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Plant Quality Control in Action!

Sabine Suess

Natural Area Nursery, Workshop Rd, Whiteman Park, WA 6068, Australia

sabinesuess@hotmail.com.au

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Abbreviations:

AFP: Air Filled Porosity
EC: Electrical Conductivity
IPM: Integrated Pest Management
NACMS: Natural Area Consulting and Management Services
NGIQ: Nursery and Garden Industry Queensland
NIASA: Nursery Industry Accreditation Scheme Australia
WHC: Water Holding Capacity

Summary

The aim of this paper is to describe my role as Plant Yield Coordinator at Natural Area Nursery, Western Australia in maximising plant yield and optimising water management. The key areas described range from monitoring and identifying areas of concern, water management, determining and implementing actions, documentation, to research and development. The focus is on the role's integration with the nursery team, and practical ways adopted in the overall application. Results achieved include improved plant quality, reduced plant losses and better water management. In addition, the approach allowed for early targeted action, with the ability to be proactive and optimise resources. Consequently, in many areas of nursery operations the efficiencies were able to be improved. At the same time, documentation and research continually is being refined and allows for analysis and improvement of future procedures and management decisions. Finally, the broader benefits of a closely forged and self-driven team are realised.

INTRODUCTION

This paper describes my role as Plant Yield Coordinator at Natural Area Nursery in Western Australia (Natural Area Nursery, 2024), its key aspects, and anticipated outcomes. Natural Area Nursery (**Fig. 1**), is a part of our company Natural Area Consulting and Management Services, located in Whiteman Park, Western Australia. The company provides environmental rehabilitation services, with teams in consulting, projects, seed, field work, animal management and the nursery.

The nursery is NIASA accredited and produces native plants for our own teams and their projects, and sells directly to clients for revegetation and landscaping.

Plants are produced seasonally, with most plants dispatched within three months in Autumn and Winter. The nursery currently dispatches approximately 1.2 million plants annually. The nursery's capability and specialty are to produce over 600 species and provenance specific stock. Many of the wide range of species are recalcitrant and difficult to propagate. The origin of the plants is traceable, and plants are grown from pure seed, avoiding hybrids.

Water is supplied by a bore, and overhead irrigation. The nursery has open areas using benches and pallet areas, and has several buildings specialised for various growing environments. The large diversity of plants, various pot sizes, growing media, and growing stages present challenges to balance all their care. Many variables for their growing requirements must be considered such as nutrition, growing media, water, sunlight, wind, and temperature exposure.

At the time of writing, the nursery is operated by 12 permanent staff, which increase up to 18 staff during peak production with the addition of a flex team. The area of open irrigation space and buildings amount to approximately 21,000 m^2.

Figure 1: Natural Area Nursery (Photo Matt Wood NACMS).

PLANT QUALITY STORY AND THE INTRODUCTION OF PLANT YIELD COORDINATOR ROLE

Production numbers were a focus previously, however with time, a need to reduce plant losses and improve quality was recognised. In addition, water conservation became crucial. With all this in mind, the Plant Yield Coordinator Role was introduced. The role's principal focus areas were maximising plant yield and optimising irrigation management. The anticipated outcomes included improved nursery efficiency and productivity, solid plant quality and refined water efficiency. It is important to emphasize that Quality Control is a team effort, to which all personnel contribute. However, the role of Plant Yield Coordinator was developed to allow early targeted action, being proactive and optimizing our resources. In essence, being the eyes for the nursery, helping the manager and team to prioritise tasks to avoid undesired outcomes. The Plant Yield Coordinator role involves the key aspects listed in **Table 1**, which are described in further detail.

Table 1. Key aspects of plant yield coordinator's work

- Monitoring of stock, infrastructure, and procedures
- Management of water and reticulation
- Implementation of actions by liaising with teams
- Documentation
- Research and development

Monitoring of Stock, Infrastructure, and Procedures

To begin with, areas of concern need to be detected and identified by performing regular surveillance or scouting. For this to occur, allocation of a regular scheduled time to monitor and assess is crucial.

Detailed Surveillance or Scouting

My approach has been adapted from Greenlife Industry Australia's (GIA) excellent information on the execution of various types of surveillance (GIA, 2024 a, b, c). A wealth of nursery best practice procedures is available on their website under the title technical information: Australian Plant Production Standard (APPS) https://nursery-productionfms.com.au

For surveillance, I walk through the nursery in a pattern to sample areas randomly, including areas at risk or of high value. Some of the scouting walks are shorter and focused on solely assessing water requirements. Other walks are more detailed with surveillance of many areas of the nursery. The water assessment walks are performed more frequently compared to the detailed surveillance.

For detailed surveillance I carry necessary equipment with a toolbelt, as listed in **Figure 2**. Any problem areas noted I record on my clipboard or electronic device for later decision making on required actions. **Table 2** lists examples monitored in detailed scouting procedures regularly.

Table 2. Detailed scouting focus areas.

- Note areas experiencing losses
- Detect hybrids, species corrections, labelling errors
- Check infrastructure problems
- Manage environment of buildings
- Check biosecurity and hygiene (perimeter, disinfestation and hygiene procedures, water and growing media testing)
- Check media moisture and plant stress (short- and long-term watering balance)
- Investigate plant health problems (detection and diagnostics)
- Detect weed focus areas (stock, ground, perimeter)
- Check production technique (potting up, cuttings technique)
- Detect pest animals or wildlife (identify type of animal involved)

Note Areas of Plant Losses

Noting areas of plant losses assists to update and accurately count stock. In addition, this allows actioning prompt removal of empty pots, which in turn results in improved pest and weed control, and optimising space.

Detect Hybrids, Species Corrections, Labelling Errors

Early detection of errors in species purity and accuracy again assists to maintain an accurate count in stock, and reduces grading pressures later in the period of dispatch.

Check Infrastructure Problems

Detecting problems with buildings or surrounds such as erosions, leaks, and damage to structures, allows early addressing of the problem. This aids in reducing costs, improving safety, and staying abreast in maintenance and repairs.

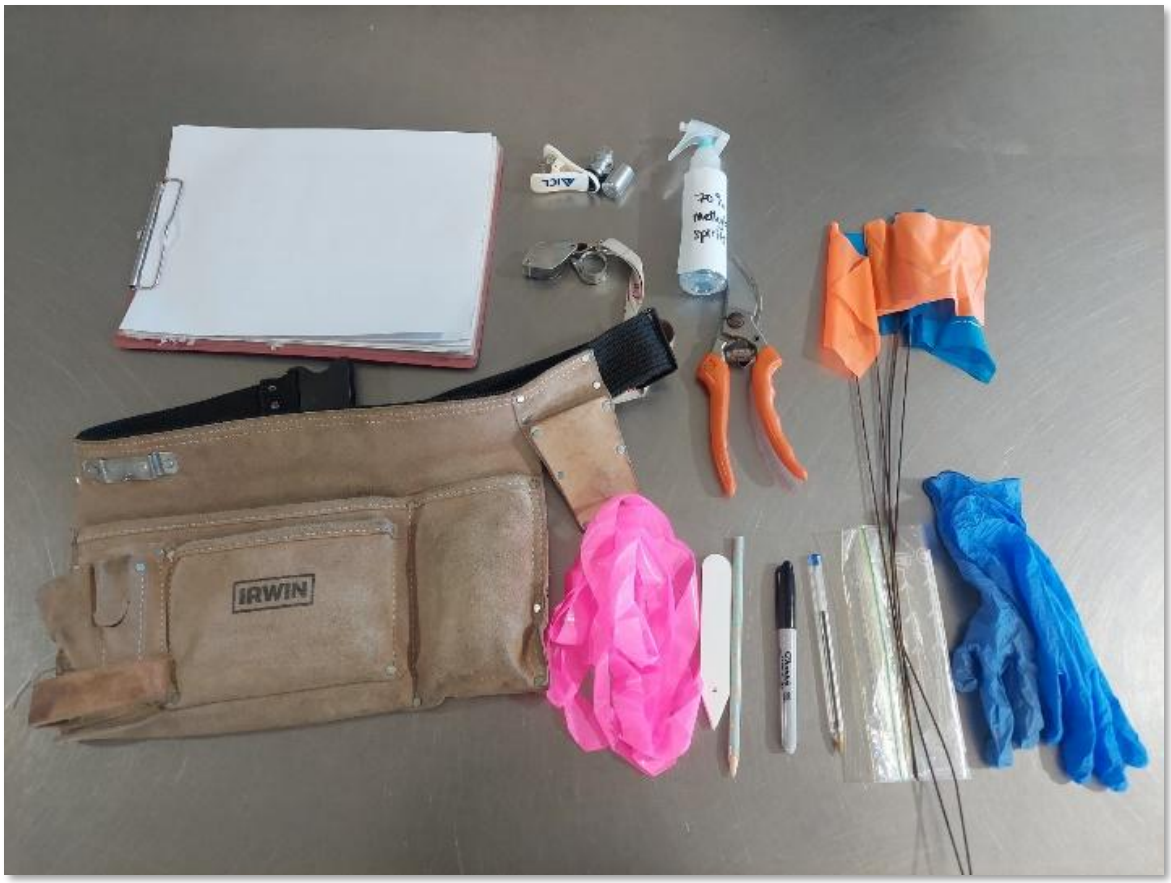

Figure 2. Equipment carried during my detailed scouting walks. (Photo Sabine Suess NACMS). These include: Recording equipment (clip board or electronic device), marker pen, white sheet of paper or plastic, plant tags, coloured markers or flags, disinfectant, gloves, secateurs, sample jar/zip lock bag, magnifying loupe, magnifying lens for camera, mobile phone with camera.

Manage Environment of Buildings

Part of my role is to manage the internal environment of production buildings. Several buildings are equipped with automated or manually regulated features. This may involve operating retractable shade roofs, or sides, and doors. Our cuttings building is highly automated, with light, humidity, and temperature sensors regulating automated fans, a wet-wall and shade curtain. Regular monitoring, maintenance and trouble-shooting of building function and environment ensures optimal conditions for the plants.

Check Biosecurity and Hygiene

Monitoring biosecurity and hygiene includes assessing areas such as entrance, exit and perimeter control. In addition, disinfestation, and hygiene procedures, and testing of water quality and growing media quality are all integral in reducing the risk of introduction and spread of disease and weeds.

Check Media Moisture and Plant Stress

As we produce native plants for the purpose of natural area revegetation and landscaping, it is important the plants are hardened to survive in the harsh West Australian environment. Therefore, minimizing overwatering is essential, nonetheless watering ac-

cording to their need. I visually and physically test random areas and known trouble spots throughout the nursery, including edges exposed to wind or reduced water. Some of the techniques used to assess optimal water applied are summarized in **Table 3** and shown in **Fig. 3.**

Table 3. Visually and physically checking media moisture and plant stress.

- Visually check media surface
- Assess entire growing media moisture by removing plant from pot
- Check for plant wilting or rotting
- Check for chronic overwatering signs (moss, algae, liverwort, fungus gnats)

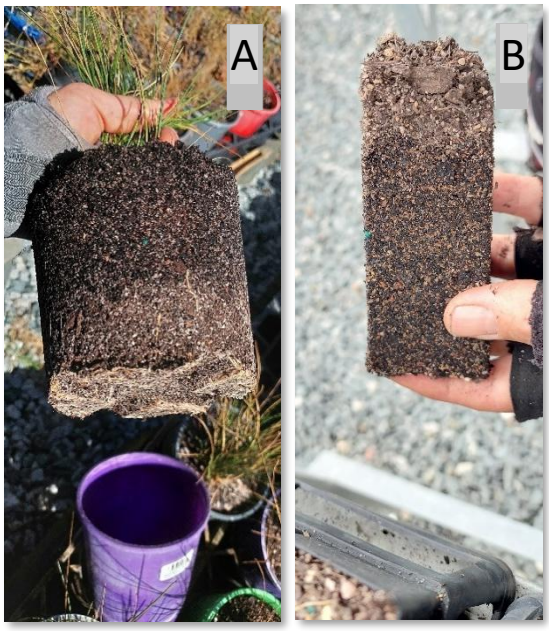

Figure 3. Assessing media moisture by removing plant from pot. **A.** 140 mm pot, **B.** Forestry Tube (Photos Sabine Suess NACMS).

Investigate Plant Health Problems

Again, my approach has been adapted from the excellent resource GIA (2024 a, b, c), where crop monitoring and site surveillance is described in detail. When I encounter an area of plant health concern, I check for patterns in areas such as listed in **Table 4**. For example, identifying whether factors such as weather condition on the day of production, origin of the seed/cutting, or operator technique, could be a common denominator. Additionally, examining aspects such as positioning relative to wind, water, sun, and proximity to other plants. Some plants may need to be spaced, trimmed, or moved to a more suitable location. Examining media moisture is naturally essential to identify problems in water application.

Table 4. Plant health investigation factors.

- Date Potted, Provenance and Potter ID
- Positioning relative to wind, sun, water, other plants
- Moisture of pot and root health
- Check foliage and stem health
- Check presence of weeds
- Check soil pH and EC, AFP, WHC
- Laboratory sample analysis

A full examination of the entire plant including roots is helpful, and looking with the assistance of magnification, such as referred to in **Table 5** and **Fig. 4**. Sometimes pests in foliage difficult to detect can be dislodged by gently beating the plant against a white sheet, GIA (2024, a, b, c).

Table 5. Magnification options.

- 10 x magnifying loupe
- Macro settings on camera/phone
- Attachable macro lens for phone
- Microscope

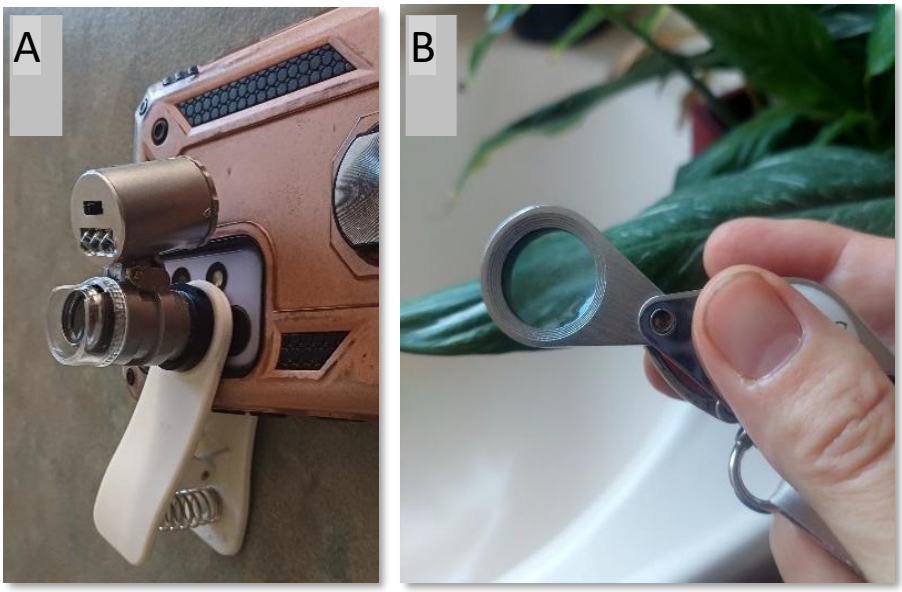

Figure 4. Useful field magnification options **A.** Lens attachment and mobile phone camera **B.** Hand-held loupe 10 x magnification. (Photos Sabine Suess NACMS).

If an unknown pest or disease is encountered, a sample is collected for further analysis under a microscope. Correctly identifying the type of pest or disease allows targeting the problem promptly and develop sound IPM management. In addition, a database of plant species and time of year affected by certain pest or disease pressures can be determined.

In Western Australia, photos and a description of a pest or disease can be submitted to the MyPestGuide Reporter App (https://www.agric.wa.gov.au/apps/mypestguide-reporter or email mypestguide@dpird.wa.gov.au). Another useful resource for pest identification is the NGIQ Pest Identification tool (https://pestid.com.au/).

If the cause of the plant's problem still cannot be found, then I consider further tests such as soil pH, EC, and even AFP and WHC. If needed, a sample could be submitted to an external laboratory for analysis.

Detect Weed Focus Areas

Keeping weeds under control is crucial for efficiencies and plant quality. We found it useful to do what we affectionately call "Power weeding": Rapid hand weeding of the entire nursery, within at least 2 weeks, targeting to remove weeds that go to seed within that time. This is an approach adapted from the excellent management plan for weeds in production nurseries by Conroy and Manners (2020), and article by Barker and Neal (2016).

Any weed focus areas and infestations are then marked with a coloured tag or flag for a team to deal with separately. This strategy ensures the whole nursery is weed controlled in a time-efficient manner and allows a targeted effort where it is needed.

In our strategy, weeds in the ground and perimeter are key areas to control, to prevent spreading into stock. Common rapidly growing and seeding weeds targeted in our nursery include *Cardamine hirsuta*, *Euphorbia maculata* and *Gnaphalium spp.*

We also focus aggressively on *Marchantia polymorpha* and *Sagina procumbens*, as they are difficult to treat once established. These weed examples are displayed in **Fig. 5.**

Any stock plant that begins to develop mature seed is a risk also; it is important seed is trimmed or harvested before contaminating other stock species or the ground. Targeted pre-emergent treatments are used where appropriate to reduce weed pressures. The main points in our weed control are summarized in **Table 6.**

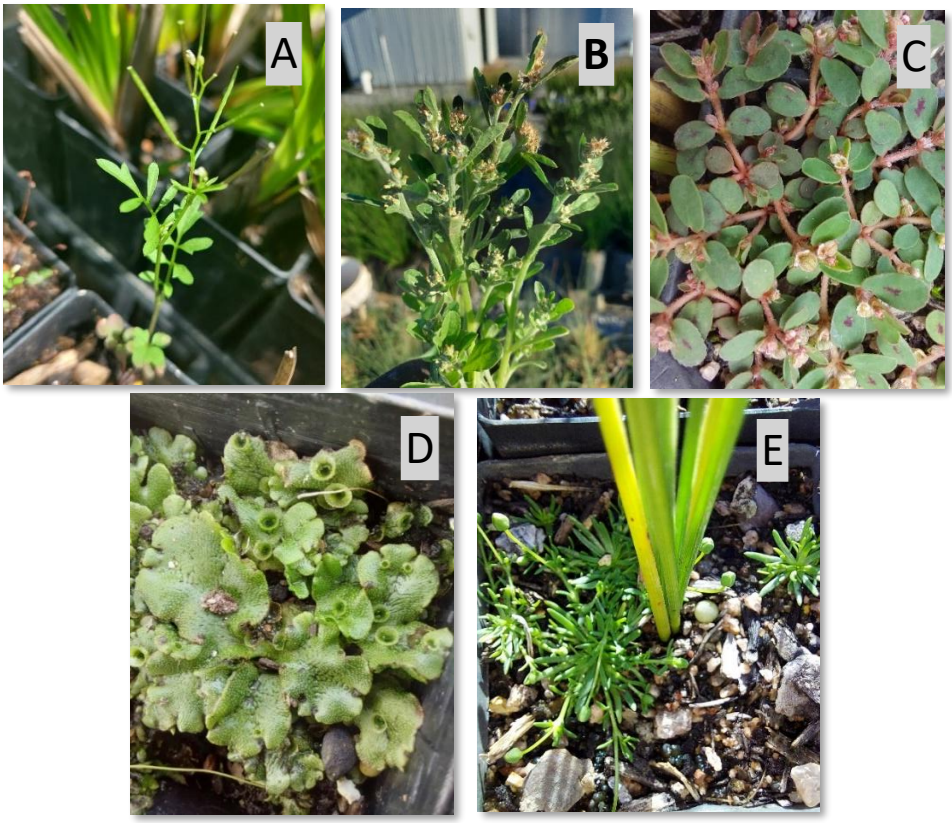

Figure 5. Common weeds of priority in our nursery **A.** *Cardamine hirsuta* **B.** *Gnaphalium spp* **C.** *Chamaesyce maculata* **D.** *Marchantia polymorpha* **E.** *Sagina procumbens* (Photos Sabine Suess NAMCS).

Table 6. Our weed control focus areas.

- Focus aggressively on weeds likely to go to seed within 1-2 weeks, spread rapidly or are difficult to treat
- Use of coloured flags or markers for infestations for targeted control
- Seeds from stock can become invasive and should be harvested
- Ground weed control is crucial
- Targeted pre-emergent herbicide as appropriate

Check Production Technique

As part of investigating plant health problems, I monitor production technique, as per summary in **Table 7** and **Fig. 6**. This allows early action to educate staff or correct the problem where appropriate. Production techniques affect plant growth, survival and growing standard requirements.

Figure 6. Example of production technique problem – "J roots". (Photo Sabine Suess NACMS).

Detect Pests Animals or Wildlife

Pests or wildlife encountered include rats/mice, rabbits, kangaroos, southern bandicoots, and birds. Animals chew on plants, remove seedlings or seeds, pull out tube stock or disturb soil in seed trays and large stock. Determining the animal pest or wildlife culprit as the cause of damage can be difficult. Early detection and identification allow correct and appropriate action.

We use a multimodal approach to investigate the cause of the plant damage, listed in **Table 8**. Again, a database of plant species and time of year for certain animal pressures can be established.

Table 7. Production technique.

▪ Potting up technique such as J roots, depth of potting, trauma to roots ▪ Angle of plant stem, branching/growth pattern ▪ Cutting preparation and sticking technique

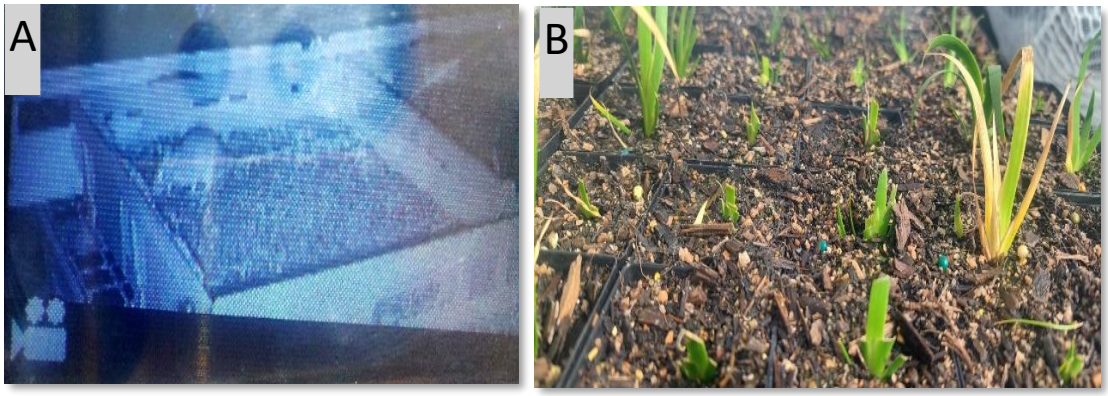

Figure 7. Examples of evidence of animals affecting plants **A.** Motion triggered camera image of a rodent in a seed tray. **B.** Suspected damage from a rabbit to *Machaerina preissii* seedlings. (Photos Sabine Suess NACMS).

Table 8. Methods for detecting and identifying pest animals or wildlife.

▪ Motion triggered cameras ▪ Trapping ▪ Chew/damage pattern, plant species targeted ▪ Scats ▪ Nests ▪ Perimeter walk to check breaches to barrier and tracks

Management of Water and Reticulation

Managing water and reticulation is part of my role. A summary of work related to this role is listed in **Table 9**. Water is becoming an increasingly precious resource, in addition, optimising water application helps to minimise losses and plant quality issues due to weeds, pests and disease. We schedule irrigation based on careful daily assessment, considering forecast data, our weather sta-

tion records and scout feedback. We can remotely observe our weather station data and monitor and adjust the scheduling using a mobile phone app. To keep our reticulation system working well, I am also responsible for weekly reticulation maintenance and testing, regular water quality and usage monitoring, and responding to system breakdowns and troubleshooting.

Table 9. Management of water and reticulation to optimise water quality and application.

- Irrigation scheduling and system monitoring
- Reticulation maintenance and testing
- Water quality and usage monitoring
- Responding to system breakdowns and troubleshooting

Implementation of Actions by Liaising with Team

After collecting information, the next step is to determine, plan and implement an action. In essence, working out what needs to be done, if it needs doing and how urgent it is, and who will do it. Action decisions are made keeping plant value, efficiency, available resources, and nursery priorities in mind. This means liaising with the team to prioritise and schedule the actions.

Our core members are all assigned coordinator roles, they create the team and determine a time and way to get the action done. For larger work most of the team will be tasked for an allocated time, for example the maintenance team. Other times it might be a specialised small team such as the nutrition team. The coordinators drive the action, and the responsibility is shared by all. **Table 10** lists some of the examples in interaction with coordinators and their teams.

There is a need to remain flexible, as priorities and available resources can change frequently. Succession planning is important, for example, when someone is away on leave, ensuring key staff are aware of current routines.

Table 10. Implementation by liaising with coordinators and teams.

- **Maintenance team:** Grading, weed focus, "power weeding", spacing, trimming, staking, plant movement, covering plants, pre-emergent herbicide application
- **Nutrition team:** Treat for nutrient deficiency, boost growth, water or environmental stress, soil conditioning, beneficial microbes, salt treatment
- **Pest and Disease team:** Treat for insects and disease, ground weeds, control animal pests
- **Production team:** Inform of plant losses and difficult species
- **Seed team:** Inform of seeds ready to collect
- **Plant Movement, and Dispatch team:** Plant placement short and long term
- **Water Management team:** Scheduling, reticulation repairs
- **Management team:** Inform of major issues, trouble shooting

Communication methods are tailored to each coordinator and team and are listed in **Table 11**. Ensuring that the actions are completed, is critical, and is part of my role. Tasks are ticked as they are completed, and I will follow-up with the respective team or manager if a task has become urgent. Informing key staff on outcome and progress for plants of interest is also important.

Table 11. Communication with coordinators and teams.

- Whiteboard (Categorised tasks, and three most urgent marked with asterisk)
- Teams posts and groups (including photos)
- Prestart meetings
- Informal communication

Documentation

Refining record keeping is an ongoing project and part of my and everyone's role. Good record keeping will help in the analysis of data, and therefore in the planning and improvement of procedures. Some examples include irrigation scheduling, fertilising requirements, when to propagate each species, plant spacing or trimming requirements, and plant placement. Some of the documents we are developing and updating are listed in **Table 12.** I also contribute to the creation and updating of Standard Operating Procedures, and to Integrated Pest Management planning.

Table 12. Examples of records being updated and developed.

- Nursery buildings maintenance
- Water management
- Pest and disease treatment
- Plant treatment trials
- Plant placement
- Nutrition treatment
- Plant health
- Growing media testing
- Losses recording, stock counts
- Integrated Pest Management development
- Standard Operating Procedures

Research and Development

The final part of my role is to advance our research and development, which is a long-term time investment. I research the current literature to continually improve procedures and foster a proactive and sustainable approach. This involves investigating new and improved products, procedures, equipment, infrastructure, and collating and creating training and information resources. In addition, analysing and solving priority problems presented, such as unique plant production requirements. For example, I have created an electronic resource library, informative and motivational posters, contributed to the development of a nursery training manual and developed product summaries with flow charts. **Table 13** describes the categories of research and development in more detail.

Table 13. Research and development categories.

Plant Production Support	**Infrastructure/Equipment**
• Pest/disease products • Nutrition/tonics • Herbicides • Growing media refinement	• Buildings • Machinery • Tools
Procedures	**Training/Information**
• Efficiency • Innovation • Plant yield • Best practice • Sustainability	• Library (electronic and paper) • Posters • Training manual • Flow charts • Product summaries

OUTCOMES AND CONCLUSION

In reflecting over our past operations and growth, we can see multiple benefits of targeted nursery quality control. The benefits are both of short and long-term nature, and are summarized in **Table 14**.

One of the most important benefits is perhaps the final point listed in **Table 14**: Pride in all staff, for the combined efforts as a self-driven team to efficiently grow a quality product. Staff morale is held high in a team where every individual can grow, contribute, and drive efficient routines, with a common goal to produce beautiful healthy plants at our Natural Area Nursery (**Fig. 8**), to give back to our precious natural areas in Western Australia.

Table 14. Benefits of targeted nursery quality control

- Reduced plant losses, improved stock quality, increased profitability, happier clients
- Early recognition of problem areas for the production and sales perspective
- Increased efficiency in dispatch grading, weeding and all maintenance tasks
- Optimised water efficiency and quality
- Improved record keeping and documentation
- Motivation for procedure improvement and innovation
- Pride in all staff for the combined efforts as a self-driven team to efficiently grow a quality product

Figure 8. Natural Area Nursery during a beautiful sunrise. (Photo Sabine Suess NACMS).

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