CRC for High Performance Soils
Bilby® DTU Impact Analysis

Ag Economics

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Executive Summary

Soil probes provide a wide range of measurements which assist farmers to optimise inputs. The market for probes is competitive and there are many options available. Probes measure soil moisture, pH, cations, movement, flooding, and other soil characteristics. They send measurement signals through wired or telemetry attachments or nodes to transmitters. Probes with attached above ground transmitters need to be fenced to exclude animals, vehicles and machines from colliding with them or damaging them. Wired units are expensive to install as they require exclusion fencing, cables, connectors and trenching work. The BILBY® DTU (Data Telemetry Unit) was developed to overcome these issues as it transmits signals to a Wide Area Network (WAN) which can be located up to a kilometre away. Farmers can traffic over the installed probes which means they can be more accurate due to their positioning and because they minimise physical interactions with corrosion, machines, insects and animals.

The BILBY® DTU saves $547.50 per unit when four or more soil probes are required. Through its research program, the Soil CRC developed the BILBY® DTU and then sold the intellectual property (IP) to Sentek Technologies to commercialise it in Australia and globally. It is estimated that demand will increase to over 200 units from 2027 to 2029. DataIntelo estimated that demand for all types of soil probes in Australia would increase at a rate of 27.6% per annum between 2023 and 2033. The CSIRO ADOPT tool was used to estimate the percentage of adoption for BILBY® DTU type units. It estimated that demand would reach a peak of 35% of the Australian market by 2035.

Benefit-cost analysis results show that the $3.23 million investment of cash and in-kind by the Soil CRC and University of Tasmania would produce a benefit of $26.05 million or a net benefit of $17.40 million over the 18-year period 2027 to 2044. Every one dollar invested would produce a benefit of $6.10. The internal rate of return was estimated to be 19% and the modified rate of return was 10%.

Sensitivity analysis showed that the potential downside changes to the investment and benefit sides of the project would still produce positive returns.

Use of soil probes could lead to water savings in areas where water is extracted from rivers or bores. This would indirectly produce environmental benefits as well as benefits to downstream water users which may include rural communities. BILBY® DTUs can be sold overseas and would produce benefits to growers in those markets. This analysis has only reported benefits to Australia rather than any international benefits.

Contents

Introduction

This analysis was focused on estimating returns for Soil CRC investment to develop and commercialise a soil sensor telemetry unit. There was a requirement for a unit that transmits wirelessly and could be buried in soil enabling the area above the unit to be trafficked for irrigation, cropping and pasture operations. The developed unit, known as a BILBY® DTU, can be combined with a multitude of measurement probes or sensors in its manufacturing process. The most common probe attachments measure soil moisture, temperature, electrical conductivity, soil pH or combinations of these. Other advanced applications could include flood and seismic sensors. The telemetry components are contained in a hard PVC casing which is waterproof and can resist traffic compression, corrosion, and below ground interactions with insects and rodents. See the photos in Appendix 2.

There are many types of soil sensors used within agricultural settings including a range of devices attached to transmit data via nodes to Wide Area Networks (WAN). In general, probes can be physically attached to WAN units, where the transmitting component is located above ground. Another version has protected wires between the probe in the ground and above ground transmitting units. In that version, the transmitting nodes remain above ground and are generally located on a post. Another class of probes are buried underground and are connected via underground cables to transmitting units or gateways which are mounted up to 30 metres away from the probe device. For these units, the probes are located in the field of measurement while the transmitting unit is located away from the traffic area. Wire units are more common in irrigation systems where the sensors interact with the irrigation management software. The BILBY® DTU is buried in the soil and data is transmitted wirelessly to a WAN unit which can be located up to 1000 metres away depending upon a range of environmental conditions. Various gateways can receive data from up to 30 BILBY® DTU units (Marcus Hardie, 2026).

Combining moisture sensors with irrigation management software has been shown to reduce water requirements between 10 and 15 per cent (Songara and Patel, 2022). The Australian Bureau of Statistics (2002) stated that “7.8 million megalitres of water was applied to crops and pastures in 2020-21”. At 2022 prices of $102 per ML when dry, $80 per ML on average, or $57 when wet (ABS 2022), the value of water savings would be $79.5 million for dry periods, $62.4 million on average, and $44.4 million in wet periods. The ABS (2022), reported that majority of the irrigated hectares, 31.41%, were used for pastures and cereals, which were fed off to animals. Irrigated crops made up 20.2%, pastures and cereals used for hay and silage represented 13.33%. Cotton used 1.23 million ML or 26% of the total irrigation water volume in the Murray Darling Basin. Horticulture products including tree fruit and nuts (16.7%) and vegetables (3.42%) totaled 18.6%.

The ABS (2022) also reported the total number of farms using irrigation systems as 20,700. The average irrigation area per farm was therefore 76.24 hectares. Crop hectares are highly variable between crop types and regions. If the 10% water saving measure was applied, then an average irrigation farm would save $3014.49 in an average year or $5652.17 in a wet year. These values are similar to the costs of installing a high-quality moisture probe and WAN gateway. The payback period would therefore be approximately one year per probe and WAN node.

Farmers located in dryland pasture regions have struggled to combine the various technologies that were previously available (Curkpatrick and Bremer, 2005). One of the issues was the difficulty in setting up the WAN devices or gateways and another was interpreting the data and using it to make feed management decisions.

Growers in the Harden Landcare Group (2023) were still recounting issues with data interpretation and devising management strategies as recently as 2023.

Agrifutures has invested in a wide range of extension projects to encourage growers and irrigators to adopt probe technologies. Using the search terms: “irrigation moisture sensors” on the Agrifutures website returns 40 investment projects that address topics including selecting and using water sensors for a range of crops between 2017 and 2023 (Agrifutures, 2026). The benefits of this investment were focused on the data transmission unit rather than probes. Other research costs associated with installing probe technologies were therefore not included in this analysis.

Benefit Analysis

Installation of the BILBY® DTU is relatively straight forward but it does require attention to detail and can take 20-30 mins to install both the probe and BILBY® DTU. It requires an augured hole to the depth of the probe and careful back filling to ensure that the sensors make good contact with the surrounding soil.

The BILBY® DTU is a sealed unit that can be set in fields and remain active for a period of up to five years. The main feature of the product is the fact that it is wireless and highly durable. It does not need to be removed for cropping activities. Since it does not need to be removed, it also minimises breakages of probes when they are extracted.

Probes that are attached to WAN transmitter units require fences to ensure that they adequately exclude livestock and native animals. Those areas are also typically mapped onto GPS devices so that vehicle drivers and machinery operators can identify their location. These fenced-in areas can become grassy and include weeds which provide a different soil moisture measure relative to the surrounding areas that they are intended to represent. These areas therefore need to be sprayed or slashed to minimise those issues and control weeds. An exclusion fence constructed of 4 sheep or cattle panels, and four-star post costs between $270 (Nana Trading, 2026), and $330 per probe site (Tophill, 2026). These stand-alone probes require data plans for each probe. The prices range from basic sim card options at around $250 per year to plans valued up to $500 for packages that analyse and report data. Single probes with WAN units may also be coupled with solar chargers or other instruments including weather stations. Appendix 1 shows the costs of probes, gateways and other items necessary to record measurements (NSW DPI 2026). The annualised cost for a probe with a WAN unit was $1600 including installation and data plan costs. This was $300 more than the BILBY® DTU unit and $720 less than the wired units.

Wired probes generally connect back to a gateway through either 5 m or 30 m cables and may be used in situations where probes need to be buried but the signal needs to be transmitted more frequently to an irrigation management system or in remote areas that require a larger solar panel to charge more powerful gateway devices or probes. For this example, a cost of $1000 was used for the probe price. Gateways can be attached to multiple probes positioned in different directions. Costs for gateways range between $881 and $3891 to average $1822 as shown in Appendix 1. n this analysis, a node cost of $800 was assumed given that the less expensive units are more likely to be purchased. A limitation of these devices is that they can only be placed within a set range of the gateway or node, and they may therefore be placed in suboptimal positions. The cable ends are most prone to damage by animals and insects (Belden 2026 & NBN Co 2026) and corrosion. Cables and joints are generally covered with materials that protect the wires and they are expensive. NSW DPI (2026) shows that 30 m cables were approximately $300 and end connectors were $85 each. The gateway units need to be fenced, and a trench needs to be made to each probe. Trenching machines can excavate a 500 mm by 200 mm, by 30 m trench within an hour. Machines can be hired by the day or half day at an approximate cost of $60 per hour. In this analysis, 2 hours of labour were assumed at $55 per hour to trench, lay cables and fill in the trench. It was assumed that the trenching machines are equipped with blades to backfill the trench after the cables have been laid. The cost to bore a probe hole to a depth of 1.2 metres was assumed to be the same across all three types of probes. Trenching and cables cost an additional $190 per probe relative to the stand-alone WAN enabled units and $505 more than the BILBY® DTU units. The total cost for a wired probe with a node device was estimated at $3185.

BILBY® DTU probes require a bore hole which is assumed to be the same cost as the competing products and range from $200 to $400 per auger. Most installers would benefit from ute mounted or trailer mounted augurs. Probe hole boring costs were not included in this analysis for any of the probe types as they were assumed to be the same cost for each type. BILBY® DTU data requires a gateway which is fenced and which has a WAN data plan. The BILBY® DTU is not on the market as yet and therefore no price has been set by the manufacturer.

The average costs of probes with WAN devices in the NSW DPI list was $1130 at the bottom of the range and $2210 at the top of the range. A price of $600 was used in the analysis for the probe, and the BILBY® unit costing $1000, plus a $1500 gateway and $300 WAN plan, with a $300 gateway exclusion fence.

Table 1 shows the costs of the probe purchase, installation and running costs for the three types of probes. When three or fewer probes are required, the most economical option is the stand-alone probe with WAN attachment ($6600 relative to $6900 for the BILBY® DTU). This cost difference does not include removing the probe which may be required in some cases for tillage activities. For four or more units the most economic option was the BILBY® DTU probe. When purchasing 7 units, the BILBY® DTU saves $300 per unit over the probe with WAN, and $1028 per unit relative to the wired probes.

There is significantly more flexibility with the placement of BILBY® DTU units relative to wired probe units as they are not constrained due to the cable lengths. Standalone units with WAN have similar flexibility but may be limited by signal strength depending on the terrain.

Table 1. Relative costs of three probe types

	Probe 1	Probe 2	Probe 3	Probe 4	Probe 5	Probe 6	Probe 7	**Total**	Average	Diff to Bilby
Probe	600	600	600	600	600	600	600	**4200**		
Bilby ® DTU	1000	1000	1000	1000	1000	1000	1000	**7000**		
Gateway	1500							**1500**		
WAN Plan	300							**300**		
Gway Fence	300							**300**		
Total								**13300**	1900	0
Cumulative	3700	5300	6900	8500	10100	11700	13300			
Probe with Wan	1600	1600	1600	1600	1600	1600	1600	**11200**		
WAN Plan	300	300	300	300	300	300	300	**2100**		
Fence	300	300	300	300	300	300	300	**2100**		
Total								**15400**	2200	300
Cumulative	2200	4400	6600	8800	11000	13200	15400			
Wired Units	1000	1000	1000	1000	1000	1000	1000	**7000**		
Node	880	880	880	880	880	880	880	**6160**		
Gateway								**0**		
WAN Plan	300	300	300	300	300	300	300	**2100**		
Gway fence	300							**300**		
Trench & cable	705	705	705	705	705	705	705	**4935**		
Total								**20495**	2928	1028
Cumulative	3185	6070	8955	11840	14725	17610	20495			
									Average	664

In the section above, it was shown that the BILBY® DTU costs $300 less per unit than probes with WAN attachments and $1028 less expensive than wired probe units. The average cost advantage for the BILBY® DTU was $664 per unit. BILBY® DTU adoption and market values were developed from Sentek data, historic data and projections from DataIntelo, and an estimate of adoption using the CSIRO ADOPT Tool.

Sentek Technologies (www.sentektechnologies.com) purchased the IP rights to the BILBY® DTU in May 2026. The Soil CRC anticipates that Sentek will sell 95 units in 2027, 190 units in 2028, and 380 units in 2029 across its agriculture and forestry portfolios in Australia. When these unit sales were multiplied by the $664 benefit identified above, then the value of the benefit would sum to $63,973 in 2027, plus $126,146 in 2028, and $252,293 in 2029. The benefits sum to $441,513 over the first three years. No sales estimates have been made by the Soil CRC for the subsequent years.

DataIntelo (2025) provide proprietary data on the value of soil sensors sold in Australia for the period 2018 to 2024 and data projections for the period from 2025 to 2033. See Figure 1. DataIntelo show that between 2018-2025 the annual growth rate in market value was 22.52%. DataIntelo forecasts the annual growth rate in sales projections to increase by 27.59% per annum between 2023 and 2033. DataIntelo's forecast extends estimated sensor demand and industry benefit to 2033.

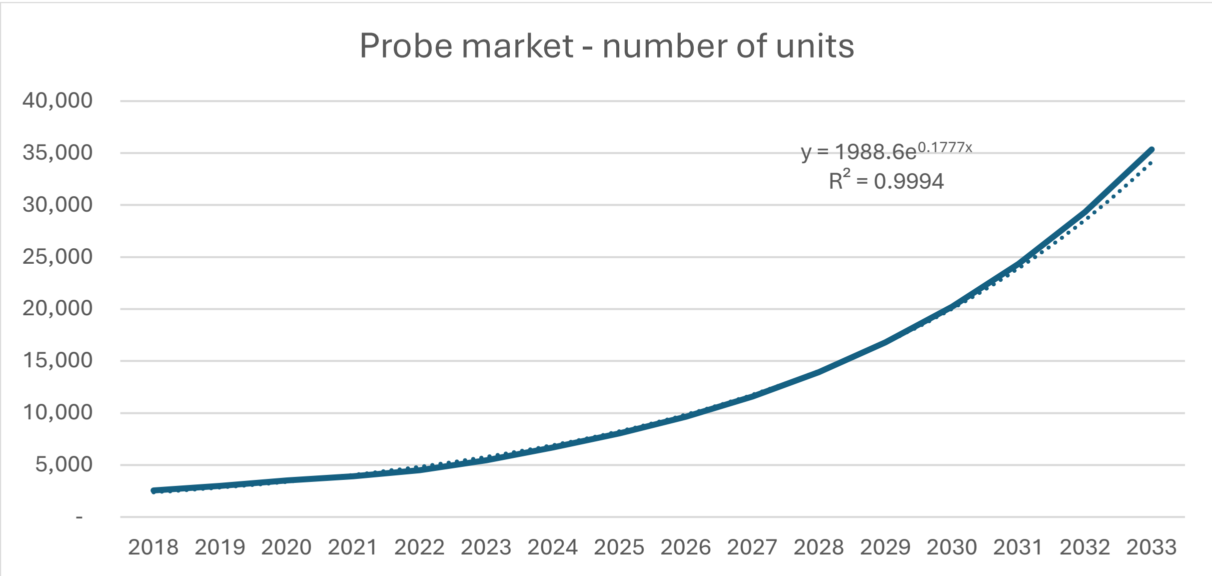

Figure 1. DataIntelo (2025) projection for soil probes sold in Australia

Kuehne et al. (2017) developed and refined the CSIRO ADOPT tool to forecast adoption for a range of technologies adopted by Australian primary producers. The ADOPT tool requires answers to 22 questions that were used to estimate adoption. The ADOPT tool estimates adoption from the time of original release of a technology to its peak adoption. The ADOPT tool estimated that 33% of the market (in this case the market was defined by the DataIntelo data) would be achieved by a BILBY® DTU type probe unit by 2035 or in 9 years. The CSIRO ADOPT tool only shows adoption to the peak of demand. Values for dis-adoption were modelled as an inflection of the adoption curve.

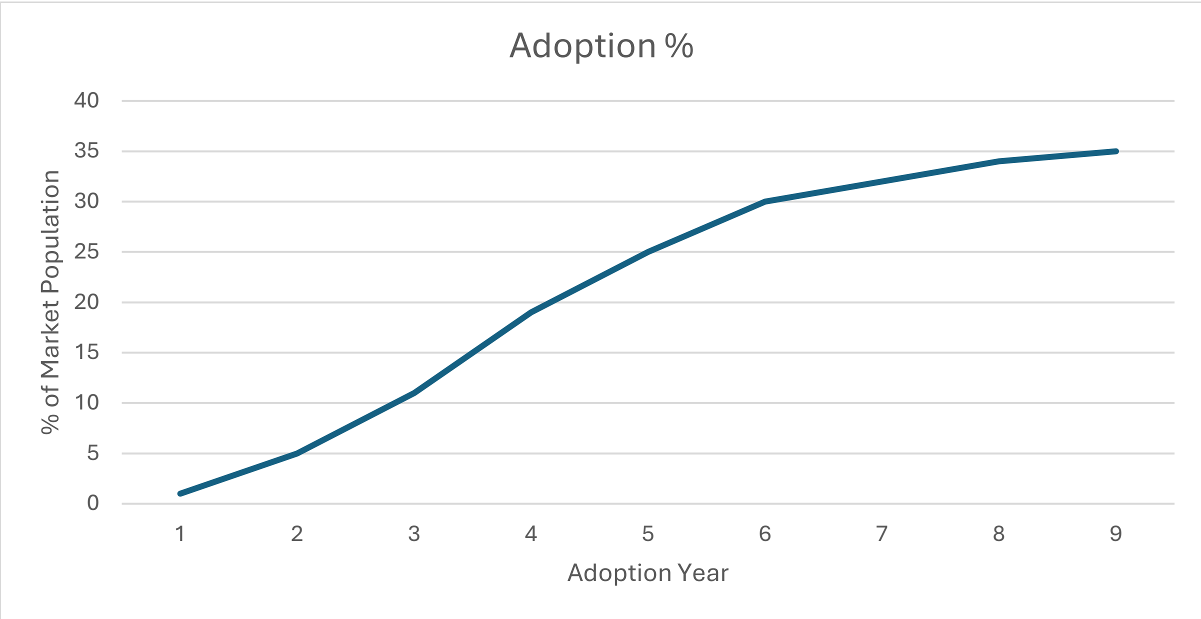

Figure 2. CSIRO ADOPT projection

Sentek, DataIntelo and ADOPT forecasts were combined to estimate market percentages for the adoption of BILBY® DTU units across all agricultural soil probe types. See Figure 3.

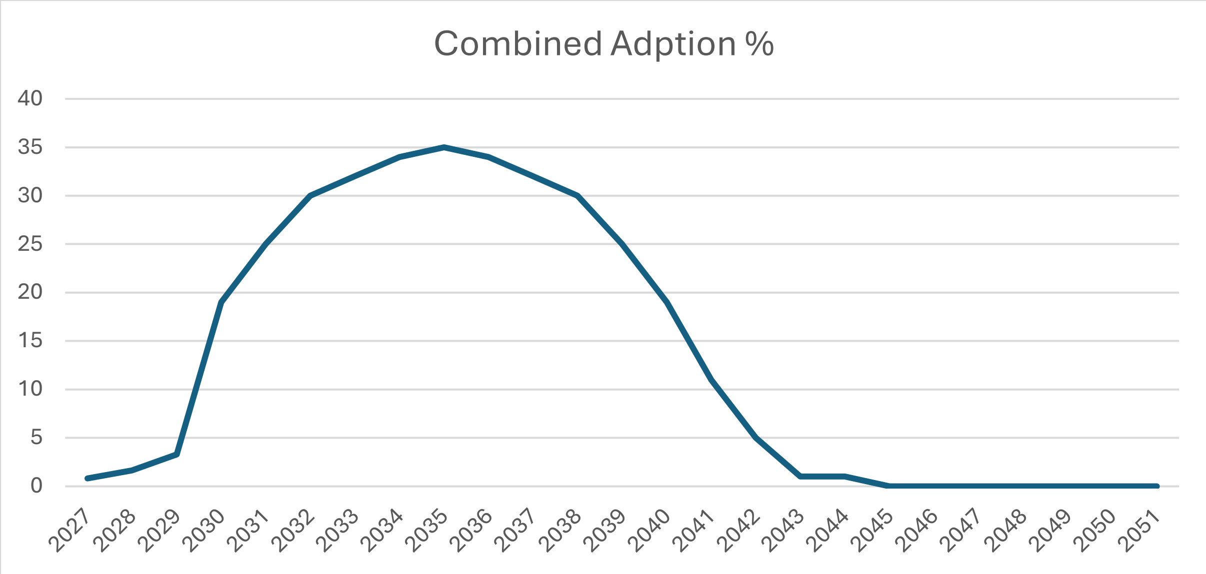

Figure 3. Composite adoption modelled.

Figure 4 shows the number of BILBY® DTU probes adopted is expected to reach a peak of 4055 units by 2035 and the industry benefit value was estimated to rise to $2.69 million in that year. The values shown in the graph are nominal, meaning that the values were not adjusted for the consumer price index or the discount rate.

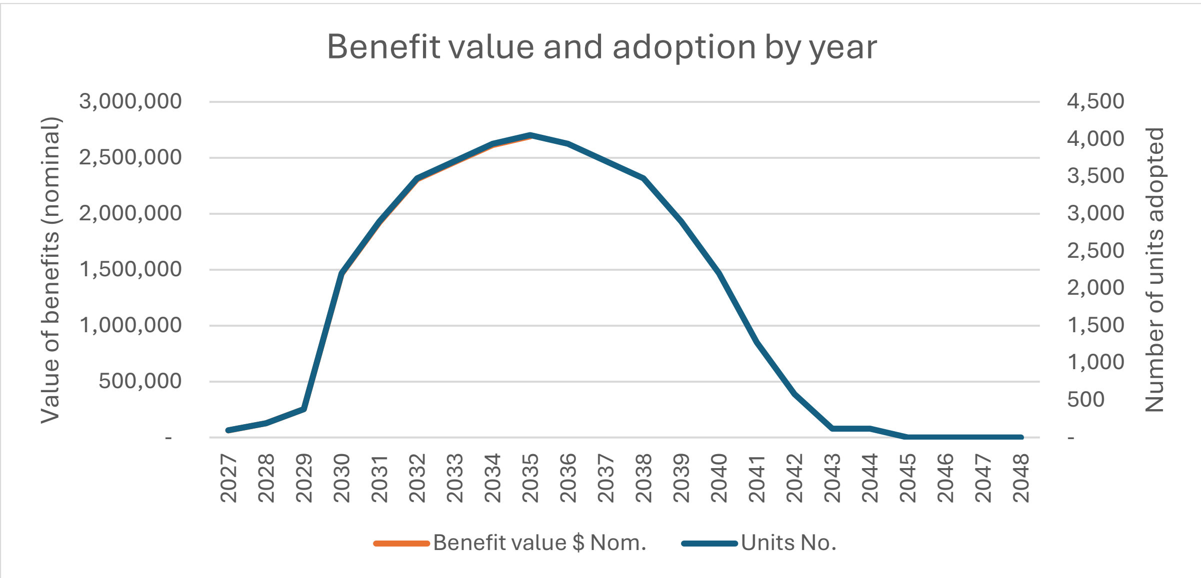

Figure 4. Estimated unit adoption and value of benefits by year.

The investment stream and benefit stream are shown as real values in Figure 5. Real values were calculated at a discount rate of 5% minus a CPI rate of 2.1% which was a net difference of 2.9%. Historic values were inflated and future values were discounted so that all values were in 2026 dollars.

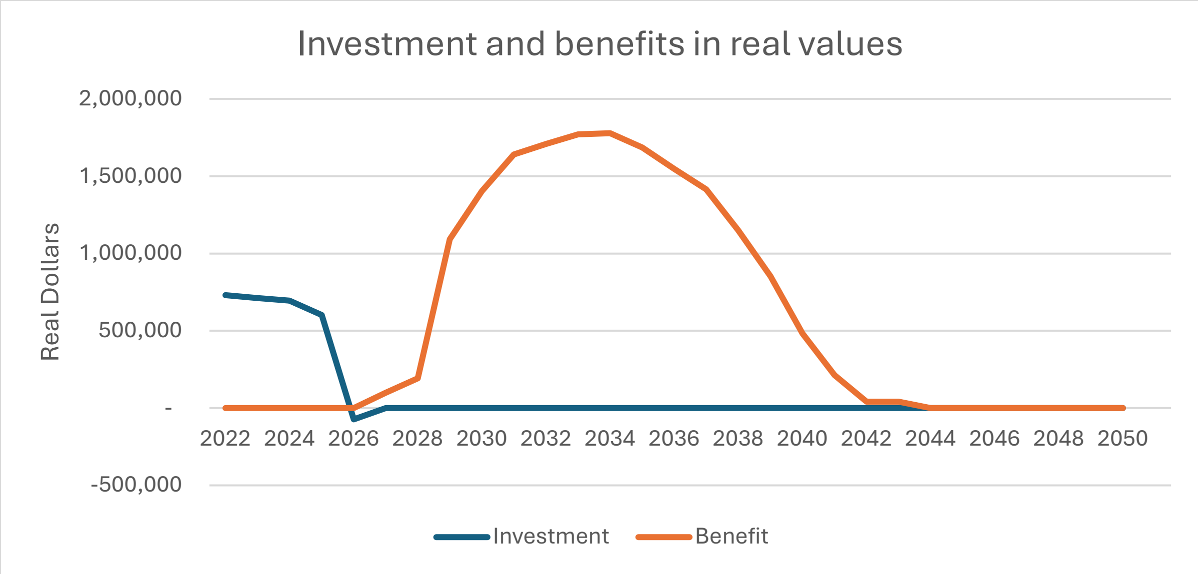

Figure 5. Investment and benefits in real values by year.

Investment Value

The Soil CRC partnered with the University of Tasmania to invest a combined $3.38 million. UTAS contributed $2.32 million of in-kind resources as part of its commitment to the Soil CRC, while the Soil CRC invested an additional $1.06 million in cash.

Table 1. Soil CRC BILBY® DTU Investments

Investment	Soil CRC	Partner in-Kind	Total
2.2.002 BILBY® DTU Development Component	620,714	1,135,690	1,756,404
2.02.006 BILBY® DTU Commercialisation	440,170	1,187,800	1,627,970
Total $	1,060,884	2,323,490	3,384,374
Percentage	31.35	68.65	100

Benefit Cost Results

Both real and nominal investment values are shown in Table 2. The real investment amount was $3.41 million. The sum of the real benefit stream was $26.05 million. The Net Present Value (NPV) is the value of the sum of benefits minus the sum of the investments which was $17.40 million. The benefit-cost ratio was 6.10:1 meaning that for every $1 invested, the project would deliver $6.10 in benefits to the industry in Australia. The internal rate of return (IRR) reflects the annual compound return of the investment, which was 19% when the opportunity cost of capital is zero. The modified rate of return MIRR shows the annual rate of return, assuming a 5.5 % cost of capital (or borrowing rate). The MIRR was 10%. These results indicate that the investment was financially positive.

Table 2. Benefit Costs Analysis results

Benefit/Cost		$
Investment	Nominal	3,234,374
Investment	Real	3,414,269
Benefit	Nominal	26,058,313
Benefit	Real	20,811,599
Net benefits	Real	17,397,331
NPV	$	17,397,331
BCR	Ratio	6.10
IRR		19%
MIRR		10%

Farmers will directly benefit from this investment through lower installation and running costs in situations where 4 or more probe units are required.

Other benefits may also accrue from using the BILBY® DTU on probes for sporting fields, golf courses, mine rehabilitation sites, and marsh and wetland management areas. The benefit values for these alternative uses has not been accounted for in this analysis as they currently use other technologies.

Sensitivity Analysis

Five scenarios were considered to test the sensitivity of the results described above. Each scenario should be compared to the base case which is the result of the analysis described above. The results are shown in Table 3 below. The five scenarios were:

1. Sentek adds $2 million to the cost of the BILBY® to commercialise it further.
2. Benefits are delayed by 2 years due to further development.
3. Benefits end in 2037 (after 10 years of sales)
4. Benefits to farmers are 25% lower than anticipated.
5. A 7% discount rate is applied.

In Scenario 1 both nominal and real costs increased by $2 million while the benefit remained the same. This reduced the net benefits from $17.39 million to $15.51 million. The benefit cost ratio fell to 3.94 to 1, and remained positive.

Scenario 2 added two years to the adoption period by shifting first adoption from 2027 to 2029. In that scenario, costs remained the same, but the sum of net benefits was lower, decreasing from $17.39 million to $16.39 million. The benefit cost ratio was still sound at 5.80 to 1.

Scenario 3 was designed to represent an event where a newer technology entered the market to make the BILBY® DTU redundant after 10 years. In scenario 3, benefits were removed after year 10. In that scenario, net benefits were reduced from $17.39 million to $10.43 million. In that case, the benefit cost ratio would decrease to 4.06 and remain positive.

Scenario 4 shows a 25 per cent reduction in the value of the benefits. This might represent a case where a competing unit was less costly to install or operate. In this scenario, net benefits fall from $17.39 million to $12.19 million. The benefit cost ratio would fall to 4.57 to 1.

The final scenario used a 7% discount rate rather than a 5% rate. In that scenario, the nominal figures remained the same: however, the real values were lower. The net benefit would fall to $13.35 million while the benefit cost ratio would fall to 4.71 to 1.

The conclusion to be drawn from the sensitivity analysis is that the business case for the BILBY® DTU is strong on both the investment side as well as the benefit side.

Use of soil probes could produce water savings in areas where water is extracted from rivers or bores. This would indirectly produce environmental benefits as well as benefits to downstream water users which may include rural communities. These benefits were not measured as the probe types vary widely, and the locations of existing probes and their uses are not known.

Table 3. Sensitivity analysis results

		BASE Case	Scene 1	Scene 2	Scene 3	Scene 4	Scene 5
			Add $2 million	Benefit add 2 years	Benefits end 2037	Benefits 25% lower	DR=7%
Benefit/Cost		$	$	$	$	$	$
Investment	Nominal	3,234,374	5,234,374	3,234,374	3,234,374	3,234,374	3,234,374
Investment	Real	3,414,269	5,294,683	3,414,269	3,414,269	3,414,269	3,597,705
Benefit	Nominal	26,058,313	26,058,313	26,058,313	16,519,324	19,543,734	26,058,313
Benefit	Real	20,811,599	20,811,599	19,808,780	13,846,657	15,608,699	16,956,584
Net benefits	Real	17,397,331	15,516,917	16,394,511	10,432,389	12,194,431	13,358,879
NPV	$	17,397,331	15,516,917	16,394,511	10,432,389	12,194,431	13,358,879
BCR	Ratio	6.10	3.93	5.80	4.06	4.57	4.71
IRR		19%	16%	15%	17%	16%	16%
MIRR		10%	9%	9%	9%	9%	9%

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Appendix 1. NSW DPI costs of monitoring components.

Probe Units	**Price (Low)**	**Price (High)**
Farm deck 400 mm fixed	2454	
Farm deck 800 mm fixed	2785	
Cropsol Aquacheck sm Probe	645	1025
Halo systems	3929	
Metro ANZ 40cm to 120 cm Enviropro	1140	2400
Metros ANZ 40-120 without EC	910	1710
Sentek 90 cm Moisture temp salinity	1120	1790
Axis tech soil probe	1350	2940
Average	**1130**	**2210**

Gateways	**Price**
AgTech360 LoRa 4G	1420
Multitech Conduit LoRaWan Gateway 5km	3898
Qantec Automation Milesight UG67-915M LoRaWAN	881
Qantec Milesight 4G	1124
Rakk Wireless 7249 LoRaWan	1199
Smart Paddock Outdoor farm network	1250
Multitech MTCAP LoRaWAN	1200
Mait Industries itracker single	2715
Cropsol itracker	2715
Average	**1822**

Subscriptions	**Price**
Smart Paddock Outdoor farm network	25
Farm Connect Agpod	41.67
Halo systems	60
Average	42.22

Solar Kits	**Price**
Smart Paddock Solar Kit Farm Network	2450

Source: NSW DPI Ag Tech 2026.

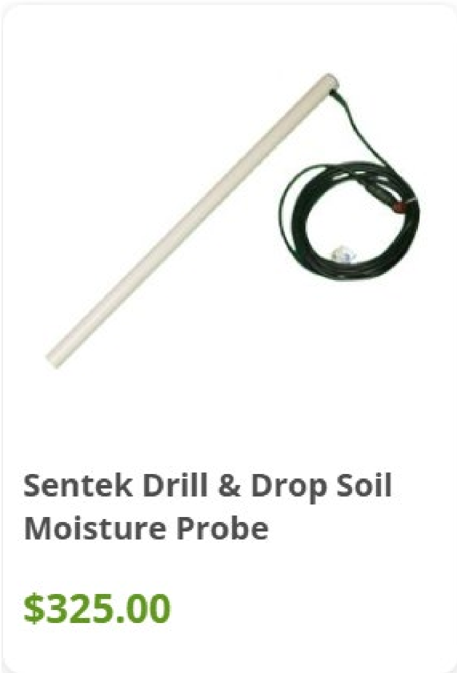
Appendix 2. Images of Soil Probes

HOBOnet 45 cm soil moisture temp sensor $2,659.00.

CropX Vertex all in one $2398 or $2637 with data analysis.

EnviroPro EP100GL series soil moisture probes $1600

https://www.instrumentchoice.com.au/products/8-sensor-enviropro-moisture-ec-salinity-temperature



BILBY® DTU - Valued in the analysis at $1000

Appendix 3. Photos of Exclusion Fencing

Source: Curkpatrick, M. and Bremer, J., 2005, MLA P.PSH.2005 – Grazing system impact on livestock productivity, soil moisture and soil organic carbon.

Exclusion fencing for gateways or Probes with WAN units

Source: [2.9m*1m Sheep Goat Lamb Fence Panel with Sheep Gate - Used Corral Panels and Cattle Yard Panels]

Appendix 4. Water use on Australian Farms 2020-21

- 7.8 million megalitres of water was applied to crops and pastures in 2020-21 (up 37% from 2019-20)
- 1.9 million hectares of agricultural land was irrigated (up 28%)
- 20,700 farms applied water to their land, unchanged from 2019-20

In 2020-21, 1.9 million hectares of crops and pastures were irrigated:

- 495,800 hectares of pastures and cereals used for grazing or fed off (up 8%)
- 320,100 hectares of cereal crops (excluding rice) (up 102%)
- 210,400 hectares of pastures and cereals used for hay and silage (up 12%)
- 197,400 hectares of cotton (up 260%)
- 197,000 hectares of fruit and nuts (up 14%)
- 157,500 hectares of sugar cane (down 17%)

In 2020-21, 5.7 million megalitres were applied to crops (73% of all water applied):

- 1.3 million megalitres for cotton (up 249%)
- 1.1 million megalitres for fruit and nuts (up 5%)
- 795,400 megalitres for sugar cane (down 10%)
- 516,500 megalitres for grapevines (up 10%)

Of the 2.1 million megalitres applied to pastures:

- 1.4 million megalitres for pastures and cereals fed off (up 13%)
- 664,700 megalitres for pastures and cereals cut for hay and silage (up 13%)

Source: https://www.abs.gov.au/statistics/industry/agriculture/water-use-australian-farms/latest-release