Temperature monitoring technologies

Monitoring transport and storage temperatures is important to identify whether temperatures depart from those required to maintain product quality. It can also identify opportunities for improvement in supply chain management. A range of temperature monitoring technologies from simple thermometers to digital data loggers are available to the fresh produce industry.

Common types

1. Non- logging thermometer (probe/ infrared) (see table 1). These have limited application, such as quality control at outgoing and incoming steps of the supply chain.

2. Loggers that require collection to retrieve the data. These include non-electronic versions (e.g. strip chart recorders) that produce a paper-based graph. Electronic versions provide a data or graph file that is retrieved via a USB computer connection. These loggers require a collaborator in the market to retrieve, download and send the data.

3. Loggers that do not require collection to retrieve the data. These include RFID (Radio Frequency Identification) types that utilise wireless radio frequency to transmit data to a communication unit connected to the internet, and SIM card-based systems with connection through mobile phone networks. The SIM-based systems can often offer real-time temperature and location data. While more expensive than those described in 2, data retrieval is effectively guaranteed assuming connection with the communication unit or the mobile network.

Selecting the logger that's right for you

The following factors will help you to select the most suitable logger.

Measurements

Do you need to record only temperature, or other parameters? Some loggers can also record relative humidity, pressure, light, vibration, shock, etc. Prioritising the measures that you need helps narrow the options and manage costs.

Your supply chain

Do you have reliable chain partners? If you can rely on your importer or retailer to retrieve your loggers and email the data files, an electronic USB-type logger would be fine.

If logger retrieval is time consuming, difficult or unreliable, then a RFID or SIM-based logger may be appropriate. If you send most of your produce through one combination of exporter, importer and retailer, RFID systems will work well, given the need for communication units at set points in the supply chain. If you send to five or more destinations, SIM-based systems might be better.

Cost

The price of each logger varies from $10 to $500+ and often there is a minimum order. While the RFID loggers are often cheaper, there are additional costs including installing, uninstalling and leasing fees of communication units. Some SIM-based loggers also require an associated mobile phone plan.

Data interpretation and use

The loggers are only of value when the data can be cost-effectively used to make sound decisions. The RFID and SIM-based systems can often generate SMS or email alerts when product temperatures exceed pre-set temperatures. This can allow a quick response to less-than-ideal cold chain conditions.

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Table 1 – Temperature monitoring technologies with commercial examples in 2017[1, 2]

Monitoring system	Non-logging		Logging but requiring retrieval of logger			Logging but not requiring retrieval	
	Thermometer		Strip chart recorder	Time-temperature indicator	USB port data logger	SIM-based	RFID
	Probe	Infrared					
Component	reduced tip probe (sensor), digital screen	internal infrared energy detector, digital screen	pull tab, bi-metal coil sensor, a view port	LED lights, internal temperature sensors	USB interface, LCD screen	SIM card, highly sensitive sensors	wireless RF sensors, with communication units
Features	measure core temperature, data is displayed on screen instantly	Non-contact with produce, data is displayed on screen instantly	air temperature can be continuously monitored, temperature data are automatically graphed	measure accumulated exposure to temperature above set threshold	fast data download speed	potential real time temperature and location data acquisition;	parallel reading of several sensors, automatic data download
Cons	**damages product**, no temperature history, random sampling	accuracy varies with surface material	cannot read product temperature, low data resolution	knowledge of product response required	data download requires physical retrieval of the logger	some still operate on 2G network, which does not operate in some countries; data upload limited in weak mobile signal areas	data upload limited by maximum distance between logger and communication units
Reusability of sensors	reusable	reusable	single	single	single	reusable/single	single
Total cost/consignment *	$72	$46	$115	$113	$138	$200+	$168+**
Commercial examples	FlashCheck® (DeltaTrak Inc.)	ThermoTrace (DeltaTrak Inc.)	In-transit chart recorder (Delta Trak Inc.)	FlashLink mini time-temperature indicator (DeltaTrak Inc.)	TempTale Ultra (Sensitech Inc.)	Locus Traxx™ (Emerson); GEO Eagle (Sensitech Inc.)	Xsense (BT9 Ltd)
Pictures							

Notes: * Total cost/consignment includes cost/consignment and labour cost/consignment. The assumptions for calculating cost/consignment is the use of 10 consignments and 2 loggers in each, and for those requiring staff to undertake measurements, labour is costed at $20/hour.. **The assumption for calculating cost/consignment is that the one CU is leased for a 6-month period for the RFID logger example. A detailed calculation methodology to estimate total cost/consignment is available on request.

Summary

Regular monitoring of your cold chain is a powerful tool to minimise damage to your product between the farm and the retailer, and to identify where your chain can be improved. As they say: “You cannot improve what you don’t know”.

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The Serviced Supply Chains project is funded by the Hort Frontiers Asian Markets Fund, part of the Hort Frontiers strategic partnership initiative developed by Hort Innovation, with co-investment from the Department of Agriculture and Fisheries (Qld), Department of Economic Development, Jobs, Transport & Resources (Victoria), The University of Southern Queensland, Manbulloo (mangoes), Montague Fresh (summerfruit), Glen Grove (citrus) and contributions from the Australian Government.