Improving silage additive coverage

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Silage additives, if applied at the appropriate rates and in the right conditions will generally result in silages with reduced losses of nutritive value and dry matter than untreated silages. Even when ensiled under "good silage making conditions" research has shown that applying silage additives to be an advantage.

However, to be most effective additives must be distributed as evenly as possible throughout as much of the fresh forage as possible, at the correct rate of application and with minimal additive loss. Additives can be lost by evaporation, wind drift of liquid droplets and possibly some of the sprayed additive not even being applied to the material at all such as in narrow windrows being fed into the pickup.

Recent research (3 trials) conducted by Matts Nysand and Antti Suokannas of MTT, Agrifood Research i Finland has examined some new ways to improve the effectiveness of additive application in loader wagons, tractor drawn and self-propelled precision forage harvesters. The self-loading wagon had a rotor which pushed the forage through stationary knives rather than one with an integrated precision chopper fitted with rotating knives.

The additives used were a mix of mainly formic acid and some ammonium formate with a target application rate of 5 litres per ton of fresh crop. The results for the tractor drawn choppers are not discussed here.

Wind speed ranged from 0 to 9.3 kilometres per hour and temperatures ranged from 15 to 25ºC during the trial periods. Bear in mind Australia can have much higher temperatures during harvest with implications on liquid evaporation.

What was trialled?

Loader wagons: Traditionally, for loader wagons, additives are sprayed onto the windrow before the pickup or on the pickup as the material flows over it. This results in much of the additive remaining towards the top of the material as it enters the loader wagon choppers. With this chopping system (fixed knives) the material containing additive is unlikely to be thoroughly mixed with untreated material and will result in an uneven fermentation in the stack.

The new technique involved spraying half the additive from above on the pickup and half from underneath the forage flow using a plastic pipe, 20 mm outside diameter and 1.1 mm holes drilled at 100 mm spacing (Figure1). This pipe was fastened towards the back of the pickup in such a way as not to restrict material flow. Figure 1 shows the traditional fan nozzles at top of the pickup and experimental jets from below, set into a small gap to the rear of the pickup, which is available on most machines.

Figure 1. Traditional fan nozzles above and new jets from below pickup

Self-propelled precision choppers: Additive was applied as solid jets via a plastic pipe with 1.5 mm holes spaced at 33 mm intervals and positioned above the front opening of the inlet channel (Figure 2), injected in the curved chute on either the outer side (where centrifugal force sends the grass) or the inner side (air) or on the top chute deflector, using 2 jets at each site

Figure 2. Jets of additive at 33 mm spacing placed at inlet channel opening

What was found?

The researchers reported their results in terms of coefficient of variation (CV). The smaller the CV, the better the distribution of the additive on the forage and so, the better the fermentation over more of the forage.

Loader wagons: The researchers found that the new technique of jetting additive from below + fan spraying over the pickup distributed the additive significantly more evenly (CV 50%) compared to the traditional methods (CV 79 – 84%, Table 1) of fan spraying on top of the forage, either before it enters the pickup or over the pickup. CV or Coefficient of Variation is a statistical measure of the variation of the evenness of the applied additive.

However, with ideally wilted material of 30 to 35% Dry Matter (DM), a good fermentation will still occur but slight losses of DM and quality might occur due to the lack of additive on some of the forage. However, in over-wet material i.e. under 30% DM, or if over-dry, i.e. over 40% DM, the fermentation losses will be higher in the material not covered by additive.

Although not statistically different, the loss of additive due to evaporation and/or wind drift appeared to be higher (48%) when applied in front of the pickup compared to when application occurred either at the pickup or at + under the pickup (34%). This makes sense as wind may blow away some of the additive droplet and some evaporation may occur before entering the wagon chamber.

Table 1. Evenness and loss of additive on loader wagons

Application Method	Evenness of application CV, (%)	Loss (%)
From above, in front of pickup	79.3[a]	48.3
From above, at pickup	83.6[a]	33.9
From above + jets under at pickup	49.7[b]	33.9

CV = Coefficient of variation. The smaller the CV, better the distribution
In terms of research results with "a" are statistically different from those with "b".

Self-propelled precision choppers: These harvesters achieve a more even coverage than loader wagons due to their fast rotating knife cylinder and very short cutting of material, both attributes encourage thorough mixing of forage and additive, However, this research has shown how to further improve the evenness and thoroughness of additive mixing in precision choppers.

Table 2. Additive evenness and amount of grass receiving too little additive on self-propelled choppers

Position of application	Evenness of application	% of grass receiving less additive than		Applied Dose
	CV, (%)	1.5 l/t	3.0 l/t	l/t
Front of inlet channel	20[a]	0	0	5.1
Chute base, outer (grass) side	61[b]	2	22	5.8
Chute base, inner (air) side	49[b]	10	24	4.4
Chute, top deflector	64[b]	14	36	4.9

It found that closely spaced jets (1.5 mm holes at 33 mm spacing) positioned at the front of the inlet channel resulted in very even distribution (CV20%) of the additive and the correct application rate (5 l/t) was applied to all the forage (Table 2). Conversely when applied on either side or top of the chute only, the CV ranged from 49 to 64%, having missed out on the mixing effect of the cutting rotor and accelerator. To add salt to the injury, one fifth to just over one third of the material received under 3.0 l/t of additive, well under the 5l/t stipulated by the additive supplier to reap the full benefits of the additive and to help offset its cost due to a quicker and more efficient fermentation.

Some caveats to this research: This research was carried out with acid and at 5l/ton. Australians tend to largely use water and this is less sensitive to evaporation than acid so losses are likely to be smaller with biological additives mixed in water. However, under the higher temperature conditions which much silage is made in many areas of Australia and the increasing use of Ultra Low Volume (ULV) applicators, what are our losses and how evenly distributed is the additive? Perhaps our silages could also benefit by applying half of the additive from below the material as it passes over the pickup.

Summary. Forage wagons and balers – apply additives at the pick-up with half the additive dosed from above and have from below. Solid jets should also be used instead of fans for better distribution and to reduce additive losses. Self propelled forage harvesters – apply additives either just before the chopping cylinder or just before the accelerator