Remote Monitoring of Stock Water Reservoirs

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Remote monitoring of stock water reservoirs

By John Walker

On the Ground

- Water is the most important nutrient for livestock and ensuring a continuous supply can be costly and time consuming.
- Failed water delivery systems have resulted in livestock deaths.
- Game cameras, pressure transducers, and automatic meter reading systems that connect either by cellular networks or satellite can be used to remotely monitor water.
- Although costs vary among systems, the user's comfort level with using technology and the characteristics of each remote water monitoring system are more important considerations.
- The peace of mind of knowing that livestock have water is equally important to economic and labor savings provided by these systems.

Keywords: Livestock water; Satellite; Game camera; Pressure transducer; Water meter

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Introduction

The most important nutrient for grazing livestock is water.[1] Livestock are mostly water (50–80%) and while an animal may lose most of its fat and about half of its protein during starvation and survive, a 10% loss of body water can be fatal.[2] Although there has been interest in monitoring the behavior of grazing livestock[3] there is limited information on remotely monitoring livestock water. Although rarely reported, livestock die from lack of water due to a water delivery system's failure every year. To help avoid these losses, livestock producers spend hours checking water drinkers. I have experienced a water delivery system failure that resulted in cattle deaths. That experience, together with the responsibility of operating several ranches without employees on the property, created an interest in investigating remote systems for monitoring water. My research goal was to compare the efficacy and cost of different systems to remotely monitor livestock water.

Methods

Systems from three different manufacturers were used and different sensor and data transfer technologies were deployed and investigated for 3 years (2017–2019) at a ranch in Crockett County, Texas, located in the western Edwards Plateau (Table 1). The systems were: 1) a game camera (SpyPoint) that transmitted pictures via a cellular network; 2) a pressure transducer with cellular capability (AguaCheck); and 3) a pressure transducer and flow meter with satellite communications manufactured by Informational Data Technologies (IDT).

The SpyPoint game camera is remotely programable with a smartphone app to send images over a cellular network. The total cost includes a mounting stand, external booster antenna, and batteries (Table 1). This camera will transmit up to 100 pictures/month for free.

The AguaCheck unit consists of a pressure transducer with a solar panel that sends text messages over a cellular network (Fig. 1). This unit sends a daily text message reporting the water level as a percentage of a full water tank (Fig. 1). The unit measures water level every hour and sends an alert if the water level drops rapidly or falls below a user-specified level.

The IDT unit can be configured with or without a remote shutoff valve (Fig. 2). This unit can be configured to report readings at different intervals and was initially programmed to send readings every 8 hours. However, based on experience, a 24-hour interval for readings is adequate. Data are accessed on a website and can be exported to a spreadsheet for additional analysis (Fig. 3). The remote shutoff valve allows the user to shut off the water if a leak is detected (Fig. 2). This option is useful for older reservoirs where the standpipe is not functional, and it can prevent the loss of water from a reservoir before a leak can be repaired.

I conducted a breakeven analysis to determine the number of trips required for each remote water monitoring unit's cost to equal the cost of physically checking the water reservoir. I assumed users would travel 10 miles roundtrip on ranch roads to check water reservoir levels, whether they lived on or off the property. I used $0.62/km ($1.00/mile; USD) as the off-road

Table 1. Description and comparison of systems* to remotely monitor livestock reservoirs.

Source	Sensor type	Website	Price (in USD)	Data transfer method	Annual subscription (in USD)	Total annual cost (in USD)
Informational Data Technology (IDT)	Pressure transducer Flow meter	https://www.idt.us.com/	1,050	Satellite	90	440
IDT	Pressure transducer Flow meter Remote shutoff	https://www.idt.us.com/	1,800	Satellite	90	690
SpyPoint Links	CMOS[1] image sensors	(https://www.spypoint.com/en)	400	Cellular	0	133
AguaCheck	Pressure transducer	https://ranchcheck.com/product/aguacheck/	780	Cellular	240	500

Note. The total annual cost is based on the annual depreciated cost of each unit using a 3-year straight-line depreciation plus the annual subscription.
[1]CMOS indicates xxx; USD, US dollars.
*The identification of specific products or scientific instrumentation is considered an integral part of the scientific endeavor and does not constitute endorsement or implied endorsement on the part of the author or Texas A&M AgriLife Research.
†Complementary metal-oxide semiconductor.

mileage cost at a speed of 24 km/hour (15 MPH, Table 2). For users that lived off property, roundtrip distances from 16.1 to 161 km (10–100 miles) were calculated. I used $0.36/km ($0.58/mile; USD) with a speed of 97 km/hour (60 MPH) for highway mileage. The labor cost was $10.00/hour (USD). The yearly cost of each unit was based on the annual subscription cost and the prorated annual purchase price of a unit. The prorated annual purchase cost was determined using a 3-year straight-line depreciation (Table 1).

Results and Discussion

The IDT system had the highest prorated annual cost at $690 and $440 (USD), with or without the shutoff valve, respectively. The SpyPoint game camera had the lowest prorated annual cost at $133 (USD), and the AguaCheck had an intermediate cost of $500 (USD; Table 1).

The advantages of the SpyPoint game camera include being readily available and having multiple options and vendors. The camera can show that water is being delivered (Fig. 3) and can detect contaminants, such as accidentally drowned animals, in the water reservoirs. However, the precision of estimating the water level is lower compared with the other systems. Furthermore, cellular reception can be an issue, and cameras may require a booster antenna. Manufacturers recommend that game cameras have three bars of cellular strength, but I have received images with only two bars.

The AguaCheck is the easiest unit to install and set up. During my study, the device's readings increased to >100% when the water reservoir was full. However, the reading can be recalibrated to the correct level by sending a text message to the unit. The sensor determines normal fluctuation patterns within the water reservoir and will send an alert if levels fall faster than the normal pattern. Occasionally, rapid water loss alerts are sent when no problem has occurred. A single warning does not indicate a water leak, but two or three warnings at successive hourly intervals does. Drift in pressure transducers is a common problem[4] and was likely the cause of both the gradual increase in readings as well as the false alerts. Overall, I found these to be minor problems and they do not detract from this device's usefulness.

The IDT system's flow meter detects leaks sooner than a pressure transducer that measures changes in water level (Fig. 4) or from an image. Monitoring both water level and flow rate can help determine whether a water system failure is caused by the failure of the water delivery or the water supply component of the system. An increased flow rate without a significant drop in water level indicates a failure of the water delivery system (e.g., a float valve failing to close or a broken water line). Conversely, a reduced flow rate could indicate a failed water delivery system caused by a blocked water line or a float valve failing to open. However, if the water reservoir delivers to multiple drinkers, the detection of these failures will have low sensitivity. Finally, a drop in water level and a normal flow rate indicates a failed water supply (e.g., the pump failed).

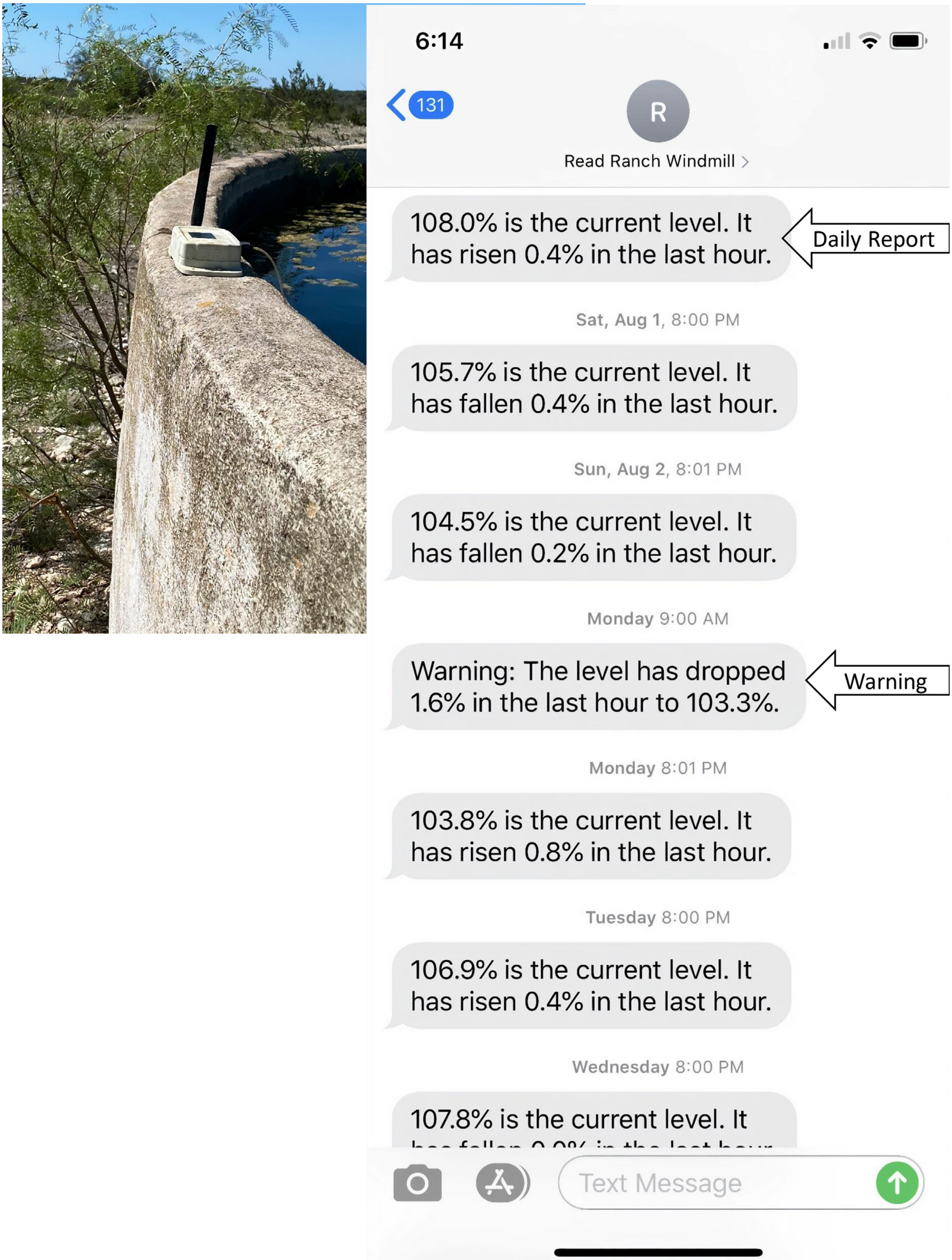

Fig. 1. AguaCheck mounted on a water reservoir and a screen shot of AguaCheck text messages showing percentage of full water reservoir and a warning message indicating the water level dropped faster than normal.

The IDT system transmits data over a satellite system and will work in any location. The optional shutoff can be activated at hourly intervals, which is invaluable for systems without a functional standpipe, especially if the water supply is limited.

Based on the assumptions in the breakeven analysis, cost per trip for on-ranch travel was $17 (USD) and for highway travel ranged from $8 to $75 (USD) for people making 16 to 160 km (10–100 miles) highway round trip to the property, respectively. For a person living on the ranch and making a 16-km on-ranch roundtrip to check the water reservoir, the breakeven reduction in the number of trips on an annual basis ranged from 8 trips for the SpyPoint camera to 41 trips for the IDT system with a shutoff valve (0 roundtrip highway miles, Fig. 5). Assuming that remotely monitoring the water in the reservoir saved two trips/week for half of a year (i.e., the hottest months) the minimum annual saving would range from $175 to $732 (USD) for a rancher living on the property using the most expensive (IDT with shutoff valve) and least expensive (SpyPoint) system, respectively. Likewise, for a rancher making a 160-km (100 miles) round trip to the property the annual savings would range from $4,054 to $4,611 (USD) for the IDT with shutoff valve and SpyPoint systems, respectively. In addition to the economic benefits of using remote water monitoring systems remotely, there is peace of mind in knowing livestock have access to water.

Ranchers should not base the most suitable system for remotely monitoring water reservoirs on cost. Other considerations include the needs of the user and the technological knowledge of the user. The AguaCheck system is the simplest and works on older cell phones. Game cameras are also simple but will require loading and configuring a smartphone app. Mounting a game camera, although not difficult, requires more effort than installing the AguaCheck. The IDT system is the most sophisticated system and installation involves plumbing components into the water line and fabricating mounting brackets. Users must log on to a website to check their system, which is not difficult but not as straightforward compared with the other systems. The IDT's ability to detect leaks sooner and

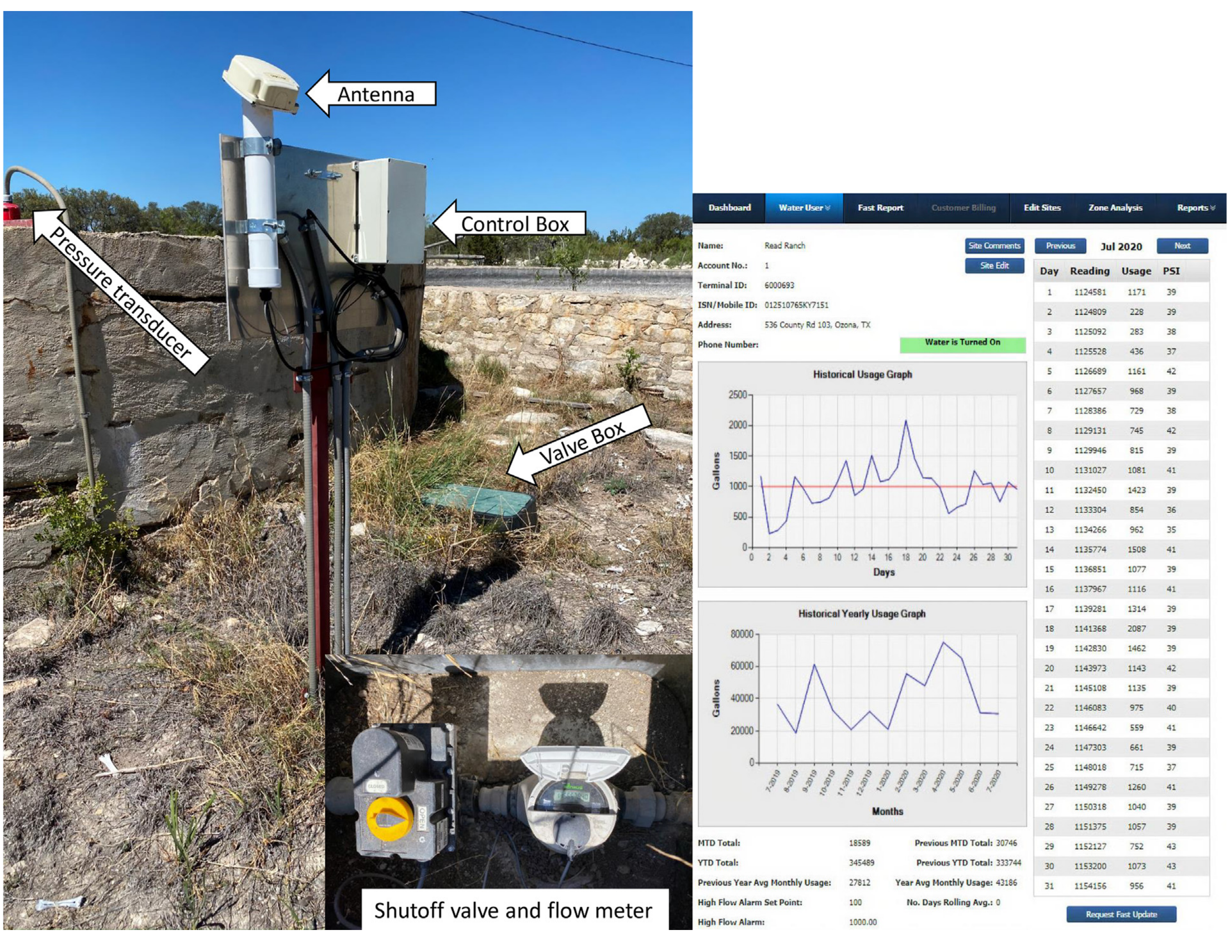

Fig. 2. IDT unit and screen shot from website. The IDT unit consists of satellite antenna, control box, pressure transducer, and valve box. Inset in photo shows shutoff valve (left) and flow meter (right). The IDT website graphically shows daily water usage for the current month and monthly water use for the past year. It also shows a table of water usage in gallons and water height (labelled PSI) in tenths of a foot for each day. IDT indicates Informational Data Technologies.

Fig. 3. SpyPoint Game camera photo showing water level in reservoir and properly functioning water delivery system.

Table 2. Estimates used for breakeven analysis of annual reduction in number of trips to check water to cover the annual cost of a remote water monitoring system.

	Cost (USD/ mile)	Speed (miles/ hour)	Labor (USD/ hour)
Highway	0.58	60	10.00
Ranch	1.00	15	10.00

USD indicates US dollar.

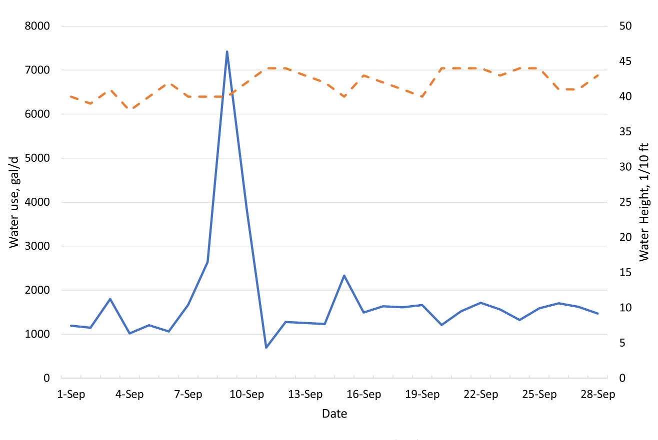

Fig. 4. Water use (blue solid line, gallons/day, left axis) compared with water height (orange dashed line, one-tenth foot increments, right axis) in the reservoir from IDT system showing when a leak in the system occurred on about 7 September 2019. Water use increased 4- to 7-fold and water height decreased about 5% to 10%.

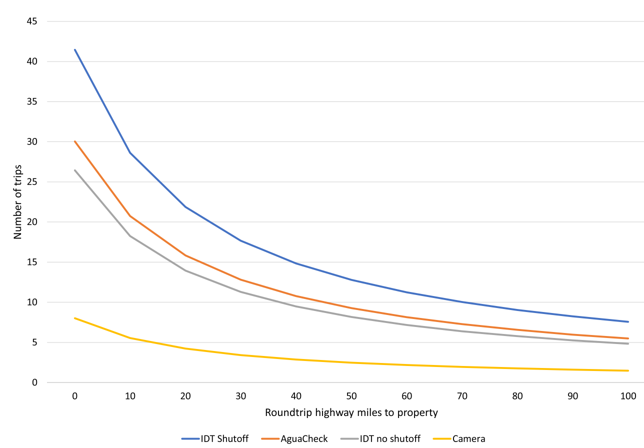

Fig. 5. Number of annual round trips to check water reservoirs to breakeven on the cost of remote water monitoring systems based on travel cost for both on-ranch and highway miles (see Table 2), a 3-year linear depreciation of equipment cost and annual subscription cost (see Table 1). Ten ranch miles are included for all calculations. For example, if the annual round trip highway miles to the ranch property is 30 miles, the breakeven number of trips would be <5 for the game camera.

turn water off makes this the most suitable system where water supply is limited or airlock problems occur, which can take days to correct. Based on my research, I developed a decision tree to determine the most suitable system of remotely monitoring water reservoirs for each user (Fig. 6).

One deficiency among the tests completed during my study is that none of the systems were used to monitor water availability at water drinkers used by livestock. The sensors for all the systems tested are inexpensive, but the cost of data transmission is not. If a cellular connection is available, a game

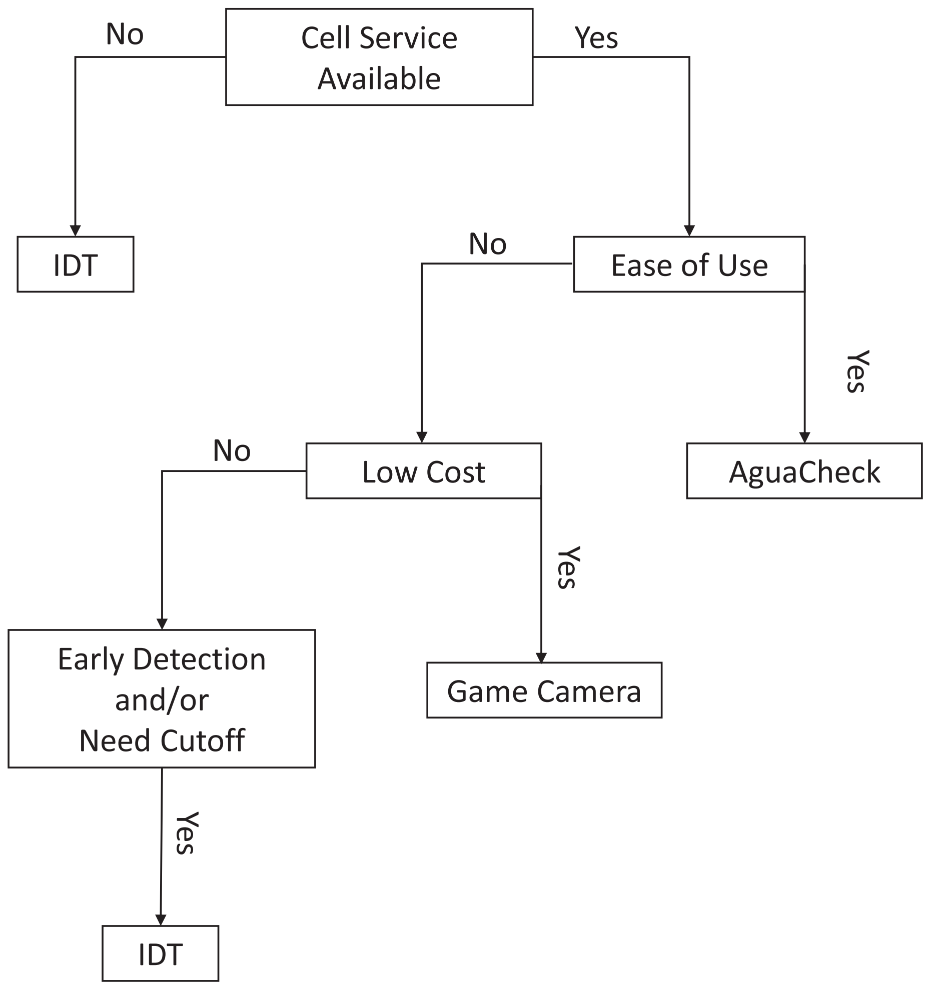

Fig. 6. Decision tree for choosing the most suitable system for remotely monitoring water reservoirs based on the technical capability, water system measurement needs, and availability of cellular service of the user.

camera at each water trough provides an affordable solution and can monitor livestock in addition to water availability in the drinker. However, as in my study, reservoirs are often located at high points on a property and gravity flow water to drinkers that lack cellular service because of their lower geographic position. The IDT system could alert a user to an obstructed water delivery system by indicating reduced water flow. However, when a water line was blocked during this study, it was not detected because the reservoir supplied 13 troughs and two residences. Alternatively, low-cost Long Range Wireless Area Network communication systems are available[5] that could be used to transmit data from multiple troughs equipped with water level sensors to a central location with either cellular or satellite connectivity, but such systems are not commercially available.

Conclusions

I tested three systems that remotely monitor livestock water over 3 years. Two systems used cellular communications (i.e., a game camera and a pressure transducer [AguaCheck]) and one used satellite communication (i.e., IDT). The prorated annual costs of the systems ranged from $133.00 to $690.00 (USD). All systems were affordable and the most suitable system for a user can be determined by preferences and technological ability (Fig. 6). I provided my results to a rancher, who was not limited by capital, and he chose the game camera because he preferred visual information. To use the game cameras, he purchased a smartphone on which I loaded and setup the app. Over the first 45 days of using the game camera, he called or texted because he could not see his pictures, even though I was monitoring his photos daily without any problems. This story illustrates how researchers and educators who use technology daily and are comfortable with it need to consider ranchers and producers' comfort level with technology when developing solutions for them. Technologies that seem simple to a developer may exceed the users' comfort level and will not be adopted. Finally, in addition to the economic and labor-saving benefits of these remote water monitoring systems, they provide ranchers peace of mind in knowing their livestock have water.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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