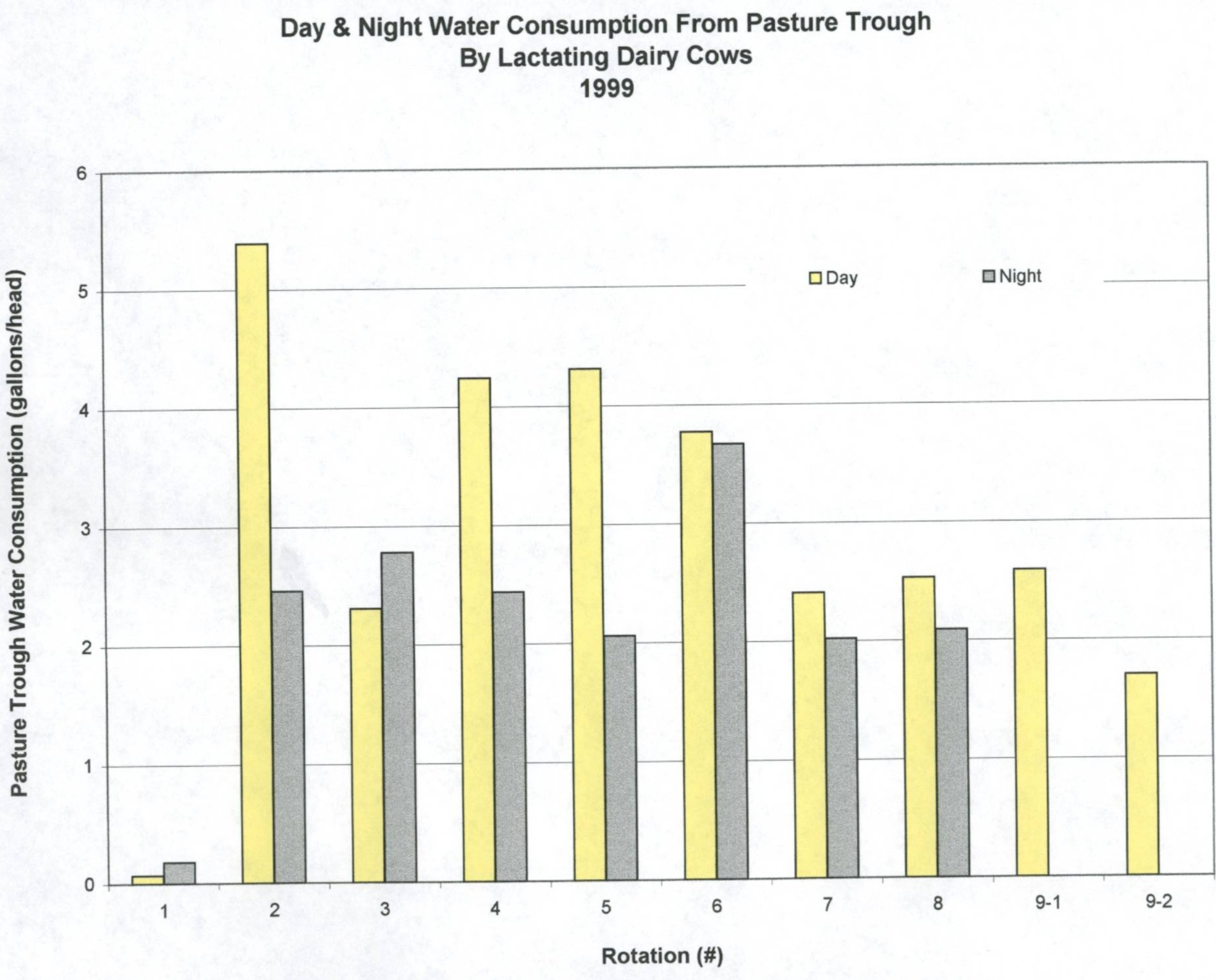

1999 SARE Farmer/Grower Project
Pace of Water Consumption from Pasture Trough
24 Hour Period
Cumulative Water Intake (%)
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
Time from Entry into Paddock (minutes)
Rotation 8; Paddock 1 (day)
Rotation 8; Paddock 2 (night)

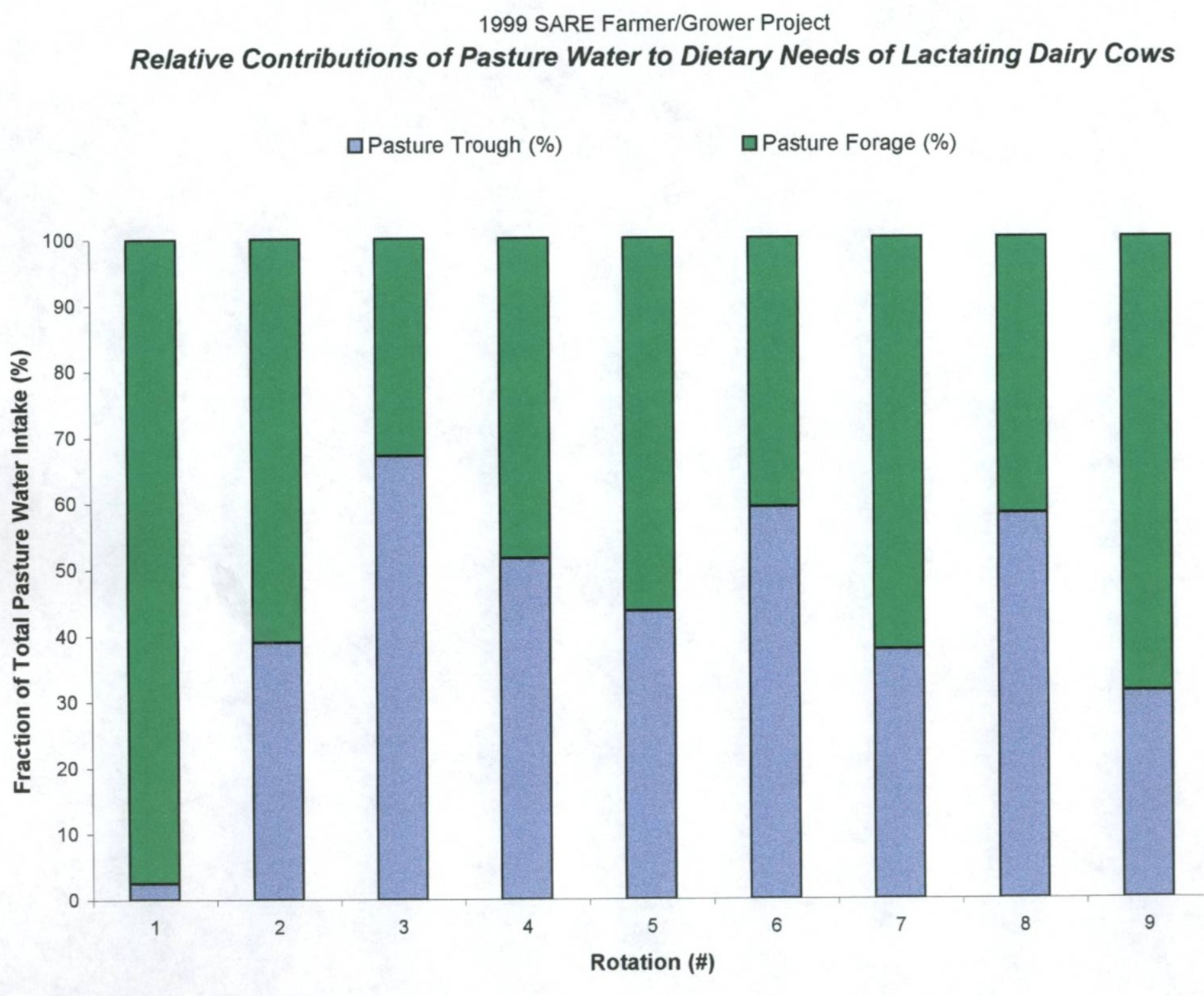

Water Consumption of 148 Lactating Dairy Cows
at Pasture Trough Over 24 Hour Period
Rate of Water Intake from Pasture Trough (gallons/minute)
7
6
5
4
3
2
1
0
Rotation 8, Paddock 1 (day)
Rotation 8, Paddock 2 (night)
9/13/99 9:15 AM
9/13/99 11:39 AM
9/13/99 2:03 PM
9/13/99 4:27 PM
9/13/99 6:51 PM
9/13/99 9:15 PM
9/13/99 11:39 PM
9/14/99 2:03 AM
9/14/99 4:27 AM
Date & Time

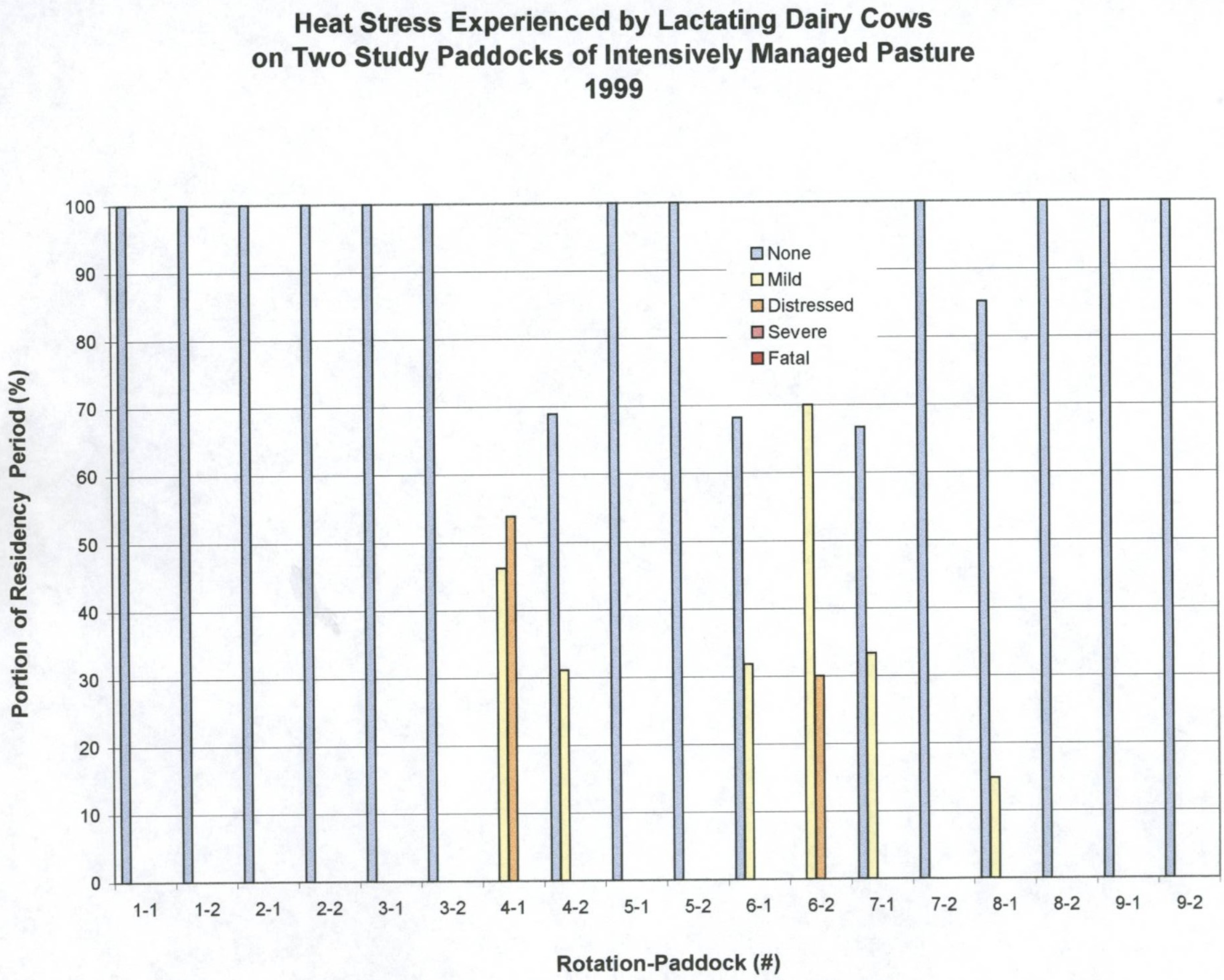

Initial Water Consumption of 145 Lactating Dairy Cows on Pasture After Morning Milking
October 17th
Water Intake from Trough (gallons/minute)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
9:17 AM
9:31 AM
9:45 AM
10:00 AM
10:14 AM
10:29 AM
10:43 AM
Time
Rotation 9; Paddock 1 (day)



Average Daily Water Consumption From Pasture Trough
By Lactating Dairy Cows
1999
Study Paddock #2
Study Paddock #1
Pasture Water Trough Consumption (gallons/head)
0
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
7
8
9
Rotation (#)


Day & Night Water Consumption From Pasture Trough
By Lactating Dairy Cows
1999
Day
Night
Pasture Trough Water Consumption (gallons/head)
0
1
2
3
4
5
6
1
2
3
4
5
6
7
8
9-1
9-2
Rotation (#)


1999 SARE Farmer/Grower Project
Relative Contributions of Pasture Water to Dietary Needs of Lactating Dairy Cows
Pasture Trough (%)
Pasture Forage (%)
Fraction of Total Pasture Water Intake (%)
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
Rotation (#)


Heat Stress Experienced by Lactating Dairy Cows
on Two Study Paddocks of Intensively Managed Pasture
1999
None
Mild
Distressed
Severe
Fatal
Portion of Residency Period (%)
0
10
20
30
40
50
60
70
80
90
100
1-1
1-2
2-1
2-2
3-1
3-2
4-1
4-2
5-1
5-2
6-1
6-2
7-1
7-2
8-1
8-2
9-1
9-2
Rotation-Paddock (#)

Pasture Trough Water Temperatures

1999

Carey Farm

Groton, NY