

Hay Fires...

This is not divine
intervention



And also recognize its **not just moisture**
impacting ...

...it goes well beyond thatto WSC and
microbial counts

Current Understanding of the cause of heating

- “Hay fires and heating are made by high moisture hay !”
- That is the extent of what is addressed as the sole means of assessing and managing risk
- It does not take into account
- “ a correlated parameter” v “ a causative agent”
- IE water does not ,of itself, make heat and fire... that is intuitively and methodically incorrect...but it can LEAD to heating via bug growth

What happens currently- Overly simple , and as 2007 etc showed , not very accurate... Hay burnt at 10% moisture !

Hay moisture		15%	20%	25%
Do I bale		Yes	maybe	NO

Lets look at what the
dangerous hay heat is NOT

...and then what it IS

What it is NOT is respiration
post baling and the normal
“sweat”

That is normal and should pass in a few
days.

Temps don't climb to dangerous levels
based on the sweat

If its not respiration... and not ONLY
moisture directly driving it ...
...what makes hay Burn?

- ***“ Baled Hay naturally contains millions of bacteria and mould fungi that produce heat as they consume hay nutrients....usually hay gets dry enough that microbes die or become dormant, but when moisture is present they persist, heating occurs , visual mould may be evident , or both.”***
- ***Bruce Anderson – University of Nebraska- Extension Forage specialist***

The heating that is dangerous is a result of microbial action

- But ...Moisture measures are just one related indicator of likely microbial action.
- Correlated with heating but not causative
- The moisture itself is not causing heat directly. But it does grow the bugs !
- The heat is a result of oxidation of plant nutrients by fungi, mould and yeast

Temperature stages

#1 Normal respiration temp peak post baling
(the sweat) gets to about 30-35deg C **Should cool again normally , but if microbes get going it will keep raising**

#2 Mesophilic bacteria can raise it to 55-65deg C
Bugs can die so It can cool in this phase still (caramel hay), but If it hits 65 c it will probably keep going as it indicates the thermo bugs are in

#3 Thermophilic bacteria can raise it from there and get up to around 80deg C + **Fire is imminent**

But...Why do bugs grow in spite of the low moisture ?

Why did things burn when hay tested at 10-12% moisture

What else is promoting and grows lots of bugs ?

A-Water soluble carbohydrates

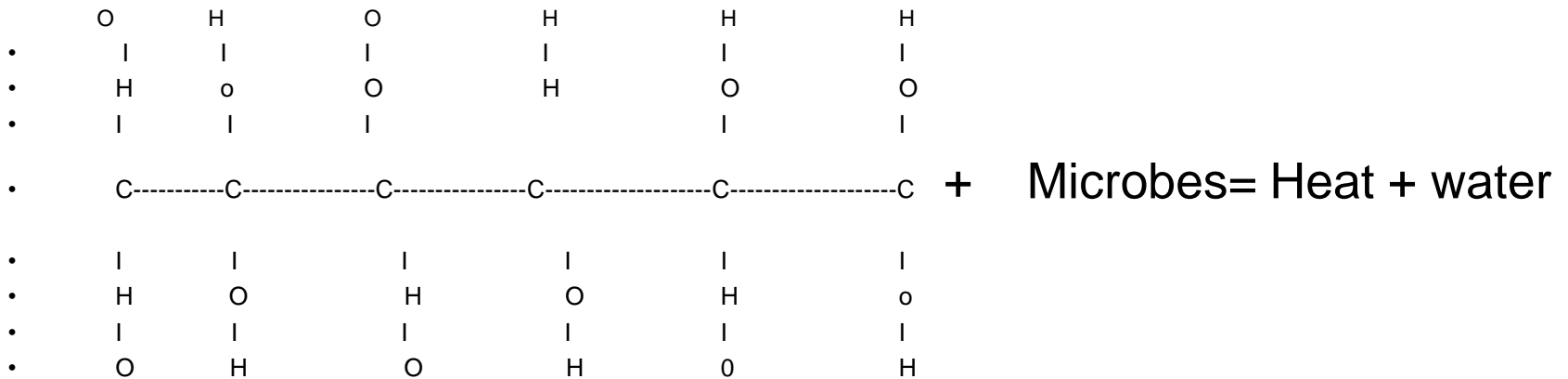
are important. ie Plant sugars that move from roots to stem to seed/flower

- Great source of nutrient for microbes in hay, that in turn can cause problems
- Its basically a composting process
- But not ONLY moisture driven (or 2007 would not have occurred)

B-Time in the windrow = more bug growth and more risk

- Extended dry down times can themselves be a point of high risk, giving high mould counts even as moisture levels decrease
- Think of 2007 cereal hay....often baled dry after 5-6 weeks curing, but still burnt after baling
- This occurred due to mould growth during the time in the windrow , and the WSC for mould to grow on

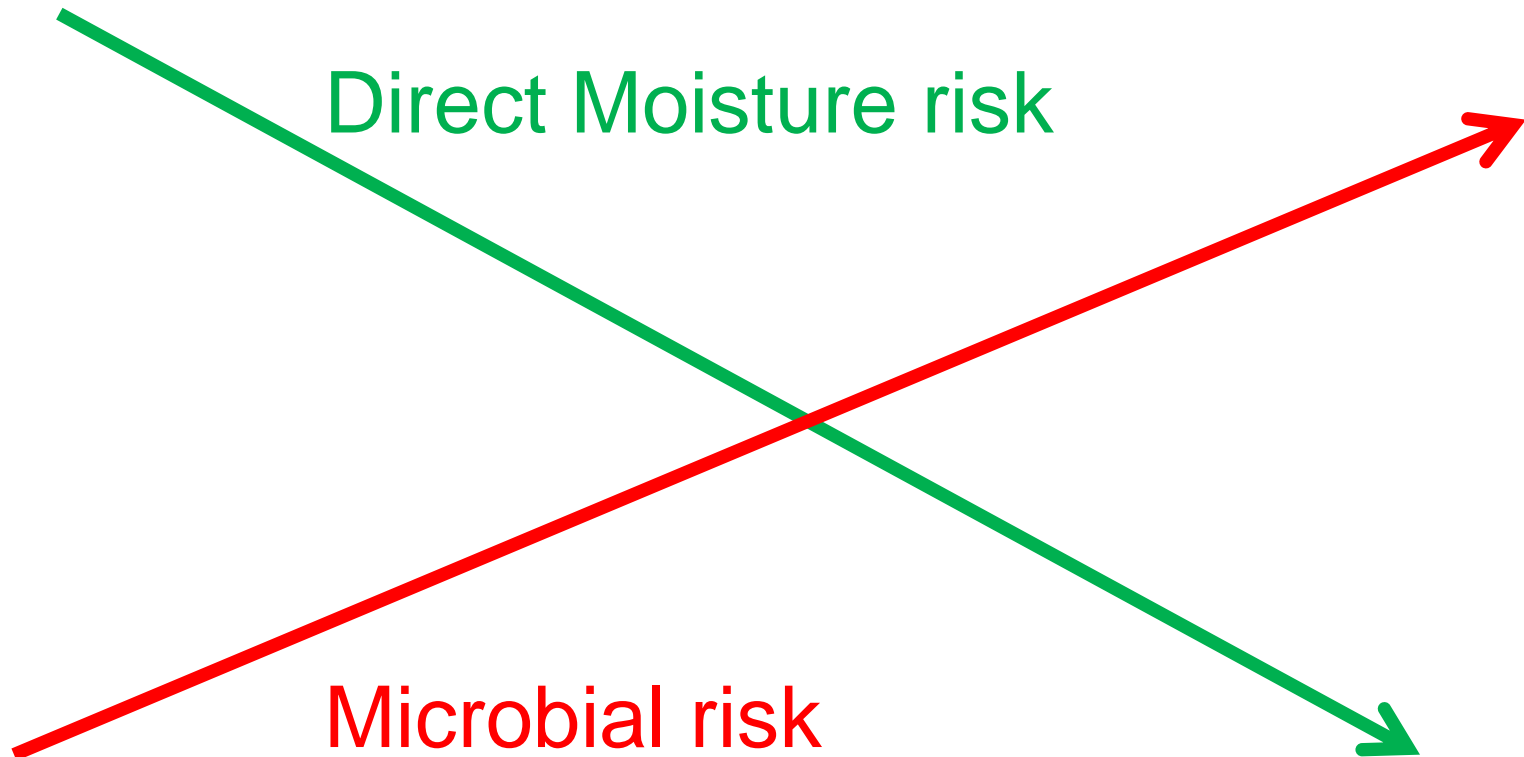
Plant nutrients + Bugs= Heat + H₂O+CO₂



- WSC is a chain of carbon atoms with hydrogens and oxygen's hanging off the chain.
- The breakdown products of WSC are heat, CO₂ and **WATER**.

So the very microbial process creating the heat is actually creating more moisture locally within the bale as well. It then grows more bugs, eats more WSC, makes more heat and H₂O in a spiral process of logarithmic multiplication

It's a balance of moisture vs bugs population



Samples from a real fire I tested	Unburnt hay	Unburnt heads	Burnt hay
Moisture	20.5	23.5	25
WSC	26	34	16
NDF	50	49	54
Protein	17	12	19

Samples from a real fire I tested	Unburnt hay	Unburnt heads	Burnt hay
Moisture	20.5	23.5	25
WSC	26	34	16
NDF	50	49	54
Protein	17	12	19



What sets this off in a tough year of high risk

- Droughted crops => High WSC in biomass
- Not conditioned or tedded after mowing
- Big windrows with micro environments
- A view that a long time down increases the dry off = a long time on the ground !!!
- Droughted / Failed crops knocked over by headers into big windrows increase the risk it seems

Mark Lourey and Feedworks undertook Local measures of Mould growth in the windrow

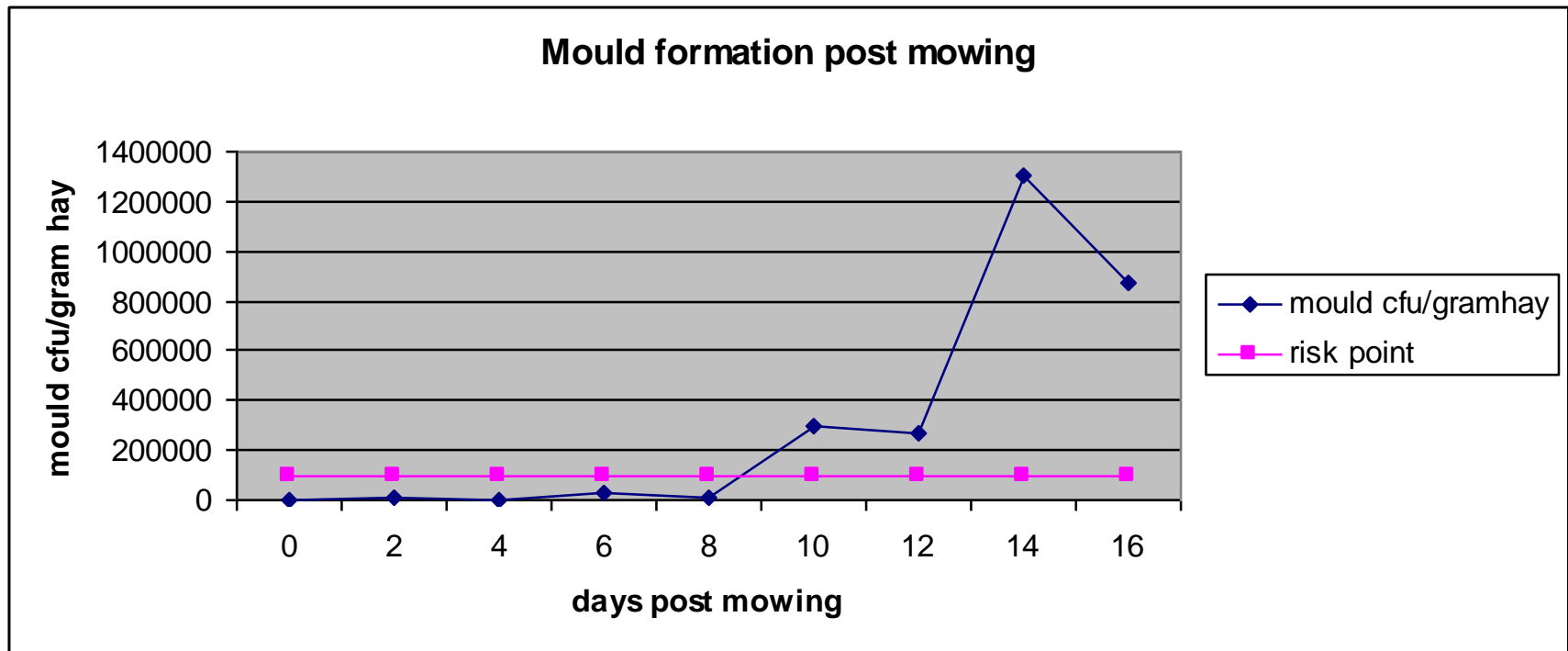
- Lets confirm this mould growth is actually occurring...lets do some measures locally of what bugs grow.
- Lets do those measures on hay that is not weather affected , and then on hay that is weather affected by rain

Danger levels for Mould growth that relate to animal health- a context for the numbers to follow

I can find no references on what specifically starts fires , but given logarithmic growth it hardly matters as we get there fast anyway

Mold Count	Guideline
10 - 10,000*	Relatively Safe
10,000 - 100,000*	Transition Zone
100,000 - 10,000,000*	Caution Advised
Over 10,000,000*	Feeding may not be recommended

West Vic hay- no weather damage.
Full 2+weeks. Max 1.3million cfu

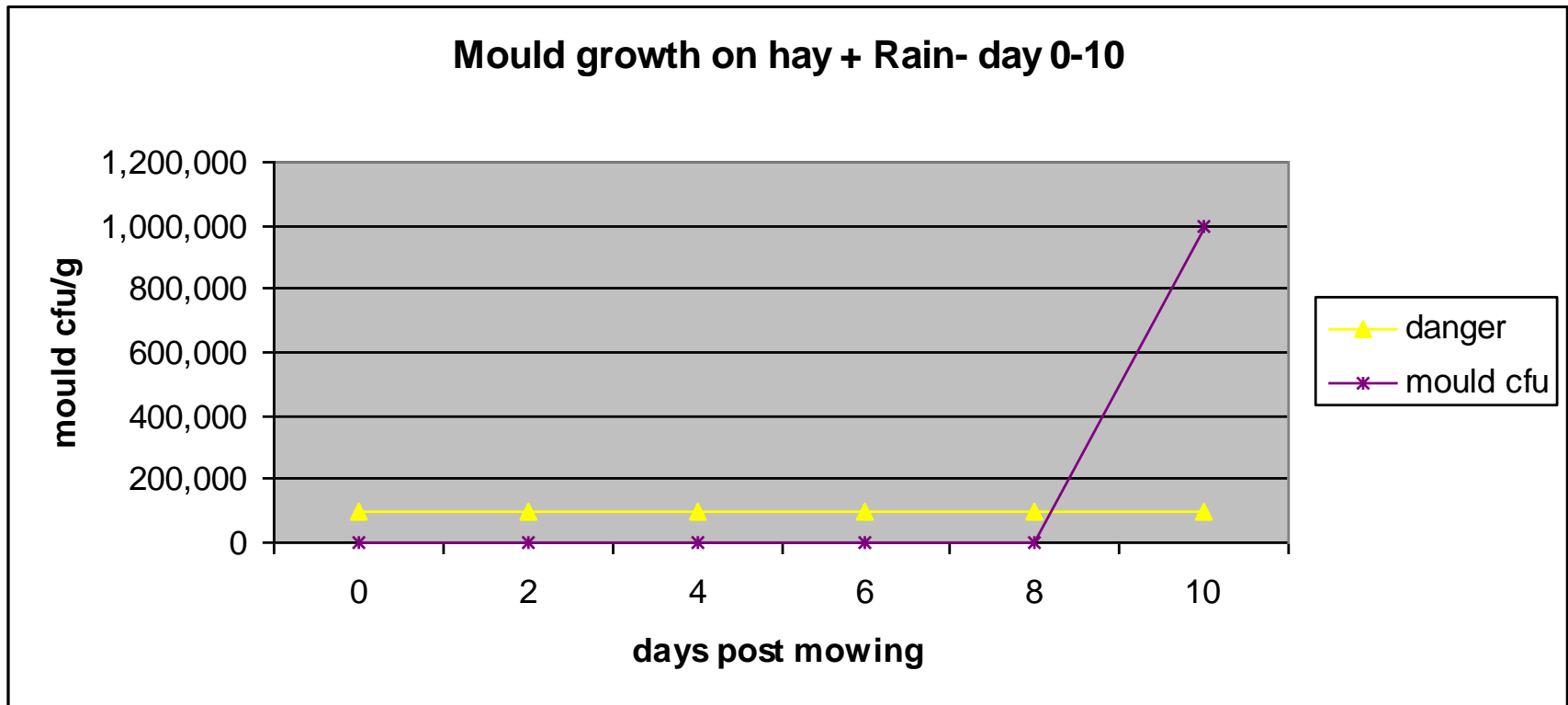


Even this “clean” hay runs well above the best practice levels

- This sample tracked along fine for a week or so. Levels stayed low, and under the risk level of 100,000 cfu/g
- After a week mould growth begins in earnest and levels exceed best practice
- Levels do not reach 10 million where the hay should not be fed, but caution is advised at the 1 million cfu mark
- Time in the windrow “brews” bugs

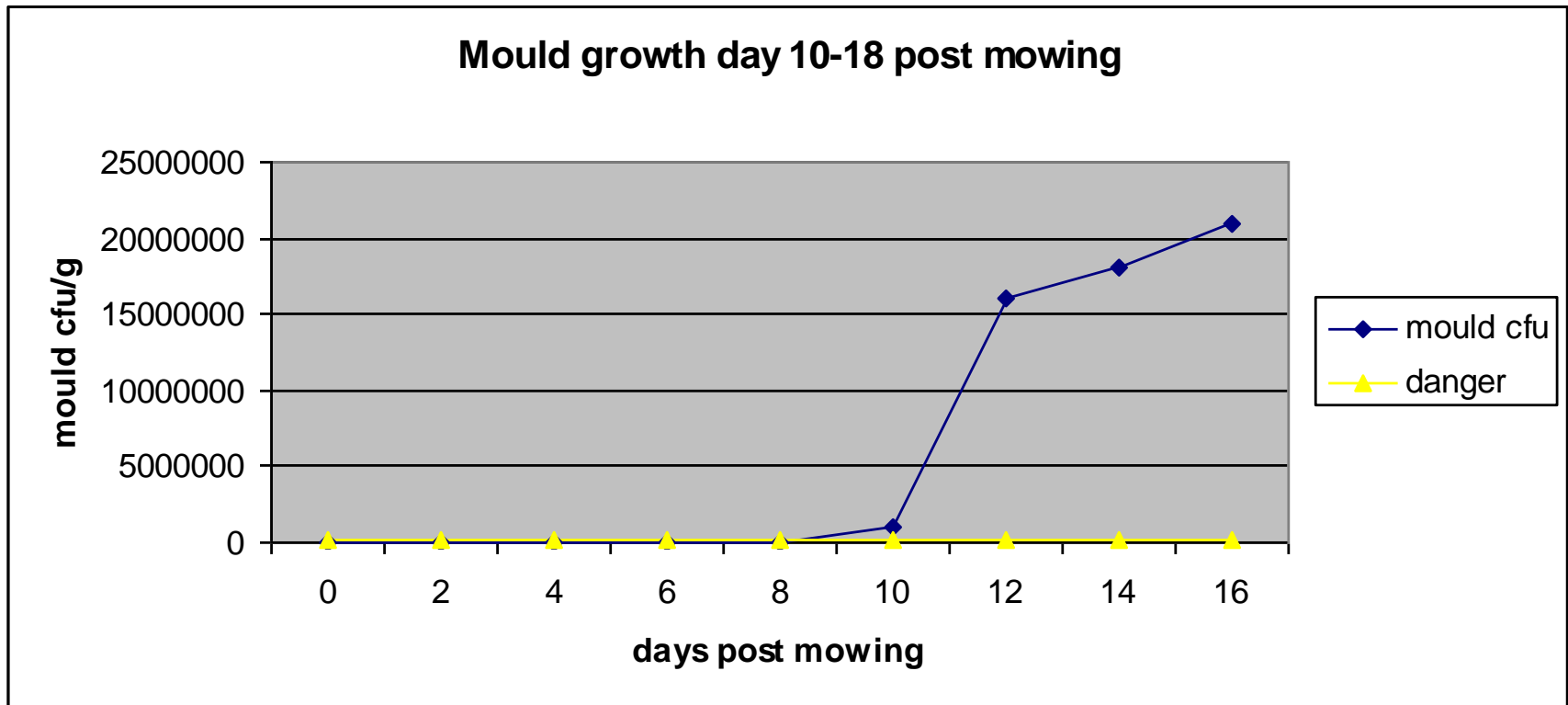
Mould growth after **rain day 2**

First 10 days only. max 1million cfu



Mould growth – full 2-3 weeks down after rain. Max
21 million cfu

YIKES!!!...its dangerous 200X safe level



Beware: Bugs lay dormant...not dead

- As we dry down hay we dry ,but not kill, the bugs. Bit like freeze dried yeast waiting to be re-invigorated in home brew or bread
- A summer storm and a leaky shed roof add water to the dormant bugs and we end up with a hot spot and a hay fire 6 or 8 months after baling

Back to baling :

Moisture alone = a poor predictor of risk- obviously or we would all be bullet proof

Hay moisture		15%	20%	25%
Do I bale		Yes	maybe	NO

WSC + moisture interaction-a better predictor of risk

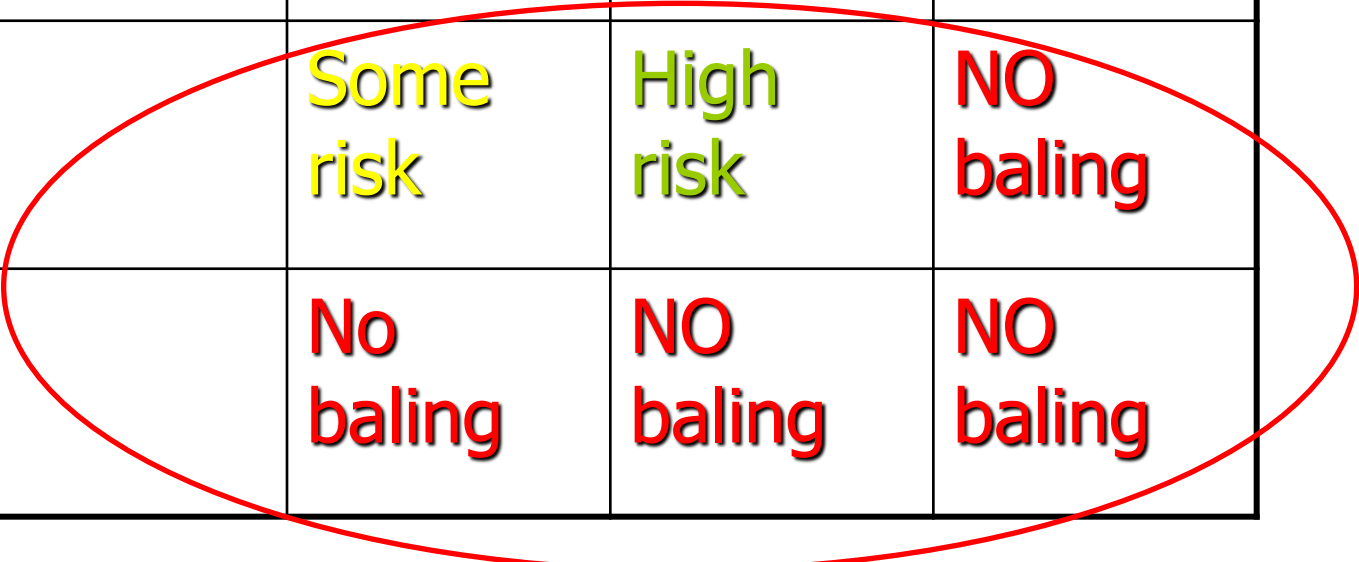
		15% moist	20% moist	25% moist
10% WSC		Fine	Fine	Some risk
20% WSC		Some risk	High risk	NO baling
30% WSC		No baling	NO baling	NO baling

WSC + moisture interaction-a better predictor of risk

		15% moist	20% moist	25% moist
10% WSC		Fine Pasture hays and lucerne	Fine	Some risk
20% WSC		Some risk	High risk	NO baling
30% WSC		No baling	NO baling	NO baling

WSC + moisture interaction-a better predictor of risk

		15% moist	20% moist	25% moist
10% WSC		Fine	Fine	Some risk
20% WSC		Some risk	High risk	NO baling
30% WSC		No baling	NO baling	NO baling



Interventions to Manage the WSC + moisture interaction

		15% moist	20% moist	25% moist
10% WSC		Fine	Fine	Treat
20% WSC		Treat	Treat	NO baling
30% WSC		Treat- still risky	NO baling	NO baling

Reducing bug growth in practice is feasible

University of Tennessee sources suggest preservative application increases margin for error on hay baling moisture by about 5%

This is based on reduction in microbial activity

It works in Aus too



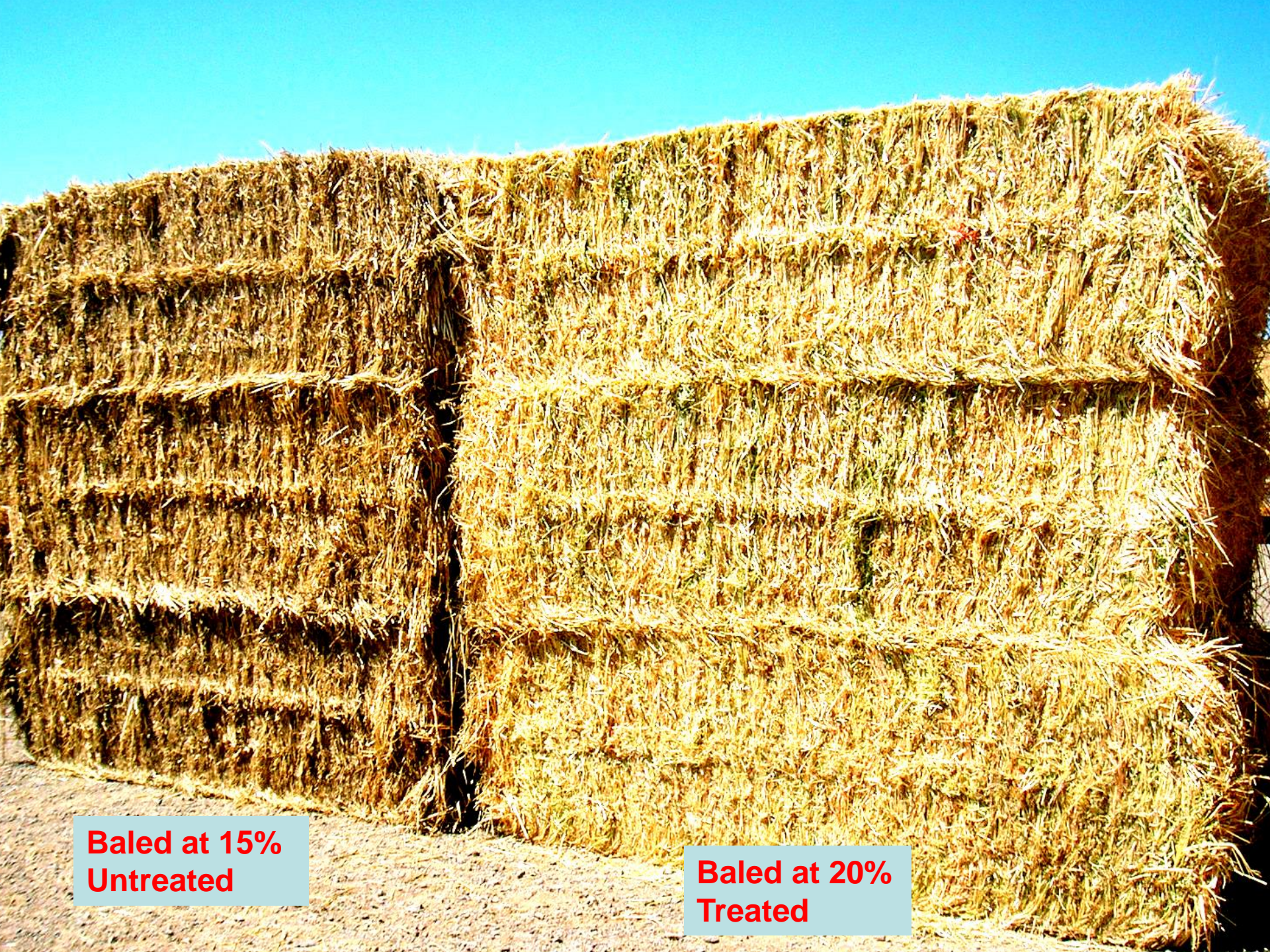
**Hay baled at 22%
Untreated**

**Hay baled at 22%
Treated with preservative**



**Baled at 22%
Untreated**

**Baled at 22%
Treated**



**Baled at 15%
Untreated**

**Baled at 20%
Treated**

Ideal Outcome to predict risk ?

- a risk matrix of...

Moisture X WSC X microbial load

- Not feasible yet , so we remain with
 - 1- moisture in hard numbers for a while
 - 2-plus a sense/idea of WSC
 - 3-plus a sense/idea of Microbial load
- On which to determine risk and respond

A word on nutrient loss

- Heating to “mid range” mesophilic level will caramelise hay maillard reaction
- Stock like it , but nutrient levels decline
- Refer Neil Griffiths(in the room) drop WSC and energy dramatically 1-1.5MJ/kg is typical
- Increase in indigestible protein measured as ADIN...can loose 10-15% of your protein