冷飲水緩解亞熱帶氣候下泌乳荷蘭牛熱緊迫：儲乳槽冰水供應應用

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本研究於夏季評估冷飲水（20.0 ˚C）與室溫飲水（28.0 ˚C）對泌乳乳牛產乳量及熱緊迫相關行為（喘氣、採食與反芻）的影響。兩組試驗牛分別提供冷水或室溫水，並使用自動控溫系統維持水溫。利用折線迴歸（broken-stick regression）分析各行為之臨界溫濕指數（THI）斷點。當THI超過斷點後，冷水組喘氣時間顯著上升但增幅較低（+30.92 vs. +33.13 分鐘/THI，p = 0.004 vs. p = 0.000）；採食與反芻時間下降幅度也較小（進食：-6.41 vs. -7.47 分鐘/THI，p = 0.022 vs. p = 0.019；反芻：-5.60 vs. -9.88 分鐘/THI，p = 0.064 vs. p = 0.002）。當 THI 低於斷點時，各行為時間並無顯著差異（p > 0.05）。此外，冷水組平均日乳量略高於室溫組（26.54 公斤 vs. 25.35 公斤），但差異未達統計顯著。冷飲水可透過降低喘氣反應並穩定採食、反芻及產乳表現，有效減緩乳牛熱緊迫影響。本研究為一種實用且具成本效益的降溫策略，即再利用牧場現有的剩餘生乳儲存槽來供應冰水，藉此降低設施建置成本，同時增強乳牛對熱緊迫的耐受力並維持生產力。此方法可作為面對氣候變遷挑戰下，推動乳業永續發展的管理策略。

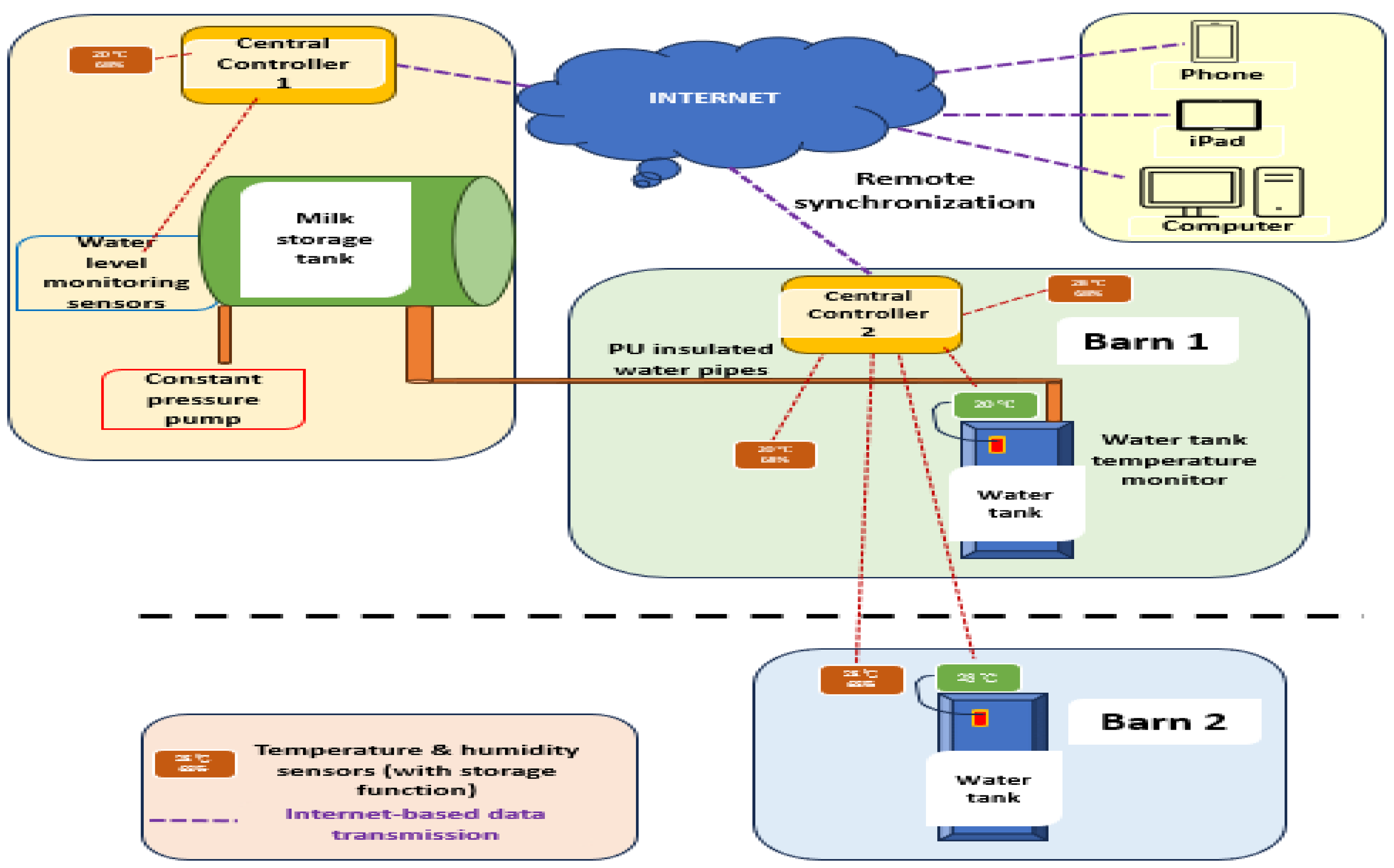

圖1. 儲乳槽式飲水系統安裝示意圖。
顯示系統如何連接儲乳槽、中央控制器、感測器與幫浦。冷卻水經由PU保冷管線由儲乳槽輸送至牛舍，並透過水位、溫度與壓力感測器監控運作狀況。系統可經由網路即時傳輸資料，使用手機、平板或電腦進行遠端監控，以確保牧場飲水供應與管理之效率。

Figure 1. Installation layout of the milk storage tank–based drinking water system.
This schematic shows how the system connects the milk storage tank, central controller, sensors, and pumps. Cooled water is delivered through PU-insulated pipes from the storage tank to Barn 1. Water level, temperature, and pressure sensors monitor system performance. Data are transmitted online for remote monitoring via mobile devices and computers, ensuring efficient water supply and management on the dairy farm.

表 1. 不同飲水溫度乳牛在溫濕指數（THI）下喘氣、採食與反芻時間之變化。THI 轉折點以折線迴歸法求得，數值表示每單位 THI 變化所對應之行為時間變化量（分/THI）。 *p* 值為轉折點前後迴歸斜率顯著性檢定結果。

Table 1. Effect of Temperature–Humidity Index (THI) on panting, feeding, and rumination time in dairy cows provided with cold or room-temperature drinking water. THI breakpoints were determined using broken-stick regression. Values indicate the change in behavior time (min/THI) estimated from segmented linear regression. *p*-values test the significance of slopes before and after the THI breakpoint.

Behavior	Cold drinking water	Room temperature water
Panting Time	THI < 81.51: -8.87 min/THI (p = 0.448)	THI < 81.68: -7.98 min/THI (p = 0.373)
	THI > 81.51: +30.92 min/THI (p = 0.004)	THI > 81.68: +33.13 min/THI (p = 0.000)
Feeding Time	THI < 81.98: +0.75 min/THI (p = 0.731)	THI < 82.10: +1.01 min/THI (p = 0.673)
	THI > 81.98: -6.41 min/THI (p = 0.022)	THI > 82.10: -7.47 min/THI (p = 0.019)
Rumination Time	THI < 81.84: +3.34 min/THI (p = 0.388)	THI < 81.90: +5.39 min/THI (p = 0.139)
	THI > 81.84: -5.60 min/THI (p = 0.064)	THI > 81.90: -9.88 min/THI (p = 0.002)

Cold drinking water mitigates heat stress in lactating Holstein cows in a subtropical climate: Application of surplus milk storage tanks for chilled water

This study assessed the impact of cold (20 ˚C) versus room-temperature (28 ˚C) drinking water on milk yield and heat-stress behaviors (panting, feeding, rumination) in lactating Holstein cows during summer in Taiwan. Two treatment groups were used with an automated cooling system. Broken-stick regression identified temperature-humidity index (THI) breakpoints for each behavior. Above the breakpoints, panting increased at a lower rate in the cold-water group, and feeding and rumination declined less sharply. Behavioral differences were not significant below breakpoints. Cold water slightly increased milk yield without statistical significance. These results show that chilled drinking water can alleviate heat stress and stabilize feeding and rumination, offering a practical, low-cost strategy using surplus milk storage tanks to improve cow comfort and productivity under subtropical heat.