Use and Effectiveness of Technology for Cattle Watering

Final Report

Prepared for

FROSTFREE NOSEPUMPS LTD.

Prepared by

Tanya McDonald, B.Sc.
Carien Vandenberg, M.Sc.
Abimbola Abiola, Ph.D., P.Ag., C.A.C.

OLDS COLLEGE SCHOOL OF INNOVATION
OLDS, ALBERTA

NOVEMBER, 2006

EXECUTIVE SUMMARY

The Frostfree Nosepump (FFNP) is an energy-free and low-cost solution to cattle watering requirements. It is a down-hole piston pump that brings up water with each stroke of the nose pad by the animal. Construction and operation of the FFNP is simple and energy free, other than the energy required by the cow to operate the lever. Applications include systems in which dugout or pond water is diverted underground to the bottom of the culvert by gravity flow, thus providing the opportunity to utilize a dugout or pond year round without the use of electrical energy or heat. This system has potential for many riparian area management applications where there are environmental concerns with livestock having access to waterways. This low-cost, year round watering facility can improve access to areas that previously were not considered for livestock watering because of the cost or unavailability of an energy source. It can facilitate winter feeding in non-traditional areas, swath grazing and accessing remote pastures. FFNP Ltd. and Olds College initiated a research and demonstration project in the fall of 2005 to verify the use and effectiveness of the FFNP for cattle watering. Primary objectives of the research were to verify the effectiveness of the technology in the winter with no supplemental energy, to document and verify the ability to train cows and calves to use the FFNP, to compare the weight gains of calves raised on pasture land equipped with a FFNP to a similar group of calves raised on the same pasture but with a standard water trough and to offer an opportunity for exposure of Olds College students, staff, researchers and agricultural producers to the technology. During the project, the cows quickly learned to operate the FFNP and also trained their calves. The FFNP successfully supported the growth and maintenance of 69 cow calf pairs during the winter and 26 pairs in the summer. There was no difference in average daily gain between calves using the FFNP (3.20lb/day) and the standard watering system (3.24lb/day) during the summer trial. The FFNP has proven itself at Olds College as a simple to use and install, low-cost and highly effective technology for energy-free and environmentally sustainable cattle watering.

INTRODUCTION

The Frostfree Nosepump (FFNP) is an energy-free solution to cattle watering requirements. It is a down-hole piston pump that brings up water with each stroke of the nose pad by the animal. Installed correctly, the FFNP will not freeze. A drain-hole in the riser pipe allows excess water to drain back, preventing contamination of water, which is another advantage of the FFNP. A nipple in the trough prevents contaminated water from draining into the water source and a cement pad prevents ground water contamination. One hundred cows per Nosepump or 50 cow/calf pairs is the recommended allowance by the technology supplier. Multiple pumps on large diameter wells will accommodate larger herds.

Construction and operation of the FFNP is simple and energy free, other than the energy required by the cow to operate the lever. The design of the waterer includes a small, enclosed trough with a lever apparatus that is pushed by the cow's nose. This is set on top of a culvert, set vertically into the ground to the depth required to make use of ground water (for a drilled or excavated well) or dugout level. Another option is installation alongside a pressure line. An installation depth of at least 20 feet with a minimum 24-inch diameter culvert is recommended to capture significant geothermal heat. The nose-powered lever apparatus operates a piston pump which is suspended in the well, much like the old hand pumps. With provision for frost protection, the pumps work trouble free. In very cold weather (minus 25°C or lower) the occasional removal of the ice that tends to build up on the sides of the hood may be necessary. This is done by tapping the side with a deadblow hammer.

FFNPs are a low cost alternative. The total cost of the system varies with the required depth (depending on the water table) and the rates charged by the contractor for installation. Estimated costs including a single pump, drilling or trenching, culvert, hose, lid, insulation, rod, pipe, and insulated platform are approximately $2000-$3500 CAD.

Applications include systems in which dugout or pond water is diverted underground to the bottom of the culvert by gravity flow, thus providing the opportunity to utilize a dugout or pond year round without the use of electrical energy or heat. This system has potential for many riparian area management applications where there are environmental concerns with livestock having access to waterways. This low-cost, year round watering facility can improve access to areas that previously were not considered for livestock watering because of the cost or unavailability of an energy source. It can facilitate winter feeding in non-traditional areas, swath grazing and accessing remote pastures.

The primary objectives of this research were:

- to verify the effectiveness of the technology in Canadian winters with no supplemental energy provided
- to document and verify the ability to train livestock to use the FFNP
- to document and verify the ability of cows to train their calves to use the FFNP
- to compare the weight gains of calves raised on pasture land equipped with a FFNP to a similar group of calves raised on the same pasture but with a standard water trough
- to offer an opportunity for exposure of Olds College students, staff, researchers and agricultural producers to the FFNP technology

MATERIALS AND METHODS

Site selection: A suitable pasture site located to the south of the Olds College campus was selected for installation of the FFNP. The pump was fed with a pressure line. This system was chosen as there was an existing waterer in the location that was fed by a pressure system so it was the most cost effective. Use of a pressure line required a small amount of pumping energy but this energy did not in any way operate the FFNP and was neglected in the overall analysis. The integrity of the system (absence of leaks) was verified by incorporating a floor in the culvert. The site selected provided opportunities for both winter feeding and summer grazing so that the same pump could be used year-round.

Installation: The FFNP owners provided the specifications for installation and supplied a single pump, culvert, hose, lid, insulation, rod, and pipe. Olds College supplied labour for installation/trenching and materials and labour for construction of the insulated platform. The owners of FFNP oversaw the installation to ensure that it meets specifications. A track-hoe was employed to reach desired depth of 7.3m (24ft) but upon trenching, it was found that is was possible to reach a depth of only 6.7m (22ft) due to shallow sandstone bedrock. The culvert was shortened and installed to this depth and the water supply was tied in.

Trenching for Culvert Installation

Installation of the FFNP

Adverse weather conditions and complications with obtaining concrete in a timely fashion for construction of the insulated pad led to the replacement of concrete with wood. A 14’ x 14’ wooden pad was constructed at minimal cost and proved to be highly effective throughout the duration of the trial.


Olds College Cattle Using the FFNP

Winter project: **Feb 1- April 30, 2006**
Livestock were preconditioned to the FFNP using a demonstration Nosepump (not drilled so very little lift is required) in the fall of 2005 to permit a smooth transition into the winter project. A total of 69 cow/calf pairs were turned out into the winter pasture site where the only source of water was a double FFNP. Pairs were turned out at a rate of 11-16 pairs at a time beginning Feb 1, 2006. Staff adhered to the protocol designed by the owners of FFNP entitled “Hints to train your livestock to use the FFNP” to achieve training success. All project details were documented including time and effort required for training, the date and numbers of cow/calf pairs turned out each time, incidences of icing and any problems or concerns noted with pump operation or livestock condition. Cattle were fed the standard ration used by Olds College. A temperature log was kept for the trial duration indicating daily high and low temperatures.

Summer project: **June 1-Sept 15, 2006**
All calves were weighed at the start of the summer project (on pasture, after breeding) and at the end of the project (off pasture, after weaning) in order to determine calf weight of gain. Weighing was conducted on two consecutive days and an average was calculated in order to reduce error.

Olds College Farm Staff Weighing Calves for the Research Project

Cow/calf pairs were split into two groups; a test group consisting of 26 cow/calf pairs on pasture with a single FFNP and a control group of 26 pairs on the same mixed grass and legume pasture with a standard stock waterer as the water source. Pairs were assigned to the test or control group in order to balance the two groups with respect to breed and genetics. All project details, including outdoor temperature, were documented as outlined for the winter project. At no time in the project were there new pasture limitations that required the groups to be transferred to alternate pasture for a short period of time during the project. There were no problems or concerns noted by Olds College farm staff regarding the operation of the FFNP or the condition of the livestock drinking from either water source.

Reporting and information dissemination: Weight gain data was statistically analyzed using Microsoft Excel. All documentation and results were compiled into a summary report. Information dissemination occurred through student and Olds College staff (instructors and farm staff) participation in the project work, a poster presentation at OCSI, a class tour for the ag-business students at Olds College and a press release at the conclusion of the project (Grain News, November issue). The pump remained installed on campus after project completion for student exposure, future technology demonstrations and research projects.

RESULTS

Winter project

The project began in the fall of 2005 with a small group of about fifteen cows on the FFNP, slowly adding more cows every three or four days. The cattle seemed to adapt quickly after the initial group was trained. When the cattle were re-introduced to the FFNP in February of 2006, the cows that had been on the pump before quickly trained the ones that were not familiar with it. The turn out schedule for cattle is provided below.

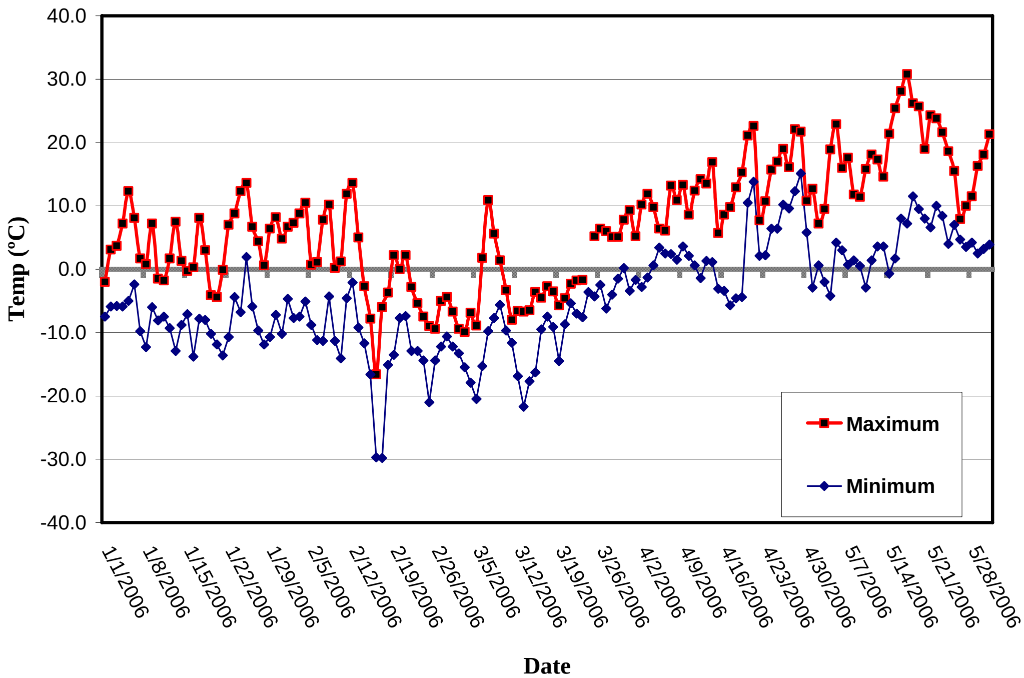
Table 1: Number of Cow/Calf Pairs and Turn Out Date for the Winter Project

Number of Cow/Calf Pairs	Turn Out Date
14	February 2, 2006
14	February 6, 2006
16	February 8, 2006
14	February 24, 2006
11	March 7, 2006

Olds College farm staff observed that a pecking order established for which cow drank first. Dominant cattle were observed to wait for the other cattle to pump the water and, when the submissive cow had pumped water to drink, the dominant animal displaced the submissive animal and drank the water in the bowl. In most cases, this continued until the dominant cow was full. This was not perceived to be a problem by the Olds College Farm staff and there was never a case reported where an individual cow did not receive enough water.

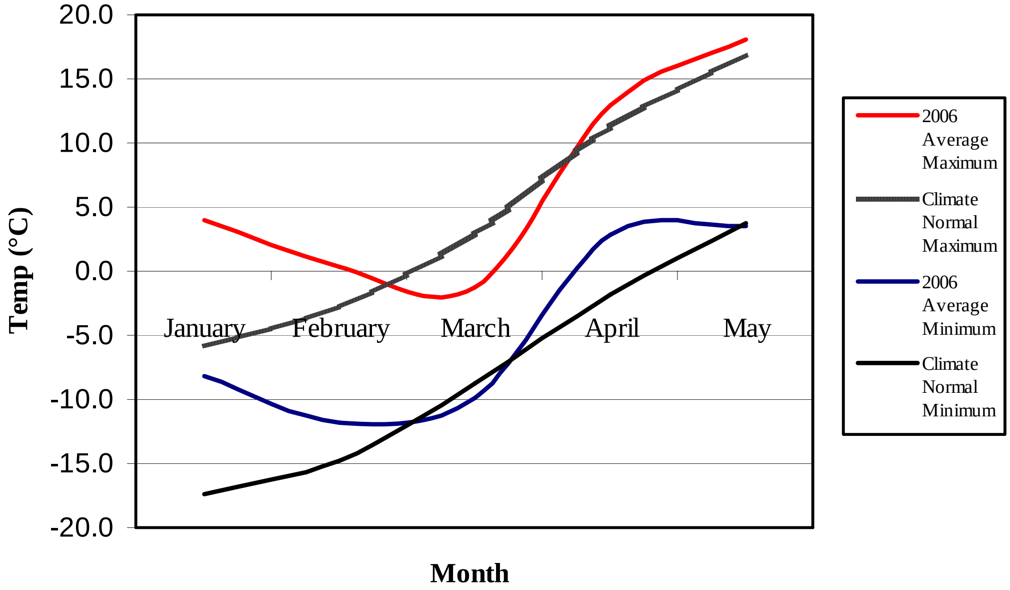
Maximum and minimum temperatures throughout the period of January to May 2006 were recorded from a weather station in Olds within close proximity to the research site (Environment Canada). Daily maximum and minimum temperature data is shown in the chart below.

Figure 1: Maximum and minimum temperatures- January to May, 2006



The majority of days in January and in the early part of February experienced daily maximum temperatures above freezing. Though temperatures remained below 0˚C, they rarely dropped below -20˚C. The winter of 2006 was relatively mild compared to Climate normal data temperature data averaged from 1971-2000 for the Red Deer Area (Environment Canada). Both maximum and minimum temperatures for the months of January, February, April, and May were higher compared to the average for 1971 to 2000. Graphical representation of this is provided below:

Figure 3: Average 2006 temperatures compared to climate normals



Though temperatures were generally warm during the winter project, there were occasional instances where the FFNP iced up. These instances occurred on cold nights that were also very windy. Cold temperatures (between 0 and -20˚C) without a wind did not seem to be a problem and incidences of icing only occurred at night when temperatures dropped to between -20 and -25˚C (the second week of Feb only). When this happened the ice would build up on the inside of the trough and as the cattle pushed the paddle forward it would stick and freeze to the side. In the mornings when the cattle were fed, the ice was knocked off with a mallet and the pump would operate well for the remainder of the day. The accumulation of ice around the culvert and pump appeared to be greater than on the standard waterer, meaning the cattle needed to reach further to get a full stroke. Project staff knocked excess ice away during routine daily checks to keep this buildup to a minimum.

Summer project

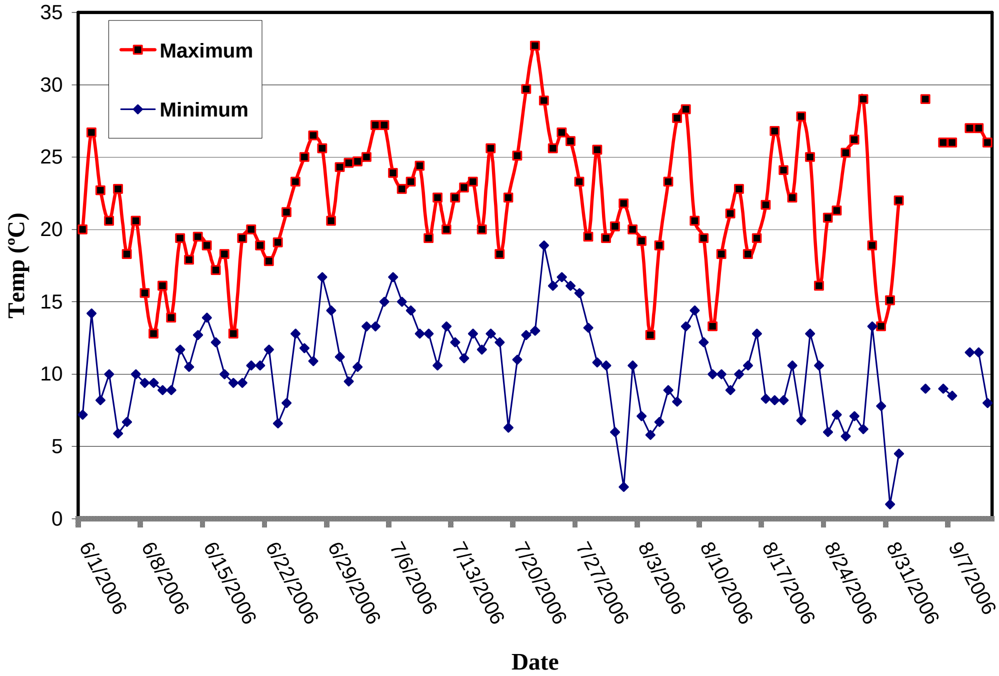
Fifty-two cows and their calves were weighed and sorted into two equal groups on June 12 and 13, 2006. Each calf was weighed on two consecutive days to minimize the impact of weight fluctuations due to large intake of water or food before eating. The average weight of each animal over the two days was used to get a cumulative average for each group. The cattle were selected randomly into 2 groups to get a similar average weight for each group as well as an equal number of steers and heifers.

Each cow and calf pair remained in either the FFNP treatment group or in the control water system group for the duration of the summer project. The objective of this study was to determine any weight gain differences among calves in either the FFNP treatment group or the control treatment watering system during this period. It was not the intent in this project to verify the number of cow/calf pairs that could be watered by a single FFNP. The number of cattle owned by Olds College during the project limited the treatment group to 26 pairs instead of 50 pairs per pump as recommended by the owners of FFNP.

At the end of the summer, each calf was again weighed on two consecutive days to minimize weight variations within an animal. Weight measurements were taken on September 12 and 13, 2006. One calf that did not remain in its designated treatment group for the duration of the summer experiment was removed from the study. As before, Olds College farm staff noted no problems with operation of the FFNP or adverse conditions of animals in the study.

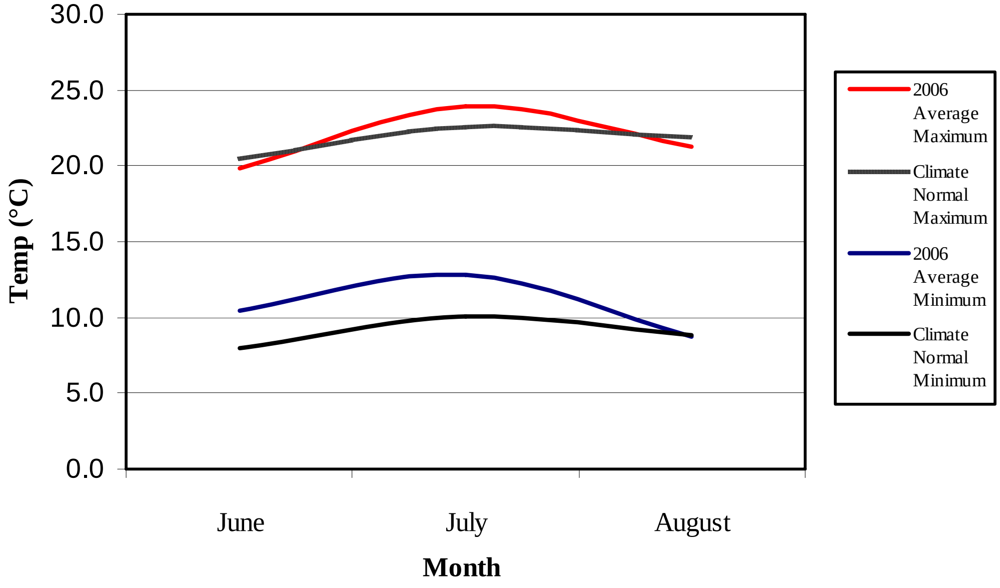
Maximum and minimum temperatures were recorded during the summer project. Temperatures during this period rarely dropped below 5°C with approximately 30 days showing maximum temperatures above 25°C.

Figure 4: Maximum and Minimum Temperatures – June to September 2006



Maximum and minimum temperatures for the summer were compared to climate normal averages for this area (Figure 5). The trendline for this summer was very similar to that of the past with the month of July appearing slightly warmer in 2006.

Figure 5: Average 2006 temperatures compared to climate normals



One calf escaped the fence line, switching groups during the trial period and had to be removed from the trial leaving a total of 25 animals (13 heifers (HFR) and 12 steers (STR)) in the control group and 26 animals (13 heifers and 13 steers) in the FFNP group. An average of the two weights was calculated for each animal and was used in the analysis. The table below shows the calf ID number, sex, treatment group, average individual calf weights in June and September, and the weight gained during the trial period.

Table 2: Initial and Final Average Weights of Calves Using the FFNP or the Control Watering System

Control Group

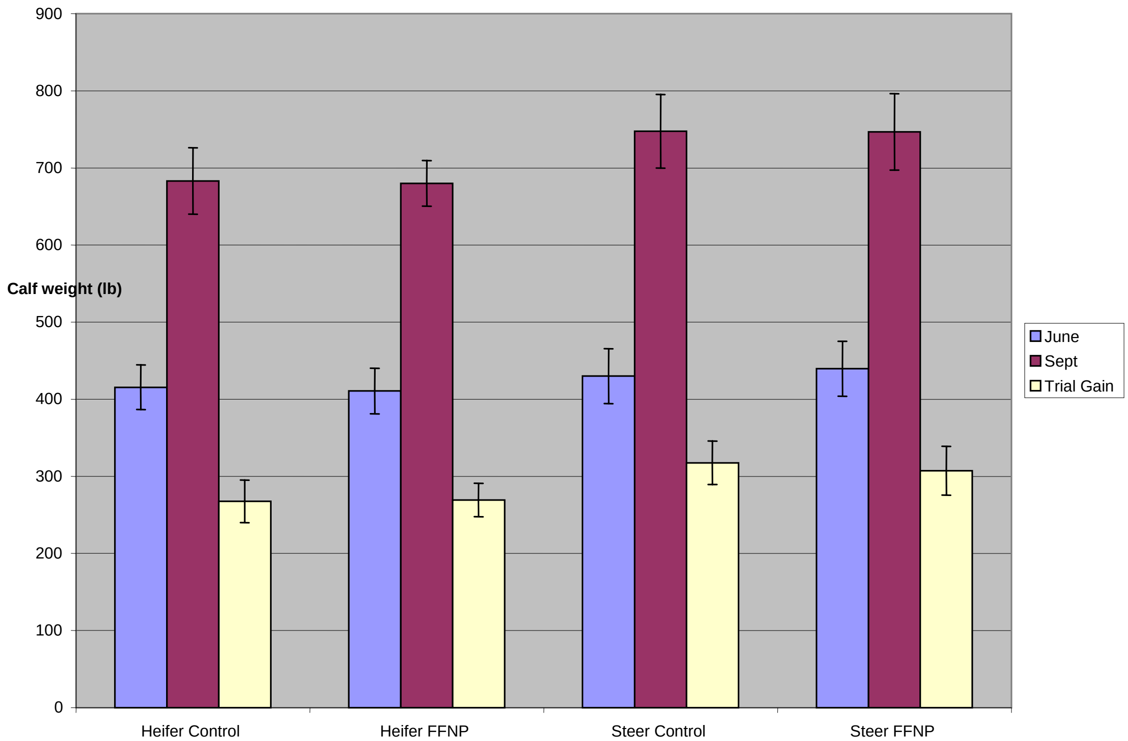
ID #	Sex	Group	Average Weight in June (lb)	Average Weight in September (lb)	Weight Gain (lb)	Average daily gain (lb/day)
103J	HFR	control	404	648	244	2.71
11L	HFR	control	372.5	619	246.5	2.74
3K	HFR	control	383.5	699	315.5	3.51
3M	HFR	control	476.5	741	264.5	2.94
3P	HFR	control	429.5	694	264.5	2.94
401N	HFR	control	409	643	234	2.60
405N	HFR	control	405.5	673	267.5	2.97
406K	HFR	control	391	650	259	2.88
406N	HFR	control	425	727	302	3.36
420K	HFR	control	405.5	634	228.5	2.54
433K	HFR	control	451.5	715	263.5	2.93
434K	HFR	control	443.5	753.5	310	3.44
8L	HFR	control	404	682.5	278.5	3.09
112	STR	control	380.5	729	348.5	3.87
101J	STR	control	441.5	766.5	325	3.61
11N	STR	control	423.5	758	334.5	3.72
12F	STR	control	450	822.5	372.5	4.14
13L	STR	control	408.5	681.5	273	3.03
1L	STR	control	433	746	313	3.48
2L	STR	control	425	766	341	3.79
3L	STR	control	405.5	699.5	294	3.27
411K	STR	control	441.5	745.5	304	3.38
411M	STR	control	481.5	797	315.5	3.51
412K	STR	control	493.5	794.5	301	3.34
431K	STR	control	376	665	289	3.21
AVERAGE			422.44	714.00	291.56	3.24
STANDARD DEVIATION			32.43	55.20	37.36	0.42

FFNP Group

ID #	Sex	Group	Average Weight in June (lb)	Average Weight in September (lb)	Weight Gain (lb)	Average daily gain (lb/day)
110	HFR	FFNP	418	695	277	3.08
10N	HFR	FFNP	398.5	648.5	250	2.78
12L	HFR	FFNP	363.5	673.5	310	3.44
400M	HFR	FFNP	387	677.5	290.5	3.23
402K	HFR	FFNP	427	710.5	283.5	3.15
403M	HFR	FFNP	412.5	648.5	236	2.62
403N	HFR	FFNP	464.5	724.5	260	2.89
404N	HFR	FFNP	419.5	691	271.5	3.02
410M	HFR	FFNP	406.5	702.5	296	3.29
414K	HFR	FFNP	400	642	242	2.69
4K	HFR	FFNP	444	700.5	256.5	2.85
8N	HFR	FFNP	361.5	629	267.5	2.97
9N	HFR	FFNP	435.5	695.5	260	2.89
111	STR	FFNP	469.5	775	305.5	3.39
1M	STR	FFNP	436.5	737	300.5	3.34
2M	STR	FFNP	398.5	663	264.5	2.94
401M	STR	FFNP	493.5	811	317.5	3.53
403L	STR	FFNP	482	802	320	3.56
405P	STR	FFNP	390	683	293	3.26
408K	STR	FFNP	461.5	704.5	243	2.70
408M	STR	FFNP	470.5	761	290.5	3.23
408N	STR	FFNP	404.5	711.5	307	3.41
417K	STR	FFNP	439.5	777	337.5	3.75
4P	STR	FFNP	406	714	308	3.42
5N	STR	FFNP	458	817.5	359.5	3.99
7N	STR	FFNP	403	751	348	3.87
AVERAGE			425.04	713.31	288.27	3.20
STANDARD DEVIATION			35.30	52.51	32.92	0.37

T-test statistical analysis of the average weight for each group revealed that there was no difference between the two groups when the experiment began in June with an average of 422.44 lb ±32.43 for the control group and an average of 425.04 lb ± 35.30 for the FFNP group ($P>0.05$). Similarly, there was no difference in average weights between groups at the end of the experiment in September with an average of 714 lb ± 55.20 for the control group and 713.31 lb ± 52.51 for the FFNP group ($P>0.05$). The average daily gain for the FFNP group was 3.20 lb/day ± 0.37 compared to 3.24 lb/day ± 0.42 for the control group. Again, there was no statistical difference in average gain between the groups (P>0.05).

Figure 6: Comparison of Heifer and Steer Average Weights Using FFNP and Control Watering Systems



Heifer calves weighed slightly less than steers in both groups in June and September but the difference was not significant (T-test, P>0.05). June average weights were 415.46 ± 28.96 and 430.00 ± 5.49 for the control group compared to 410.62 ± 29.59 and 439.45 ± 35.62 for the FFNP group for heifers and steers, respectively. September average weights were 683.00 ± 42.99 and 747.58 ± 47.59 for the control group compared to 679.88 ± 29.58 and 746.73 ± 49.49 for the FFNP group for heifers and steers, respectively. In addition, the average daily gain during the trial was not different between heifers and steers (t-test, P>0.05).

Out of interest, weights were recorded for the cows as well as the calves during the trial and the results are provided (Table 3).

Table 3: Comparison of Cow Weights Using FFNP and Control Watering Systems

ID #	Group	Average Weight in June (lb)	Average Weight in September (lb)	Weight Gain (lb)
112	control	1357	1436	79
101J	control	1551	1699	148
103J	control	1579	1628	49
11L	control	1485	1590	105
11N	control	1227	1355	128
12F	control	1411	1515	104
13L	control	1337	1418	81
1L	control	1497	1622	125
2L	control	1317	1435	118
3K	control	1503	1633	130
3L	control	1373	1373	0
3M	control	1146	1253	107
3P	control	1190	1314	124
401N	control	1338	1502	164
405N	control	1433	1413	-20
406K	control	1391	1520	129
406N	control	1641	1741	100
411K	control	1557	1603	46
411M	control	1203	1320	117
412K	control	1470	1501	31
420K	control	1491	1585	94
428K	control	1443	1582	139
431K	control	1430	1531	101
433K	control	1709	1769	60
434K	control	1565	1717	152
8L	control	1212	1363	151
AVERAGE		1417.54	1516.08	98.54
STANDARD DEVIATION		145.15	141.44	46.78

ID #	Group	Average Weight in June (lb)	Average Weight in September (lb)	Weight Gain (lb)
110	FFNP	1447	1513	66
111	FFNP	1536	1599	63
10N	FFNP	1313	1371	58
12L	FFNP	1272	1398	126
1M	FFNP	1307	1452	145
2M	FFNP	1314	1415	101
400M	FFNP	1411	1483	72
401M	FFNP	1237	1414	177
402K	FFNP	1445	1490	45
403L	FFNP	1566	1674	108
403M	FFNP	1462	1550	88
403N	FFNP	1172	1290	118
404N	FFNP	1187	1278	91
405P	FFNP	1178	1331	153
408K	FFNP	1495	1661	166
408M	FFNP	1544	1634	90
408N	FFNP	1090	1250	160
410M	FFNP	1481	1579	98
414K	FFNP	1475	1482	7
417K	FFNP	1542	1634	92
4K	FFNP	1391	1467	76
4P	FFNP	1268	1405	137
5N	FFNP	1323	1400	77
7N	FFNP	1144	1297	153
8N	FFNP	1197	1344	147
9N	FFNP	1234	1394	160
AVERAGE		1347.35	1454.04	106.69
STANDARD DEVIATION		143.01	123.60	43.29

Individual weights show both control and FFNP groups gained weight over the course of the summer with the exception of two animals that retained a net gain of zero and one animal that lost 20 lbs. There was a slight, but insignificant difference (P>0.05) in the weights of cows between groups (FFNP group weighed 60-70 lbs lighter than the control group). There was no statistical difference in weight gain among the two groups (P>0.05).

CONCLUSION

The trial at Olds College was successful in verifying the effectiveness of the FFNP technology in winter months in Canada without supplemental energy. Maintenance of the pump during the summer was minimal with only brief inspections to ensure proper equipment function and water availability. Although the temperatures during the trial were relatively mild, there were some instances where cold, windy weather conditions at night resulted in ice buildup on the pump. This ice was removed according to the supplier's instructions with little effort or trouble during routine chores. Daily inspections of the functioning and icing of the FFNP, particularly in cold wind conditions, is recommended to ensure adequate water availability.

There were no concerns with the ability of cattle to learn to operate the FFNP when the recommended training instructions were followed. Cattle learned to pump the water quickly and in the summer project, taught their calves to use the pump without hesitation. It was noted that group dynamics of the herd may influence watering order, as cattle of higher status or dominance assumed priority of access to the FFNP. This was not considered a problem, but rather an interesting observation by Olds College staff.

The double FFNP had the capacity to successfully support 69 cow/calf pairs on a winter pasture site where it served as the only source of water. The FFNP successfully supported the growth and maintenance of 26 cow calf pairs during the summer. There was no difference in average daily gain between calves using the FFNP (3.20lb/day) and the standard watering system (3.24lb/day) during the summer trial. It is anticipated that the pump has the capacity to support a larger herd than this (50 pairs per pump is the recommended allowance from the supplier), but the project was restricted by the number of cow/calf pairs held by the Olds College at this time. The maximum capacity should be determined by the user in consideration of the topography, pasture and temperature conditions.

The project provided an opportunity for students and staff of Olds College as well as visitors to gain exposure to the successful Frostfree Nosepump technology. This technology will remain at Olds College for future workshops and educational opportunities as well as for continued use on the Olds College Farm. The FFNP has proven itself at Olds College as a simple to use and install, low-cost and highly effective technology for energy-free and environmentally sustainable cattle watering.

ACKNOWLEDGEMENTS

Special thanks to Trevor Hamilton and the Olds College farm staff involved with the project for giving their time and their consideration for the trial animals during the research project. Thank you to all the students involved in collecting and recording data. Sincere thanks to the Campus Facilities Department and Glen Fox in particular for excellent workmanship during pump installation. Finally, the author would also like to thank the project sponsor, Frostfree Nosepump Ltd. for the opportunity to conduct this research and for providing a continued learning opportunity for agricultural students.

REFERENCES

Environment Canada, National Climate Archive, Online: www.climate.weatheroffice.ec.gc.ca