SYNCROFLOW® Technology
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Press Release
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Introduction

The key to sustainable long term commercial food production lies in the balance found between high production levels and the impact on the natural, non-renewable environment (Air, Soil and Water).

The design of mechanization processes and equipment, as required during modern day Agricultural Production, could either have a detrimental, even devastating, effect on these environmental resources, or could support their conservation and even improve it. This is what we call *CONSERVATION AGRICULTURE*.

The ***SYN***ergy in ***CRO***p production between the mechanized solutions used for commercial production and the natural resources will determine whether *conservation agriculture* or *destructive agriculture* is practised.

The ROVIC philosophy of design is 100% focussed on *conservation agriculture*, and ***SYNCRO®*** technology is the priority of each design.

Background

The efficient application of agrochemicals (insecticides, fungicides, growth regulators and foliar feeds amongst others) on pome and stone fruit is one of the key elements in assuring a quality crop in commercially acceptable quantities.

Over the past three to four decades the change in the shape of the tree structure has been dramatic, originating back to structures with an *open vase* format, planted in *6,5 – 7m row widths* and trees reaching *heights of 6m* and *depths of more than 5m*. This resulted in about 230 – 250 trees planted per hectare. These monstrous structures were sprayed with Conventional low profile axial fan sprayers, delivering in excess of 50 000 cub m/hr air volume at outlet speeds of around 35m/s. (Fig.1) These machines required more than 35 Kw to drive the fan and the high pressure pump, responsible for spray liquid atomization and calibration to the required volume, which sometimes exceeded 3000 l/ha. For the purpose of this paper this practise will be referred to as the historical planting method.

Figure 1: Conventional Axial Fan Mistblower

The modern day orchard structure has seen radical changes both in shape, size and density of planting. A *central leader* system is used with *row widths between 3,5 – 4,5m*, tree heights limited to *4m* and *tree depths from 800mm to maximum 2m*. These orchards will have in excess of 1000 trees planted per hectare, and application volumes are currently 500 – 750 l/ha, with the tendency to be even more reduced. This modern day orchard practise is referred to as high density planting.

The main reasons for this complete change in orchard structures are found in the following advantages for high density planting:

1. More sunlight reaching more foliage supports more vigorous growth, resulting in trees reaching full production within 5 years of planting. Historical planting required up to 10 years to reach full production.
2. In full production, the total amount of foliage receiving sunlight is much more in the high density plantings, resulting in far superior crop volumes being produced. It is not uncommon to expect up to 50% higher yields than the historical orchards.
3. Crop quality is potentially far superior, because of easier harvesting.
4. The efficient application of agrochemicals is *expected* to be easier with the less complex tree structure as the target, resulting in *potentially* better utilization of the chemicals, *less expected* environmental contamination (soil, ground water & air) and the *expected* result of better crop quality.

The first 3 advantages materialized, but the industry found that #4 expected advantage has actually become a challenge. Fungal disease infections (eg. Fusicladium) in high pressure areas like the Ceres Witzenberg and Grabouw production areas clearly showed the challenge – it became evident that control in the top centre of the tree and the bottom outside perimeter of the tree became the challenged areas. (Fig.2)

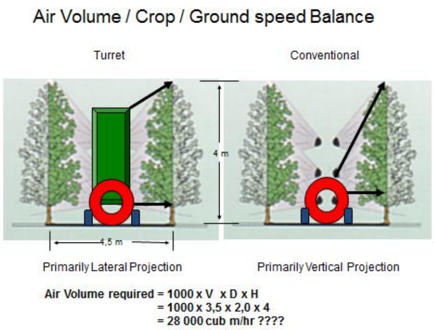

Figure 2: High Density tree shapes with Conventional and ROVIC EVENFLOW Turret

In 2012 HORTGRO (Fruitgro Science) registered a project (2012 – 2015) and contracted a research group to analyse the problem and try to find solutions. EXPERICO was contracted to set up the trials and do the recovery analysis, whilst Marius Ras from ROVIC LEERS was invited to offer models and suggestions on what machinery configurations to evaluate, and how to set them up optimally.

At this point ROVIC LEERS (Marius Ras) has already pre-screened the situation, having done field evaluations since 2009, and came to the conclusion that the imbalances of air momentum reaching the different areas of the tree structure could cause that:

- Excessive air momentum reaching the target will actually blow the chemical off again – and would be found in the cases where infection manifests on the outside of the bottom tree part, infecting on the outside of the fruit literally 500mm away from the sprayer outlet in some cases, *and the spray equipment used was still the same configuration as the machines used in the historical orchards.*
- Detuning on the delivered air momentum to prevent the previous situation, resulted in not ample air momentum being available to transport the atomized liquid to the top centre part of the tree, which is still 4,5m away from the outlet, and the air jet travelling a large distance through open air with these conventional sprayers, being susceptible to unfavourable environmental conditions like wind and low humidity. This then resulted in infections found in the top centre part of the tree.
- The worst scenario emerged where both areas were infected in most cases, pointing solidly to the fact that *effective application with the conventional machine configuration, designed 5 decades ago to spray the historical tree structures, did not have the correct design parameters to suit the high density tree structures and can potentially thus not produce the required results.*

Requirements for an effective Agrochemical Application

1. Correctly calibrated atomized droplet spectrum to 80 – 175 micron VMD (Volume Median Diameter)
2. Correctly balanced Air Momentum and Air Velocity profiles to the tree dimensions and application speed.
3. Correctly optimized application volumes per hectare.

These three requirements must be met simultaneously, and defaulting on one of the three will potentially result in compromised recovery of active ingredient and risk for poor control.

It was clear that the inability of conventional spray machines, designed with the historical orchard structures in mind, could not satisfy the second requirement and thus risking disease infestation as described above.

Balanced Air Momentum

The empirically researched (Ras, 1988) air momentum balance (Fig. 2) in historical orchards has been re-evaluated for high density orchards and conventional machines in the FRUITGRO Science project (2012 – 2015) and found to be still the best suited principle – although results in recovery with conventional machines were beyond doubt shown to be problematic in the areas as expected.

Balanced Air Velocity Profile

This new focus in research revealed and confirmed the problem – oversupply of air momentum in the bottom tree structure and under supply in the upper part, as a direct result of the design of the conventional machine.

The complete approach to air velocity profile design to suit the tree structure was seen as the key to solving the problem.

SYNCROFLOW® technology.

The theory of progression of a turbulent jet is described by RAJARATNAM 1976 and RAS 1991 used this theory as a base for predicting and measuring air velocity profiles and their progression under various conditions, predicting tree shapes that could be effectively approached by the various machines used in the trials.

The dissipation of air momentum in a pome/stone fruit tree structure is a well-researched subject, originating in results from STAFFORD et al 1970, through to recent work by PANNETON et al 2005.

Utilizing the above research data, and applying it to the design of a turbulent jet emitter to match the modern high density tree structures is the ***SYNCROFLOW®*** technology built into the ROVIC LEERS EVENFLOW® Turret sprayer (Fig. 3) for high density pome and stone fruit.

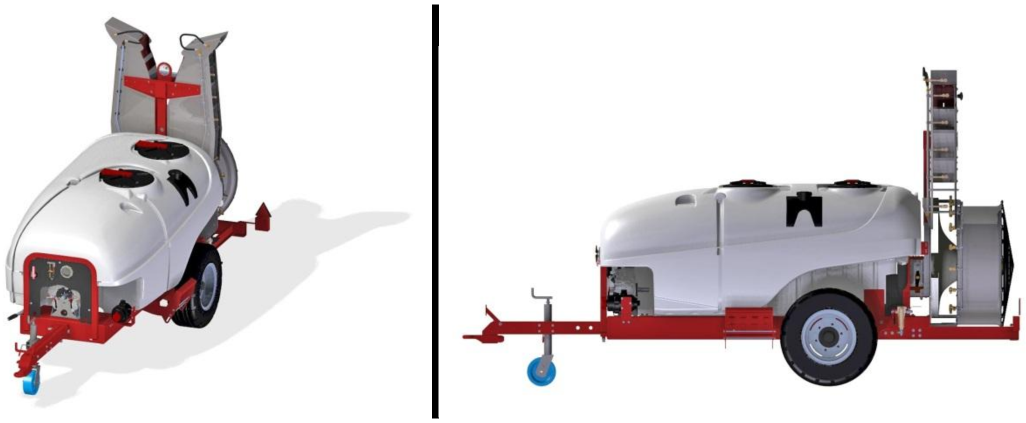

Figure 3: ROVIC EVENFLOW® turret Sprayer with SYNCROFLOW® technology.

The following parameters of achievement were set from the tree structure centre as point of reference:

1. Actual Air Volume delivery such that high density plantings on the extreme sides of the spectrum can be sprayed up to 5km/h, based on the Empirical Required Air Volume model (RAS 1988):

   Air Volume required (cub m/hr) = 1000 V(km/h) x D(m) x H(m)

   High Density Model 1: Larger Trees in 4,5m Row Widths
   V =5 km/h
   D = 1,8m
   H = 4m
   Air Volume Requirement = 36 000 cub m/hr
   Achieved: 36 200 cub m/hr with 4:1 Gearbox ratio @ 540 rpm input = 2160 rpm impeller speed.

   High Density Model 2: Smaller Trees in 3,5m Row Widths
   V = 5 km/h
   D = 1.25m
   H = 4m
   Air Volume requirement = 25 000 cub m/hr
   Achieved: 26 600 cub m/hr with 3:1 Gearbox Ratio @ 540 rpm input = 1620 rpm impeller speed.

2. Left / Right balance of air velocity profile and air momentum with 95% objective.
   Achieved:
   36 200 cub m/hr: +- 0,6% (99,4% balance)
   26 600 cub m/hr: +- 1,9% (98,1% balance)

3. Tree depth and shape air velocity balance for the two extremes in high density orchards.

   Required:
   High Density Model 1: Larger Trees in 4,5m Row Widths
   D = 1,8m
   H = 4m

High Density Model 2: Smaller Trees in 3,5m Row Widths
D = 1.25m
H = 4m

Achieved: See Figure 4 below.

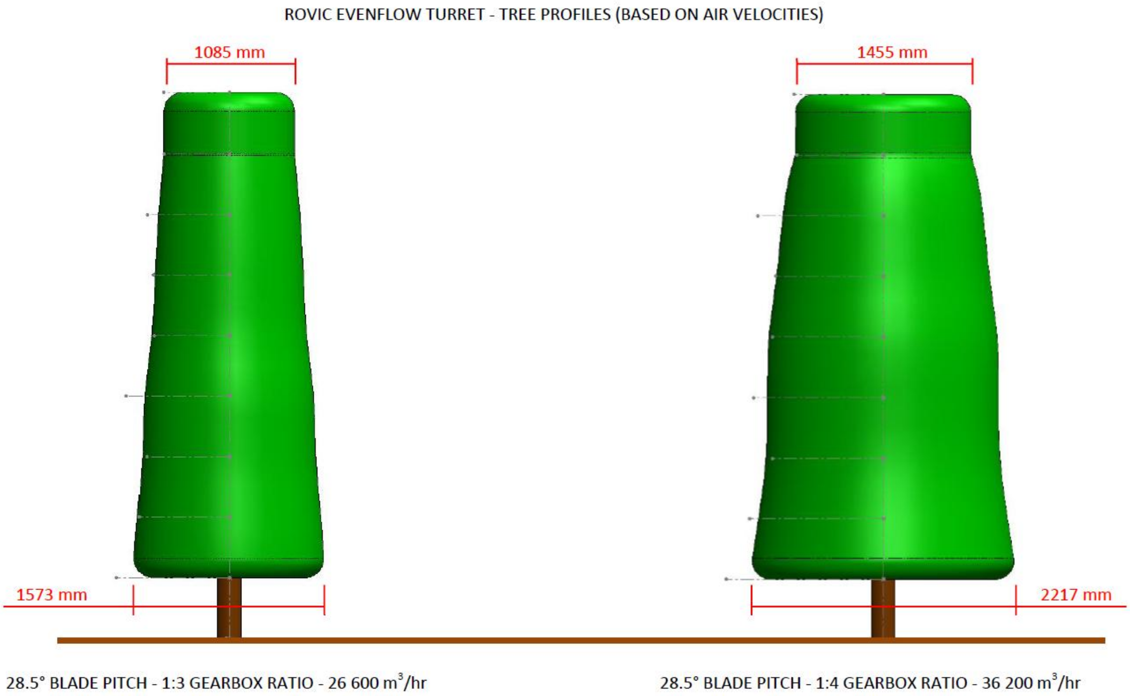

Figure 4: Tree profiles that are in velocity and momentum balance with the ROVIC EVENFLOW® design.

4. Non perpendicular impact of air jet on foliage to achieve greater penetration with less momentum.

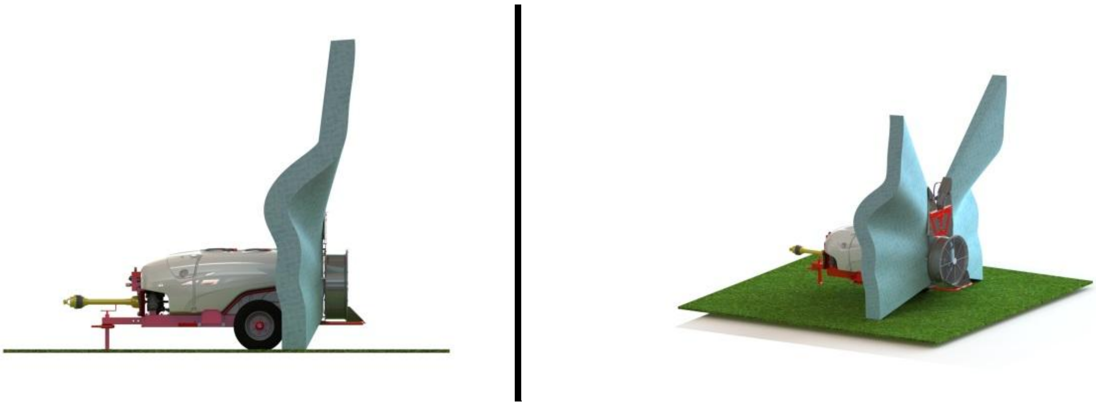

Figure 5: Forward and aft projection of air jet

Agrochemical recovery results achieved

PROGRESS REPORT
2013

Programme & Project Leader Information

	Research Organisation Programme leader	Project leader
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Project Information

Research Organisation Project number	A 07-13
Project title	Continue evaluating commercial spray application and development/use of protocols to deposit fungicide residue of required amounts, for effective pathogen control on pome fruit.

Fruitgro Science / Experico report.

The above series of trials concluded the following on the advantage of the SYNCROFLOW® technology as used in the ROVIC EVENFLOW® sprayer:

1. *An increase of: (Fig.6)*
- More than 35% (1.1 to 1.5) in the deposition efficiency of Agrochemicals on the fruit during 1x Applications when compared to the Conventional Sprayer.
- More than 115% (1.6 to 3.5) in the deposition efficiency of Agrochemical on the fruit during 4x Applications when compared to the Conventional Sprayer.

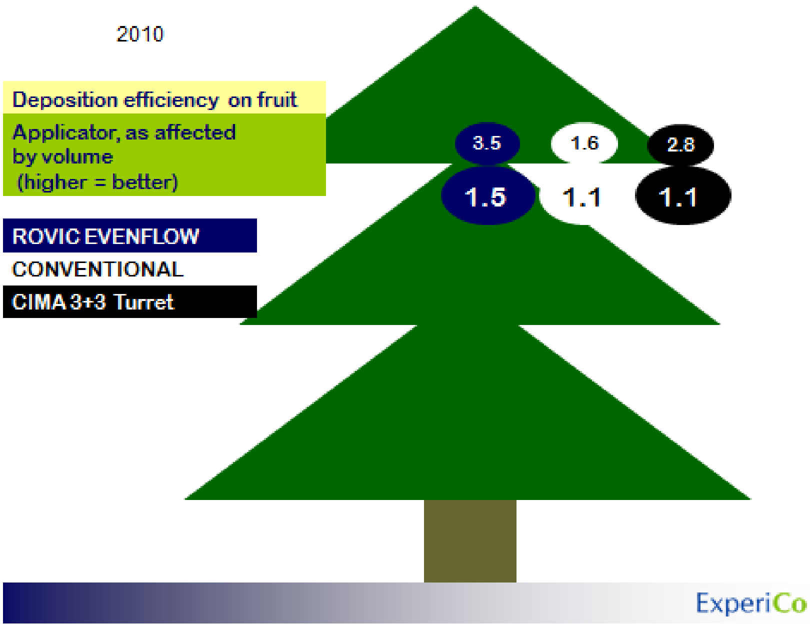

Figure 6: Increase in deposition efficiency of the ROVIC EVENFLOW compared to CONVENTIONAL.

2. *Superior performance even under elevated ground speed applications, both on leaf (Fig. 7) and fruit (Fig. 8) recovery.*

Table 5 : **Deposition quantity** of a fluorescent pigment on the **leaf surface** of Pink Lady apple trees as significantly affected by **Spray applicator x Canopy depth**

Interaction[2]					Prob > F[1]
Spray applicator (Factor A)			Canopy depth[3] (Factor B)		
Applicator technology	Energy delivery[4] (m³ / h)	Ground Speed (km/h)	Outer leaves	Inner leaves	AB
1. Atasa (+)Turret	Standard	3.9	8.7a	4.3bc	***
2. Atasa (+)Turret	Standard	6.2	7.5a	3.3cd	
3. Atasa (+)Turret	High	6.2	5.3b	2.4de	
4. Atasa (-)Turret	High	6.2	3.0cde	1.3e	
5. Cima (+)Turret		6.2	2.9cde	3.0cde	

Figure 7: Recovery of Agrochemicals on leaf surfaces at elevated ground speeds.

The Conventional sprayer (ATASA (-) Turret) recovered a level 2.2, whilst the ROVIC EVENFLOW® (ATASA (+) Turret) recovered 5.4, which equates to a 145% superior recovery on leaf surfaces for the ROVIC EVENFLOW® during elevated speed (6.2 km/h) spraying.

Table 6 : **Deposition quantity** of a fluorescent pigment on the **fruit surface** of Pink Lady apple trees as significantly affected by **Spray applicator x Canopy height**

Interaction[2]					Prob > F[1]
Spray applicator (Factor A)			Canopy height[3] (Factor B)		
Applicator technology	Energy delivery[4] (m³ / h)	Ground Speed (km/h)	Top fruit	Bottom fruit	AB
1. Atasa (+)Turret	Standard	3.9	2.3ab	1.0c	***
2. Atasa (+)Turret	Standard	6.2	2.8a	0.9cd	
3. Atasa (+)Turret	High	6.2	2.0b	0.4d	
4. Atasa (-)Turret	High	6.2	0.4d	0.4d	
5. Cima (+)Turret		6.2	0.5cd	0.8cd	

Figure 8: Recovery of Agrochemicals on fruit surfaces at elevated ground speeds.

The Conventional sprayer (ATASA (-) Turret) recovered a level 0.5, whilst the ROVIC EVENFLOW® (ATASA (+) Turret) recovered 1.8, which equates to a 250% superior recovery on fruit surfaces for the ROVIC EVENFLOW® during elevated speed (6.2 km/h) spraying.

3. *Reduced energy required*

The ROVIC EVENFLOW® machine requires a true 7 Kw input into the fan to create the 26 600 cub m/hr and the required air velocity profile as stated, resulting in the above superior results in Agrochemical recovery.

At the same time, the Conventional machine requires 25 Kw to produce enough air momentum to reach the top part of the tree, resulting in the far inferior recovery data as indicated.

Summary

Independent field tests under controlled supervision confirmed a 40% saving in diesel when changing from Conventional to EVENFLOW® equipment. This equates to the SYNCROFLOW® technology paying for itself in 2 - 3 years of usage, whilst vastly increasing chemical recovery efficiency as shown above.