An overview of Westfalia technological services' research – roots, shoots and fruit

Z. Van Rooyen[1], A.T. Bruwer[1], S. Mhlophe[1], Z.S. Mavuso[1], R.J. Blakey[1], C. Fernández Noguera[1, 2], J.S. Köhne[1]

[1]. Westfalia Technological Services, Limpopo, South Africa

[2]. Brokaw Nursery LLC, California, United States of America

ABSTRACT

The South African avocado industry is strongly export driven. Westfalia Fruit Estates (Pty) Ltd is one of the largest avocado producers in southern Africa and Westfalia Marketing SA (Pty) Ltd is responsible for just under half of South Africa's total avocado exports. Part of the Hans Merensky Holdings Group, Westfalia Fruit is a vertically-integrated organization with a growing international footprint.

The research conducted at Westfalia Technological Services (WTS) covers most aspects of avocado production – from the cultivation of nursery trees to ensuring that avocado lovers around the world are served perfectly ripe and attractive fruit. The WTS team comprises horticulturalists, plant pathologists, fruit physiologists and food technologists. Research is aimed at solving both short- and long-term challenges, with our rootstock selection programme running for over 30 years and producing the highly-successful Merensky 2 (Dusa®) rootstock.

With ever-increasing competition in the international avocado market, producers and suppliers need to remain at the forefront of technological advancements while satisfying consumer preferences. Such requirements were foreseen by the organization's founder, Dr Hans Merensky, whose pioneering strategies can now be shared with future generations across the globe. This paper shares some of these strategies with you.

La industria Sudafricana de la palta está basada principalmente en la exportación. Westfalia Fruit Estates (Pty) Ltd es uno de los mayores productores de palta en el sur de África y Westfalia Marketing SA (Pty) Ltd es responsable por casi la mitad de las exportaciones totales de paltas de Sudáfrica. Parte del Hans Merensky Holdings Group, Westfalia Fruit es una organización integrada verticalmente con una huella a nivel internacional que está en constante crecimiento.

La investigación llevada a cabo por Westfalia Technological Services (WTS) cubre la mayoría de los aspectos de la producción de palta – desde el cultivo de plantas de vivero hasta asegurar que los amantes de las paltas alrededor del mundo puedan obtener una fruta perfectamente madura y atractiva. El equipo de WTS cuenta con horticultores, fitopatólogos, fisiólogos frutales y técnicos en alimentos. La investigacíon se enfoca en resolver desafíos, tanto de corto como de largo plazo, a través nuestro programa de selección de patrones que se ha estado llevando a cabo por más de 30 años y ha producido el altamente exitoso patrón Merensky 2 (Dusa®).

Con el permanente incremento de la competitividad en el Mercado internacional de la palta, productores y proveedores tienen que estar a la cabeza de los avances tecnológicos mientras satisfacen las preferencias de los consumidores. Dichos requerimientos fueron previstos por el fundador de la organización, Dr. Hans Merensky, cuyas estrategias pioneras pueden ser ahora compartidas con las futuras generaciones alrededor del mundo. Este artículo comparte algunas de estas estrategias con ustedes.

Keywords: cultivar, rootstock, orchard practices, plant pathology

INTRODUCTION

Westfalia Fruit (Pty) Ltd is a leading multinational supplier of fresh subtropical fruit and related processed products to international markets. Part of the Hans Merensky Holdings Group, Westfalia grows, sources and ripens, packs, processes and markets sustainably-grown avocados year round.

Westfalia Fruit Estates (Pty) Ltd, now part of the global Westfalia Fruit (Pty) Ltd group, has been producing avocados for over eighty years and while a lot has changed since its inception the principles of the company are still firmly based on those set down by the company's founder. The founder was a geologist, Dr Hans Merensky, who made his money through prospecting and who, in his later years, started to take a keen interest in timber and avocado production.

Dr Merensky bought the farm Westfalia in the northern subtropical region of South Africa in the late 1920s where he pioneered sustainable forestry practices, water conservation and prevention of soil erosion. Today it can still proudly be said that the legacy and agricultural lessons that Merensky left behind are still being honoured and integrated in "Business as usual" within the Westfalia Fruit group and that this heritage remains the firm foundation to which the company owes its success today.

This paper will share some of Dr Merensky's philosophies and his approach to integrating science with farming operations. It will detail Dr Merensky's conviction and experience that in agricultural enterprises one had to think about the longer term solution. With this as background information one will see how Westfalia Fruit, and specifically the research division, works to offer the Group that competitive edge by integrating Dr Merensky's legacy into their research trials and subsequently incorporating results into commercial practice.

BACKGROUND

Hans Merensky's legacy

Dr Merensky never married, and had no immediate relatives who could inherit his estate and so, as he grew older, he began to think about the continuance of his legacy. He trained in Germany as a geologist and subsequently returned to South Africa where he practiced his trade until his retirement. Upon retiring, Dr Merensky spent years rehabilitating the Westfalia Farm and on his passing (in 1952) wanted his farming principles to continue and for his development work to benefit South Africa as much as possible. Dr Merensky thus created a Trust with the mandate to continue and later be formed into a Foundation once the farm had developed into its final structure (after no more than 25 years after his death). In 1973 the Trust became the Hans Merensky Foundation and according to the 1949 founding document, the objective of the Hans Merensky Foundation is "to promote and assist in the development of the resources of South Africa and neighbouring territories – particularly such natural resources as soil, water, minerals, flora and fauna – and to promote the health and welfare of the inhabitants; more specifically by research, experimentation and demonstration and through the correlation and application of scientific knowledge".

Then and now

From the 1930s Dr Merensky undertook to deal with aridity and soil erosion on Westfalia, and while he favoured a scientific approach he realised that in agriculture there were no quick fixes. His approach was thus to first take stock, then gather facts, including observations and advice from elsewhere, and then to think carefully about the whole problem. If the matter was very complex, he consulted experts and, if necessary, instituted additional scientific studies. At last when he reached a decision about what he (Dr Merensky) wanted to do he would run a small experiment. If the experiment was technically possible and promised to produce good results, the method would be implemented more broadly.

Since 1988, when Merensky Technological Services was established (today known as Westfalia Technological Services, WTS), Dr Merensky's three steps between experimentation and commercialization have been followed on the farm. WTS is the privately funded research division of the Westfalia Fruit group and are responsible for the "Experimentation", "Demonstration" and "Pre-commercial" testing of all new plant materials, agrochemicals, farming equipment, postharvest applications and general innovation. Over the years the company has employed highly specialized researchers and today the research team is comprised of plant physiologists, horticulturalists, food technologists and plant pathologists. WTS has further expanded to include an Intellectual Property Division to deal with the protection of both locally and internationally acquired plant material and innovative farming solutions.

WTS research: Roots, Shoots, and Fruits

Roots

One of the most limiting factors to profitable avocado production in South Africa is that imposed by *Phytophthora cinnamomi* root rot (PRR). While cultural improvements in land preparation, horticultural care of trees (e.g. irrigation, pruning, and fertilization) and chemical intervention have gone a long way to improving the longevity of orchards the true success of the industry undoubtedly lies in the introduction of clonal rootstocks to South Africa in the 1970s, something that Westfalia Fruit Estate played an active role in importing and testing. Not only did clonal rootstocks result in improved and more predictable yields, they also facilitated improved orchard management through improved tree health and growth uniformity.

While the WTS rootstock research programme, starting in the 1980s, has yielded the successful Dusa® rootstock the true success of the programme is not measured in royalty income but rather by the improved yield the rootstock offers growers. With the rootstock programme running for over 30 years now (Kremer- Köhne *et al.,* 2011) WTS has a team of dedicated researchers looking after the numerous trials in which plant material, sourced both from the WTS breeding programme as well as successful selections from international programmes (Roe *et al.,* 1995), is tested. While the initial focus was aimed at finding rootstocks which offered some tolerance to PRR and/or improved yields the expansion of Westfalia Fruit into other countries has forced a more refined search for a rootstock which offer more benefits/advantages to a wider range of conditions.

Avocado growers are being forced to grow avocados in more marginal soils as prime agricultural land is swallowed up by housing and the expansion of urban developments, and as the demand for avocados has increased to 12 months of the year. Furthermore water is becoming a scarce *commodity*, consumers (or rather suppliers/supermarkets) are demanding that less agrochemicals are used to produce their produce so that they can offer more exclusive and "healthy" products. Growers are also faced with increasing labour, energy and fertilizer costs.

WTS is thus busy expanding its rootstock programme to include salt and cold tolerance, and this is also then paired with fruiting cultivar evaluations. During the rootstock testing phase (i.e. Experimentation phase) selections are grown from seeds obtained in an isolated breeding block which contains mother trees which are known to offer some PRR tolerance. Seeds are grown out and then exposed to PRR in a test unit dedicated for this purpose. Surviving selections are then cleaned up, the material is bulked up, and clones are made of the promising selection. This cloned material is then exposed to PRR again and compared to the commercial standard (which in South Africa is Dusa®). Any cloned material which looks superior to the commercial standard in terms of root health is then taken to field trials in which the material is grafted with 'Hass' and the first yield data is taken. Normally about 15 new rootstock selections would be compared against a commercial rootstock in such a trial. These trees are planted in soils with a long PRR history and no chemical intervention is offered after the first two years of establishment. After thorough field testing the most promising material in terms of yield and tree health is taken to larger pre-commercial trials (i.e. Demonstration phase) which are planted in various geographic areas, and under various management regimes. The WTS rootstock team will make regular visits to these trials sites to monitor any tree decline, and generally assist with tree establishment. Individual tree yield data is collected annually, as well as tree health, tree and fruit size. A few cartons of fruit from each rootstocks are also placed in storage to determine whether the rootstock has any effect on postharvest quality. The commercial control and test trees are made in the same nursery, at the same time and planted together for a more accurate comparison. The scion cultivar is always 'Hass' for the formal trials, but with the commercial release of 'Gem®' and 'Carmen®-Hass' in the last ten years additional trials have/will be planted to determine the rootstock that gives the best production when paired with the

various scion cultivars. A rootstock may take up to 20 years to proceed from "experimentation and demonstration" to a point where material can be commercialised. During this time WTS also prepares the necessary paperwork, including plant descriptions for Plant Breeders Right (PBR) applications, to assist with a smooth transition into commercialisation.

Salinity screening is still in its infancy at WTS and has to be confined to pot trials at this stage as there are very few (if any) current avocado orchards that have a salt problem within the main production (and research) regions. For field testing WTS has a rich history of exchange with other research bodies that do rootstock screening and this enables WTS to test their material under very different climatic and edaphic conditions. Similarly international testing partners can share their material with WTS and see how their material performs under South African conditions. In this way WTS was able to establish that Dusa® does fairly well in areas where salinity is a problem (e.g. California) (Menge, 2002; Crowley, 2004), and similarly that trees with Dusa® as the rootstock could still be productive when exposed to a certain degree of hypoxia (e.g. as found in certain soils in Chile which have poor drainage (FONDEF, 2005-2012), and as seen in Australia after various tropical cyclones caused flooding in orchards where Dusa® was planted). Further it is through the testing of rootstock material in various countries that growers can best determine whether the new rootstocks will offer them any benefits over the commercially available material available (Fernández Noguera *et al.,* 2011).

The discovery of a dwarfing rootstock, especially one that would impart some decrease in scion vigour, would be considered a "game changer". With increased competition between growers and countries the search for a rootstock that will lend itself to closer planting spacings, increased picking efficiencies, less costs in terms of the need for pruning and spray volumes needed to ensure good coverage for disease control would help growers to improve their margins significantly. The challenge at this stage would be to find a non-vigorous rootstock that can live in the presence of PRR and still be productive.

Shoots

In this article shoots refer to the tree and to orchard practices. The WTS team are involved in various aspects of orchard management and production issues. Firstly, the pathology team have to look after tree (and fruit) health. Westfalia Fruit orchards are commercially mulched as a rule. WTS has conducted many trials over the years (Mavuso, 2009; Mavuso, 2008; Mavuso & Willis, 2007) to determine what materials make a good mulch, and more so in years where a large percentage of orchards were managed "organically" (Duvenhage *et al.* 1993). Today most orchards are managed conventionally. Nevertheless the team are encouraged to have a holistic approach to orchard health and thus often work together to improve tree condition through evaluating various new fertilizers, biocontrol methods or agrochemicals for controlling both fruit diseases (Duvenhage, 1994; Duvenhage & Köhne, 1997; Duvenhage, 2002; Willis & Mavuso, 2009) and PRR (Bezuidenhout *et al.,* 1987a; Bezuidenhout *et al.,* 1987b; Duvenhage, 1999; Duvenhage, 2001). Further WTS test various pruning approaches, specific cultivar intricacies and a number of tree manipulation techniques (Bertling & Köhne, 1986; Bruwer & Robbertse, 2003). WTS are also investigating the application technology with which agrochemical are applied to determine if chemicals can be applied more efficiently, and using less water (Van Niekerk & Mavuso, 2011). Recently abiotic stress mitigation has also become a main focus point for the WTS team. Two approaches are currently under investigation: shadenets and chemical manipulation (Blakey *et al.,* 2014).

Fruit

Over the last 30 years South Africa has slowly made the transition from a green skinned dominated industry to producing more "Hass-like" cultivars (Bruwer, 2007; Bruwer & Van Rooyen, 2007; Bruwer & Mokgalabone, 2006). This was to fit in with global trends, and to enable Westfalia Fruit to remain competitive as the company was, and is, export driven. In the last decade there has also been a tremendous shift to adding value to fruit by serving the end customer with a "ready to eat" fruit. The "Hass-like" cultivars are perceived to handle shipping better (14 to 28 days), with their thicker, more robust, skins which also slightly masks any mis-handling during shipping and handling. Over the years WTS has tested over 100 cultivars both from South Africa and other countries around the world (e.g. Chile, USA, Spain, Australia, Mexico, and Israel). The search being for high yielding cultivars, with low disease susceptibility, good pack out, acceptable size, good storability, good shelf life and excellent eating quality. Further, a spread of cultivars is needed to enable Westfalia Fruit to provide its customers with fruit for 12 months of the year. The main avocado production areas of South Africa are located in subtropical conditions where winters are mild and the annual rainfall can often exceed one metre. Cultivars which are less affected by fungal infections are thus highly sought after.

As with the rootstock breeding and screening programme all cultivar screening at WTS follows the three steps laid out by Dr Hans Merensky, specifically: experimentation, demonstration and then finally commercialization. Successful selections may take anything between 15 and 20 years from first testing before being commercially released depending on what is known about the material when it is received. All material entering South Africa has to undergo a mandatory period of 12 to 18 months in quarantine before being released.

In the final stage of cultivar testing WTS will send test consignments to various international markets (e.g. Europe, and the United Kingdom) where various customers/supermarkets will get to test the cultivars in a taste panel. Furthermore, cultivars may be sent for professional organoleptic testing to gauge how well the cultivar will do if placed in the market at the same time as the traditional commercial cultivars. Westfalia Fruit's international ripening operations are then also given the opportunity to see how the cultivar does in their ripening facilities, and how easy the cultivar is to handle. In some instances technical support may be required from the WTS cultivar team to assist with determining, for example, the correct fruit firmness at which to label fruit as "ready to eat". From shipping simulations done at the WTS research facilities the team is able to make recommendations as to the correct shipping temperatures, and to the expected shelf life and quality that can be expected from the fruit as they mature during the season. This groundwork is pivotal to ensuring that avocado lovers around the globe are served perfectly ripe and attractive fruit from Westfalia Fruit.

Determining the right time to harvest fruit at the beginning of the season remains a challenge due to the prolonged flowering period of most cultivars (6-8 weeks), and to the fact that a certain threshold dry matter content does not guarantee that the fruit won't shrivel or render a poor

eating experience. WTS thus invested time and money into investigating the potential of near infrared spectroscopy (NIR) as a non-destructive tool for determining the maturity of fruit 1) while still attached to the tree (Blakey, 2014) and 2) to sort fruit "online" in the packhouse. The former as a guide to growers for determining which orchards were more advanced in maturity, but also to establish how wide the maturity range was on a tree/in an orchard and thus how best to selectively pick his/her crop. The online NIR was further tested to see how accurately it could predict the occurrence of certain disorders, with some success being achieved in correctly identifying grey pulp in ripe fruit, and orchard cold damage in freshly harvested fruit (Blakey, 2012).

CONCLUSIONS

Today Westfalia Fruit is a vertically integrated company dealing with all aspects of avocado production, processing, and marketing on a global scale. We owe our success to a man ahead of his time who dared to dream and make a difference. Who believed that patience was a virtue, and that greed should not come in the way of thoroughly testing new concepts and plant materials. A man who believed in being a good neighbour and farming responsibly. Dr Merensky's strategy: "Experimentation, demonstration and then commercialization".

LITERATURE CITED

Bertling, I & Köhne, JS 1986, Investigation into fruitset of avocado. South African Avocado Growers' Association Yearbook 9: 59-60.

Bezuidenhout, JJ, Darvas, JM, & Kotzé, JM 1987b, The dynamics and distribution of phosphite in avocado trees treated with phosetyl-Al. South African Avocado Growers' Association Yearbook 10: 106-108.

Bezuidenhout, JJ, Darvas, JM, & Toerin, JC 1987a, Chemical control of *Phytophthora cinnamomi*. South African Avocado Growers' Association Yearbook 10: 106-108.

Blakey, R 2012, Detection of pre-harvest cold damage in avocado fruit using an online near-infrared spectrometer. South African Avocado Growers' Association Yearbook 35: 76-78.

Blakey, R 2014, Semi-commercial testing of handheld NIR to determine avocado maturity (Progress report – Year 4). South African Avocado Growers' Association Yearbook 37: 44-46.

Blakey, R, Savage, M, Tesfay, S, Malapana, C & Mazhawu, E 2014, Reducing environmental stress to increase avocado yield and fruit quality. South African Avocado Growers' Association Yearbook 37: 66-68.

Bruwer, AT & Robbertse, PJ 2003, Flowering of avocado (*Persea americana* Mill.) as influenced by gibberellic acid treatments. Proceedings of V World Avocado Congress (Actas V Congreso Mundial del Aguacate 2003).

Bruwer, AT 2007, Evaluation of the Hass-like avocado cultivars Harvest, Gem and Grace. South African Avocado Growers' Association Yearbook 30: 32-33.

Bruwer, AT & Mokgalabone, ML 2006, Evaluation of the Hass-like avocado cultivars Harvest, Gem and Grace. South African Avocado Growers' Association Yearbook 29: 41.

Bruwer, AT & Van Rooyen, Z 2007, Performance and market acceptability of the Hass-like cultivars Gem and Harvest in South Africa. Proceedings of VI World Avocado Congress (Actas VI Congreso Mundial del Aguacate 2007).

Crowley, D 2004, Salinity tolerance in avocado. Proceedings of the California Avocado Research Symposium, October 30, 2004, pp, 108-111.

Duvenhage, JA 1994, Monitoring the resistance of *Phytophthora cinnamomi* to Fosetyl-Al and H3PO3. South African Avocado Growers' Association Yearbook 17: 35-37.

Duvenhage, JA 1999, Biological and chemical control of root rot. South African Avocado Growers' Association Yearbook 22: 115-119.

Duvenhage, JA 2001, Efficacy of H3PO3 leaf spray and resistance of *Phytophthora cinnamomi* to H3PO3. South African Avocado Growers' Association Yearbook 24: 13-15.

Duvenhage, JA 2002, Evaluation of new generation fungicides for control of Cercospora spot on avocado fruit. South African Avocado Growers' Association Yearbook 25: 11-14.

Duvenhage, JA & Köhne, JS 1997, Biocontrol of root rot in avocado orchards and monitoring for resistance o *Phytophthora cinnamomi* to phosphites. South African Avocado Growers' Association Yearbook 20: 116-118.

Duvenhage, JA, Köhne, JS & Kirkman, B 1993, The influence of organic amendments and discontinuation of chemical root rot control on tree condition and yield of avocado. South African Avocado Growers' Association Yearbook 16: 75-76.

Fernández Noguera, C, Van Rooyen, Z & Köhne, JS 2011, Reasons for the use of clonal avocado rootstocks around the world. Proceedings of VII World Avocado Congress (Actas VII Congreso Mundial del Aguacate 2011).

FONDEF, 2005-2012. Proyecto FONDEF D04I1346. 2005-2012. Evaluación agronómica y propagación de nuevos portainjertos y variedades de palto en distintas zonas agroclimaticas de Chile. Facultad de Agronomia, Ponteificia Unversidad Católica de Valparasio.

Kremer- Köhne, S, Van Rooyen, Z & Köhne, JS 2011, Avocado rootstock evaluation techniques over the last 30 years. Proceedings of VII World Avocado Congress (Actas VII Congreso Mundial del Aguacate 2011).

Mavuso, Z & Willis, A 2007, Effect of different mulch materials, composts and organic treatments on tree condition and root health. South African Avocado Growers' Association Yearbook 30: 21-25.

Mavuso, Z 2008, Effect of different mulch materials, composts and organic treatments on tree condition and root health. South African Avocado Growers' Association Yearbook 31: 32-35.

Mavuso, Z 2009, Effect of different mulch materials, composts and organic treatments on tree condition and root health. South African Avocado Growers' Association Yearbook 32: 6-9.

Menge, JA 2002, Screening and evaluation of new rootstocks with resistance to *Phytophthora cinnamomi*. Proceedings of the California Avocado Research Symposium 2002, pp. 55-59.

Roe, DJ, Kremer- Köhne, S, Köhne, JS 1995, Local and imported avocado rootstocks in South Africa. Proceedings of III World Avocado Congress (Actas III Congreso Mundial del Aguacate 1995).

Van Niekerk, JM & Mavuso, Z 2011, Ultra-low volume fungicide applications for the control of diseases on avocado – A three year review. South African Avocado Growers' Association Yearbook 36: 64-68.

Willis, A & Mavuso, Z 2009, Alternative control of Cercospora spot on 'Fuerte' – progress report. South African Avocado Growers' Association Yearbook 32: 64-66.

ACTAS · PROCEEDINGS

VIII CONGRESO MUNDIAL DE LA PALTA 2015

del 13 al 18 de Septiembre. Lima, Perú 2015

www.wacperu2015.com

PERÚ ProHass

ASOCIACIÓN DE PRODUCTORES DE PALTA HASS DEL PERÚ