AUSTRALIANmacadamia

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FACT SHEET 3
SILO MODIFICATIONS TO IMPROVE EFFICIENCY AND KERNEL QUALITY

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Introduction

This fact sheet was generated following the nut-in-shell (NIS) dehydration and post harvest handling workshops conducted by Dorran Bungay and coordinated by the AMS in February 2010. There is no doubt that a properly designed NIS curing system that achieves constant NIS dehydration, regardless of the ambient conditions, will minimise kernel quality loss and hence maximise grower returns. Research has shown that significant quality losses may occur if NIS is held on farm for longer than two weeks at moistures above 10%. The aim of every grower should be to harvest, sort and deliver to the factory in the shortest possible time at the lowest possible cost and highest possible quality. On farm sorting should only be carried out if there is a positive benefit. Remember, the longer you hold NIS on farm the greater the risk of kernel quality deterioration.

The capital expense of installing new drying systems is beyond the reach of many growers at this time. This information is provided as a guide to help growers modify, and manage, older style silo systems to improve drying efficiency and kernel quality at minimal cost.

Recommended silo modifications

1. Install fan controllers that operate on relative humidity (RH) and temperature, e.g. an mDhT Controller®, or similar. Relative humidity based controllers have been proven to reduce NIS moisture faster and more effectively than manual control or time clocks. The controller should also have a temperature override to turn fans on if the heat from respiration rises when the fans are not operating (this could be either at night or during the day in extended periods of wet weather) and to ensure that the maximum temperature in the nut bed never exceeds 30°C. Quote: *"A drying system incorporating a relative humidity based aeration controller (e.g. mDhT aeration controller) should be installed as an absolute minimum requirement for all on-farm drying and storage facilities",* (Kowitz and Mason, 2001).

2. A RH and temperature sensor will allow the NIS moisture content to be calculated by referring to the equilibrium moisture content (EMC) of macadamias (Table 1). When the inlet and exhaust temperatures are the same the equilibrium moisture content of the nut bed has been reached. By using the RH and temperature information, the NIS moisture content can be read from Table 1.

Table 1 Macadamia NIS equilibrium moisture content.

Relative Humidity %	Equilibrium moisture content NIS (% wet basis)							
	Temperature							
	5	10	15	20	25	30	35	40
10	4.6	4.2	3.8	3.4	3.1	2.8	2.5	2.3
15	5.2	4.8	4.4	4.1	3.7	3.4	3.1	2.9
20	5.8	5.3	4.9	4.6	4.2	3.9	3.6	3.3
25	6.3	5.8	5.4	5.0	4.7	4.4	4.0	3.8
30	6.7	6.3	5.9	5.5	5.1	4.8	4.5	4.2
35	7.2	6.7	6.3	5.9	5.5	5.2	4.9	4.6
40	7.7	7.2	6.8	6.4	6.0	5.6	5.3	5.0
45	8.2	7.8	7.3	6.9	6.5	6.1	5.7	5.4
50	8.9	8.3	7.9	7.4	7.0	6.6	6.3	5.9
55	9.5	9.0	8.5	8.0	7.6	7.2	6.8	6.5
60	10.3	9.7	9.2	8.7	8.3	7.8	7.4	7.1
65	11.2	10.6	10.0	9.5	9.0	8.6	8.2	7.8
70	12.2	11.6	11.0	10.5	10.0	9.5	9.0	8.6
75	13.4	12.8	12.1	11.6	11.0	10.5	10.1	9.6
80	14.9	14.2	13.5	12.9	12.4	11.8	11.3	10.9
85	16.7	16.0	15.3	14.6	14.0	13.5	12.9	12.4
90	19.0	18.2	17.5	16.8	16.2	15.6	15.0	14.5
95	22.0	21.2	20.5	19.8	19.1	18.5	17.9	17.3
100	26.2	25.4	24.6	23.9	23.2	22.6	22.0	21.5

3. Reduce nut bed depths to a maximum 2.5m. The deeper the bed depth the longer the drying front takes to move through the bed. Nuts at the top of the bed will stay wet or be re-wet by moisture removed from the nuts at the bottom. This extends the time to reach equilibrium moisture content and reduces kernel quality.

4. Ensure that the depth is as even as possible following the shape of the silo floor. Uneven bed depth creates areas of high and low pressure. Air will follow the path of least resistance (i.e. the shallowest depth) and create uneven drying.

5. Reduce the angle of the silo floor to the minimum angle that still allows NIS to flow (Approx 15-20°). This will help create a more even bed depth.

6. Ensure the silo floor doesn't restrict the airflow. As a general rule the silo floor should have at least 30% open space (holes) to allow free air movement into the nut bed.

7. Air-Velocity should be 1m / sec through the nut bed. To calculate if your fan is delivering the correct velocity (Note: measurements must be done when the silo is full): *Measure the average air velocity at the fan inlet (m/s) x fan area (m_2) ÷ 0.2m/s. This should be greater than or equal to the cross sectional area (m_2) of the silo.*

8. To ensure drying and dispatch are as rapid as possible, do not add more than two consecutive days harvest to a silo.

9. Wherever possible, source the air from inside a nearby shed, preferably near the roof. Air inside a shed is generally warmer and drier than air taken from outside. Use a common duct for multiple silos. The cross sectional area of the duct should be at least 1.5 times the cross sectional area of the combined fan inlets.

10. To improve the quality of the air from the shed, install a ceiling and paint the roof black. Highest efficiency is achieved by having the air travel the length of the shed before being drawn into the silo. The ceiling cavity must have an inlet opening at the opposite end to where the air is being extracted. Ensure the ceiling cavity and inlet is large enough not to restrict airflow. The ceiling inlet should be 1.5 times the area of the fan.

11. Wet processes, such as water baths, should be in a separate room from where the silo air is being extracted. This separation keeps the air as dry as possible.

12. Silos should never have condensation on the inside or free water dripping from the base. This is a warning sign that the system is inadequate and requires urgent attention.

13. Air outlet size needs to be 1.5 times larger than the fan inlet, and the air outlet velocity must be less than air inlet velocity.

14. Make sure the plenum is sealed with no air leaks. One way to check if the base is sealed is to wet the ground around the base of the silo and check for bubbles. If there are bubbles present this indicates a leaky plenum that needs to be sealed.

15. Insulate silos wherever possible. Metal allows rapid heat loss from the silo reducing the speed of drying. At night condensation can form on the inside and rewet the nuts.

16. If silos are inside they must vent outside the shed to avoid increasing the RH inside the shed where the air is being drawn from.

17. Vents to the outside should angle down away from the top of the silo to stop condensation flowing back into silo.

16. Install easy let downs into silos and into the back of transport vehicles.

17. Where heaters are fitted to silos they should be controlled by RH (between 60% - 70%) at the inlet, rather than temperature. Controlling the RH of the air to between 60% and 70% RH will dry nuts to about 10% moisture without the risk of over drying. Controllers must have a temperature override to ensure the maximum temperature never exceeds 30°C.

18. Once drying starts do not stop!! Don't change the drying parameters i.e. cooler set point at night or change fans speeds. Drying then rewetting will damage kernel quality.

References:

Bungay D, (Undated) "Macadamias. Guide to on-farm post-harvest care, SAMAC & Eskom.
Kowitz T and Mason R (2001) "Drying Macadamia Nut-in-Shell On-Farm" HRDC Report Project No. MC97011

Further Information

More detailed information on maintaining quality is also available in the Australian Macadamia Industry Code of Sound Orchard Practices, the Macadamia Grower's Handbook and on the AMS Website www.australian-macadamias.org

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