CROP PRODUCTION PROGRAMME

Crop production programme research strategy

The research conducted in the crop production programme is primarily focused on the following areas stated in the strategy plan:

a. Production efficiency (volume of exportable fruit per unit area) through the use of rootstocks, technology and data systems
b. Climate change mitigation and water productivity
c. Plant material quality and availability.

Current crop production research needs per theme

(High priority research needs are in bold)

1. Rootstock research

1.1. **Evaluate stone fruit rootstocks and scion cultivars for salinity tolerance.** Rootstock assessment: Utilise a recently completed rootstock evaluation trial and induce salinity stress by fertilising with salt. Scion assessment: Plant the most important scions at a suitable site, all on the same rootstock. Induce salinity stress by fertilising with salt. Consult technical advisors on which scion cultivars to include. A soil scientist should be involved or consulted on the project.

1.2. **Quantify the cost of WAA, stem canker and nematode infestation in terms of impact on productivity using a threshold approach**. Stem canker might be the easiest to study since it is possible to infect trees next to uninfected control trees.

1.3. **Develop a screening procedure for incompatible and brittle apple graft unions, especially for new scion cultivars.** Consult technical advisors as well as plant improvement organizations on which rootstock and scion combinations to assess. Use a published protocol.

1.4. Use Rosemarie Select as scion when new pear rootstocks become available for evaluation.

2. Irrigation and nutrition research

2.1. **A multi-disciplinary project is required to investigate the effect of plant/soil water status (under, optimal and over irrigation) and different irrigation practices such as pulsing irrigation to mitigate the effect of heat waves in apples and plums. The effect on internal heat damage (plums) and sunburn should be determined. The relationship between plant water status and shrivel susceptibility in plums can also be assessed as part of this project.** Consult with the programme manager during the conceptualization of this project. Separate proposals can be submitted for the two fruit types. The project will require further scoping before finalization.

2.2. **Assess the effect of an over irrigation regime and flooding during the harvest time on tree physiology, production and growth, nutrition, fruit quality, profitability, postharvest storability and disorders etc.** Conduct the research on a ‘Cripps Pink’ clone such as ‘Rosy Glow’ or ‘Lady in Red’. The project will require further scoping before finalization.

2.3. **Determine the water use of peach/nectarine and cherry orchards.** These studies are dependent on funding by the Water Research Commission and proposals should only be submitted in response to WRC open calls.

2.4. **Mine Fruitlook data and production data of grower groups to determine variances in regional water use of different crops as well as in water productivity.** In addition to deciduous tree crops, the study can also include table and wine grapes as well as citrus. The study should be done in collaboration with the research team at the WCDoA, Elsenburg. Prof Stephanie Midgley can be consulted.

2.5. Assess the effect of an over irrigation regime on the growth performance and physiology of newly planted apple trees.

2.6. Test the available range of microtensiometers for use in irrigation scheduling based on plant water status.

2.7. Investigate the effect of rootstock/interstem/scion physiology on the response of apple trees to water deficit. Utilise the completed apple rootstock evaluation sites at either Oak Valley or Breëvlei.

3. Dormancy research

3.1. **Utilize the ProHort ecophysiology platform to investigate the effect of autumn, winter and growing season conditions on bud and flower quality, fruit anatomy/density and size, and storability.** The results generated can be tested against historic industry fruit size distribution data. This is seen as a potential PhD project, which will require further scoping before finalization. Also falls under Growing Season Climate.

3.2. **Study the effect of rootstock, scion and climate on dormancy progression, cambial/vascular reactivation, and auxin transport.** The study could also assess the differences in growth habit/tree architecture induced by rootstocks as well as root growth. Potentially utilize apple rootstock evaluation sites where data collection has come to an end and/or potted trees grafted on a range of rootstocks to study the effect of rootstock. Potentially utilize the different apple genotypes planted in the ProHort ecophysiology platform to study the effect of contrasting climates and scions. The study may consist of more than one project and is potentially suitable for multiple postgraduate students and will need to be scoped prior to finalization.

3.3. **Study the effect of autumn temperatures on endodormancy induction in apple using potted trees.** A molecular approach may form part of this project.

3.4. Study the role of the fermentation pathway in dormancy release.

3.5. Determine temperature thresholds for root growth of various apple rootstocks. The ProHort ecophysiology platform and the Louterwater Granny Smith plantings (winter 2023) in low chill areas could be utilized. This could also form part of 3.2.

4. Growing season climate research

4.1. **Quantify the effect of heat stress on sunburn, productivity/carbon cost and fruit quality.** We envision a collaborative project with Prof Lee Kalcsits of the Washington State Tree Fruit Research Centre. The project will utilize the ProHort ecophysiology platform.

4.2. **Develop suitability maps for important existing pome and stone fruit cultivars in different regions and microclimates.** The aim of this project would be to provide producers/grower groups with high-resolution spatial maps indicating the best localities to plant these cultivars. The models will be developed using existing knowledge on the performance parameters of the cultivars in question and overlayed with current orchard performance data to ground truth. Please consult with the crop production programme

manager and with relevant technical experts in terms of which cultivars to include. It is recommend to start with a single apple, pear and plum cultivar. The project will require further scoping before finalization.

4.3. **Investigate the possibility of developing suitability maps for new, high-potential cultivars.** Include cultivars for which Provar has evaluation data available in multiple climatic regions. Cultivar licencees will need to be consulted and permission will need to be obtained to include cultivars in the study. The rest of the study will be similar as decribed for 4.2.

4.4. **Develop crop suitability maps for various crops that could be grown in traditional deciduous fruit production areas.** Emphasis should be on those crops that will fit in best with current infrastructure. Indicate change from current suitability to 30 years in the future. Detailed climatic requirements/thresholds of different fruit types will be required to develop the maps. Further scoping will be required before the finalization of the project.

4.5. **Verify the research of I Kritzinger on the effect of cuticle composition and hypodermis anatomy on shrivel susceptibility using a range of susceptible and tolerant plum cultivars.**

4.6. **Study the effect of climate, harvest maturity, canopy position, shade nets and superficial sunburn on cuticle development and hypodermis anatomy related to susceptibility to shrivel in plums.** The project could utilize the ProHort ecophysiology platform to study the effect of climate and genetics on cuticle development and shrivel susceptibility.

4.7. **Investigate the effectiveness of sunburn protectants such as Raynox, Deccoshield etc. under existing shade nets.**

4.8. **Study the pre-harvest factors that contribute to the development of lenticel breakdown.** Use Nicoter apples. Assess the Dutoit risk assessment tool for bitterpit development in Golden Delicious for use to identify orchards susceptible to lenticel disorders. Determine the effect of climate on lenticel development. Study the role of fruit position in the canopy on lenticel defects.

4.9. Study the effect of flat nets with open or closed sides on orchard, canopy and fruit temperature and relate to the incidence of heat damage in plums and sunburn/green pigment loss in apples.

4.10. Determine the impact of climate on fruit texture (fruit anatomy and physiological defects).

4.11. Mine the FEMA database for factors that can affect maturity.

5. Farming technology research

5.1. **Identify and visualize variation between trees in orchards as relating to fruit quality and maturity. i) Establish effect on variability in postharvest quality and disorder incidence. ii) Use the information generated to inform selection of trees to use for MI sampling. iii) Assess the usefulness of measures to decrease variation.** The project will require further scoping before finalization.

5.2. **Conduct a preliminary study in the main pome fruit production regions using TerraClim data to identify the most suitable sites for select apple and pear cultivars based on the site-specific data of highly productive orchards.** Consult with technical advisors as to which cultivars to include in the study. Potentially combine with a study aimed at identifying the most productive/profitable orchards of different fruit types in the different regions or at different packhouses and analyse the orchard components that contribute to performance. Also see 4.2. The project will require further scoping before finalization.

6. Reproductive biology research

6.1. **Assess the effect of leaving fruit on young trees on dwarfing and semi-dwarfing rootstocks on growth performance**. The study should include a physiological component aimed at explaining the results observed.

6.2. **Assess the effect of late growth on return bloom and fruit storability in a Gala type apple.** Consult the completed project of Dr X Siboza on prohexadione application and regrowth in Fuji apple as starting point. Assess the effect of later prohexadione applications.

6.3. Study bee activity under nets.

6.4. Develop a future scenario plan for pollination under reduced availability of bees.

CROP PROTECTION PROGRAMME

Crop protection programme research strategy

The research conducted in the crop protection programme is primarily focused on the following area stated in the strategy plan:

a. Market access and management of phytosanitary and invasive pests and diseases.

The framework below addresses the current needs of the industry and therefore should not be regarded as comprehensive. Emphasis has been placed on aspects such as biological control and non-chemical control of pests and disease. Furthermore, research which allows for the integration of management methods is encouraged. The development of appropriate beneficial technologies for the pome and stone fruit industries is vital, and the industry is more than willing to support the research and development of such technologies.

Current crop protection research needs per theme

(High priority research needs are in bold)

1. Integrated pest management

1.1. **Loss of registered pesticides: The loss of pesticides (deregistration) and the integration of alternatives is critical.**
1.2. **Assess results of the preliminary research on polyphagous shot hole borer and conduct additional research if needed**. Research framework is available.
1.3. Phytophagous mites are an increasing problem in the industry. The failure of biological control in orchards and the use of biological agents to manage mites needs to be assessed.
1.4. Quantification of the impact of pests, i.e., woolly apple aphid and nematodes on production.
1.5. Development of a framework to produce organic or low residue fruit.

2. Nematology

Research is currently in progress on nematode susceptibility of rootstocks and cover crops. EPN research is also ongoing. However, evaluation and integration of the use of EPN's into integrated pest management programmes is needed i.e. banded fruit weevil and mealybugs.

3. Plant pathology

3.1. ***Rosellinia*** in orchards is an ongoing problem especially in the Langkloof. To date no fungicides have been registered locally.
3.2. Quantification of the impact of pathogens, i.e., stem cankers on production.
3.3. Postharvest decay control using alternatives (commercial products). Assessment needed.
3.4. Effects of orchard management practices on postharvest pathology.
3.5. Pack shed sanitation methods need to be assessed and improved.
3.6. Alternative treatments during blossom to replace lost insecticide chemistry.

4. Phytosanitary and biosecurity

4.1. **The use of methyl bromide has been suggested as a phytosanitary measure for pome export markets. The effects of the treatment on organisms of phytosanitary importance and on fruit quality need to be assessed.**

4.2. **Mite contaminated fruit entering packhouses is a major concern. Conduct a comprehensive study and include aspects such as miticide resistance, biological control and rapid identification methods.**

5. Orchard soil ecology

5.1. **Water use by cover crops and the ability to grow them in very dry areas i.e., using drip irrigation. Also assess cover crop nutrient needs and nutrient dynamics in orchards with cover crops.**

5.2. **Conduct a cost benefit analysis on the use of cover crops.** Emphasis must be placed on estimating the costs of establishing cover crops and accrued benefits over time i.e., nutrients and ecosystem services.

5.3. **Assess the effects of cover crops on young tree performance.**

5.4. **Conduct a study on the carbon footprints of orchards over their lifetime.** In-orchard measurements are needed and other nutrients and factors need to be measured. The fate of carbon and ecological status of soils during replant of an orchard was also raised. This project can form part of an orchard of the future project aimed at maximizing soil carbon levels.

5.5. **Evaluate weed management strategies following an integrated approach.**

5.6. Determine the impact of diversity (both animal and plant) on soil ecology in relation to fruit production and sustainability. It was noted that due attention should be paid to management.

5.7. Assess and analyze the physical management of cover crops. Machinery to either cut, cultivate or roll cover crops and or weeds in the tree row (under trees) is needed. In addition, machinery is needed to transfer cut plant material from the work row to under the trees as a mulch.

6. Precision agriculture

6.1. Electronic data collection, analysis and dissemination of information.

6.2. Use of remote sensing and associated techniques to detect amongst others, tree stress, fungal and insect infestations. Could be used to identify trees in orchards or in the vicinity of orchards infested with PSHB.

6.3. Develop spray application guidelines for the pome and stone fruit industries.

6.4. There is need to quantify the persistence of chemical residues under nets and the possible accumulation of chemical residues on nets.

POSTHARVEST PROGRAMME

Postharvest programme research strategy

The research conducted in the postharvest programme is primarily focused on the following area stated in the strategy plan:

a. Maintenance of postharvest quality and reducing risk throughout the value chain
b. Finding effective replacements for plastic packaging

Current postharvest research needs per theme

(High priority research needs are in bold)

1. Defects research

Pome fruit

1.1 **Quantification of inter- and intra-tree variation and the effect thereof on storability and incidence of disorders.** Also see Crop Production 5.1.

1.2 **Utilize the ProHort ecophysiology platform to study the effects of autumn, winter and early spring climate on flower quality and fruit internal quality, and these effects relate to storability and susceptibility to defects.** See Crop Production 3.1.

1.3 Further investigate humidity control and the impact it has on disorders like lenticel breakdown.

1.4 Role of climate prior to and during fruit development on pear susceptibility to corky spot.

Stone fruit

1.5 **Assess the effect of plant water status/irrigation strategy on the incidence of pitburn/heat damage in plums**. This is a physiological study with opportunity to involve postgraduate students. See Crop Production 2.1.

1.6 Utilize the ProHort ecophysiology platform to study the effect of winter conditions on fruit internal quality and susceptibility to defects as related to protracted bloom, flower quality and mixed maturity. The effect of winter conditions on fruit size, especially on the high chill stone fruit cultivars should also be assessed. See 1.2 above and also Crop Production 3.1.

2. Quality management research

Pome fruit

2.1 **Study the link between climate and TA levels in pears (Forelle and Packham's Triumph). Also assess the effect of TA levels storability and quality during shelf-life.** Sensory and consumer studies will be required. Hortec's database on FEMA pears could be used to investigate the link between TA and other quality parameters**.**

2.2 Determine the physiology behind the mechanism of step down cooling in preventing/reducing the incidence of internal browning in apples.

2.3 Study how better relative humidity management during storage may affect green colour retention in Golden Delicious and Granny Smith. Learn from the management of Conference in Europe.

2.4 Determining how tree variability influences green colour variability and whether selective harvesting could improve the situation. Is it more of an issue in warmer compared to colder winters with more condensed flowering?

2.5 Assess packhouse and cold store compliance with protocols – similar to the project for fungicide application in stone fruit packhouses

2.6 Determine how flower quality relate to fruit storability? See 1.2 above and also Crop Production 3.1.

2.7 "Blue sky" research – look at ways to remove ethylene blockers so that pear fruit can ripen.

Stone fruit

The focus area in this theme is management of shrivel. See 3.2 below and Crop Production 2.1, 4.5 and 4.6 for research needs.

2.8 **Determine the effect of mixed maturities, crop load and rootstocks on shrivel incidence**.

3. Packaging and logistics research

3.1. **Evaluate non-plastic packaging.** Assess effect on fruit quality.

3.2. **Determine the effect of packaging with or without plastic liners on fruit quality in pome and stone fruit**. Quantify effect on value, weight loss, yellowing and shrivelling.

3.3. **Ground truth the models developed by the SARCHi research team and optimize as necessary**.

3.4. **Assess the new load shedding loading dispensations.** This project will be dependent on the outcome of 3.3.

3.5. **Reinitiate carton testing with the aim of developing a carton certification method.** The project should explore the option of renting CRI's carton testing machine or otherwise build a new machine for the deciduous fruit industry.

4. Storage techniques research

4.1. Evaluate DCA storage on cultivars like Fuji, Braeburn and Cripps' Pink.

CHERRY RESEARCH GAPS

1. Evaluate alternative postharvest decay control options for use in the packhouse.
2. Cold sterilisation of fruit infested with fruit fly larvae for export to phytosanitary markets.
3. Identify the best adapted and most yield efficient rootstocks for different regions and planting systems.
4. Evaluate rootstocks for tolerance to diseases such as crown rot, white rot, etc.