Where are we going? Global modern silviculture trends

Methods and Materials

Results

Introduction

Conclusion

Muedanyi Ramantswana

Modern Silviculture Symposium
Howick, KwaZulu-Natal
16 October 2024

Introduction

- Even age clearfell silvicultural system
- Increased focus on technology development

- Challenges:
  - Globally fragmented
  - Variable sites and treatment requirements
  - No standardization of activities globally
  - Different landowner objectives

(Britannica, nd)

Main change drivers

Status of silviculture technology globally

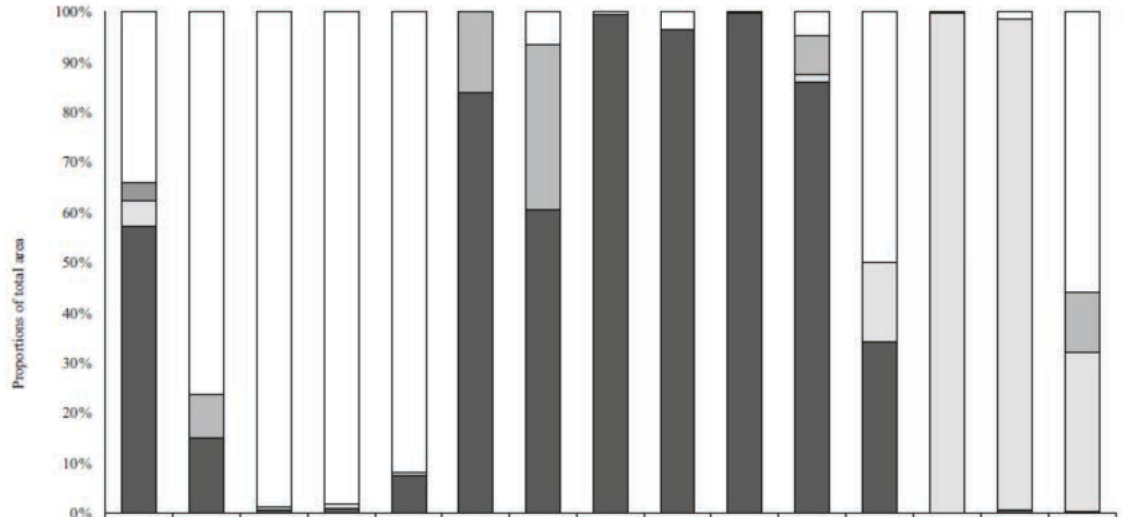
Research objectives

Change Drivers

- Health and safety improvement
- Increasing costs and productivity improvement
- Quality and consistency improvement
- Social challenges e.g labour availability
- Environment e.g reduction of waste and better adherence to certification bodies

(Steenkamp & McEwan 2014; Ramantswana et al 2021)

Status of silviculture technology



	South Africa	Brazil	Sweden	Finland	Canada	South Africa	Brazil	Sweden	Finland	Canada	South Africa	Brazil	Sweden	Finland	Canada
	Site preparation					Planting					Stand tending				
Mechanized	13 309	87 412	152 000	105 000	171 723	0	6 852	<1 000	2 660	1 000	5 932	42 118	<1 000	<2 000	154 535
Semi-mechanized	1 300	9 951	0	0	0	5 894	34 859	0	0	0	9 808	0	0	0	32 661
Motor-manual	2 079	145	<1 000	<1 000	<1 000	0	0	0	0	0	1 923	13 493	420 000	145 000	87 487
Manual	22 325	17 310	<1 000	<1 000	14 456	30 859	63 854	169 000	76 340	409 000	110 011	28 943	<1 000	<1 000	<1 317
Total ha	39 013	114 817	152 000	105 000	186 179	36 753	105 565	169 000	79 000	409 559	127 674	84 555	420 000	146 000	276 000

(Ramantswana et al 2020)

Technology progression

Silviculture
Technology progression

	MANUAL	MOTOR-MANUAL	SEMI-MECHANIZED	MECHANIZED	AUTOMATED
SITE PREPARATION					
TREE PLANTING		—			
STAND TENDING					

Research objectives

- Identify potential areas of technological development in silviculture
- Silviculture technologies that are likely to emerged and be adopted going into the future

Where are we going? Global modern silviculture trends

Methods and Materials

Results

Introduction

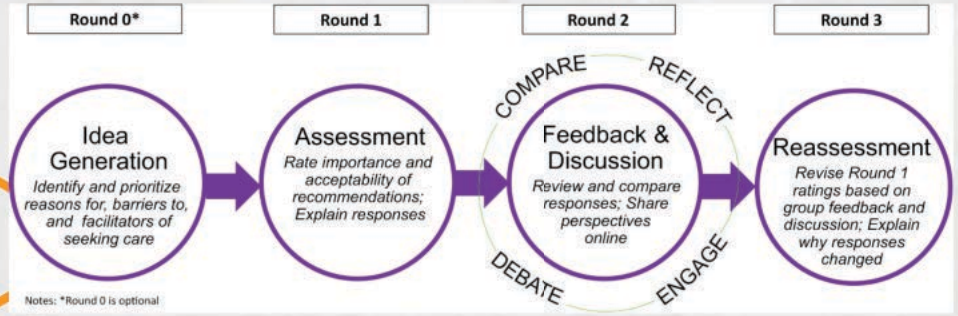
Conclusion

Muedanyi Ramantswana

Modern Silviculture Symposium
Howick, KwaZulu-Natal
16 October 2024

Methods and Materials

- Information gathering
  - Literature review
  - Industry visits e.g. Brazil, Finland and Sweden
  - Interviews with 30 global experts (semi structured)
- Delphi method - panel of 24 experts



(Twiss 1992)

Where are we going? Global modern silviculture trends

Methods and Materials

Results

Introduction

Conclusion

Muedanyi Ramantswana

Modern Silviculture Symposium
Howick, KwaZulu-Natal
16 October 2024

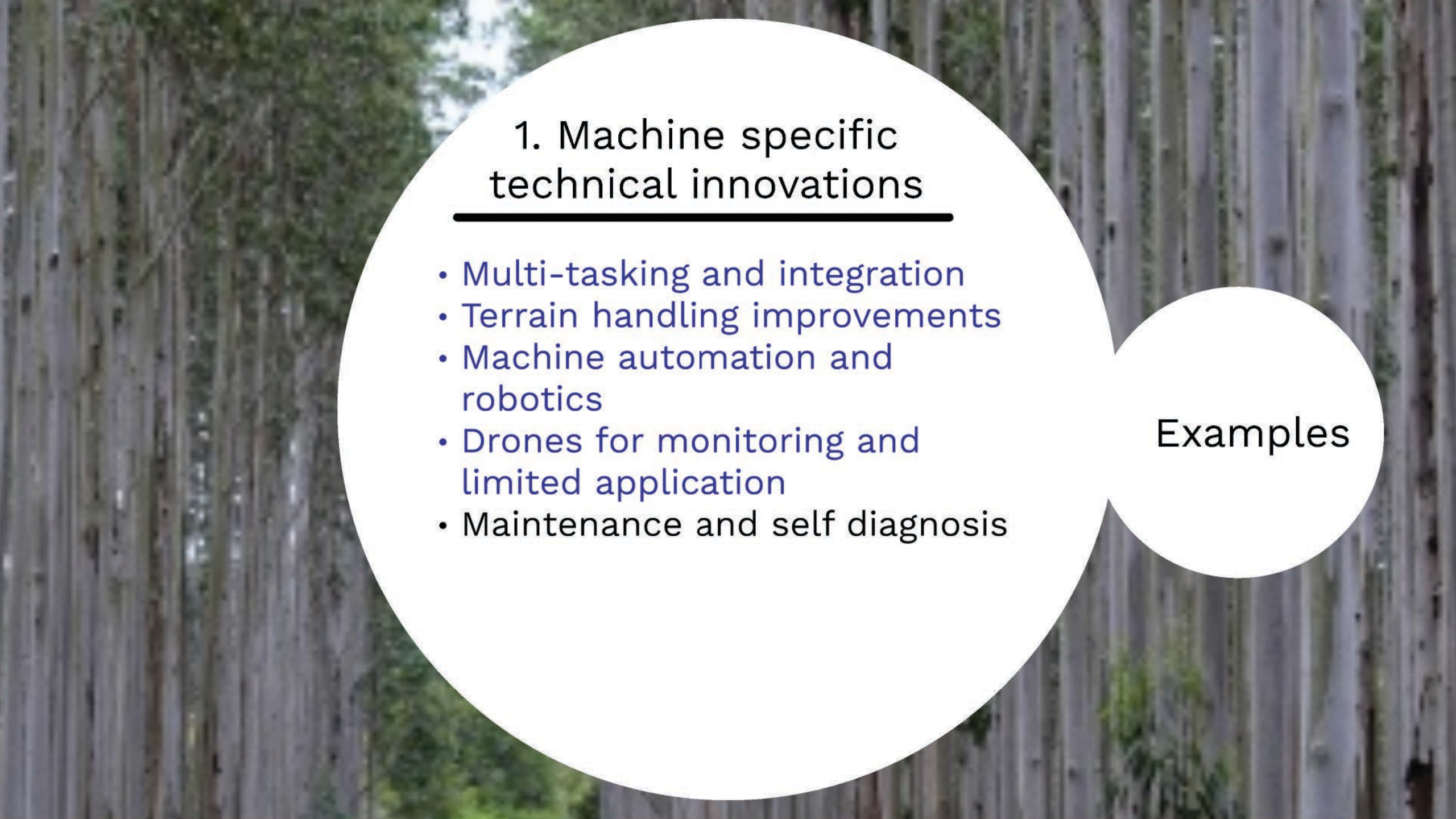
Technology trends

18 technologies were identified

Categorised into four main groups:

1. **Machine** specific technical innovations
2. **Material** input innovations
3. Machine **operator** innovations
4. **Digital** technology applications

Technology area 1
Technology area 2
Technology area 3
Technology area 4
Summary of results



1. Machine specific technical innovations

- Multi-tasking and integration
- Terrain handling improvements
- Machine automation and robotics
- Drones for monitoring and limited application
- Maintenance and self diagnosis

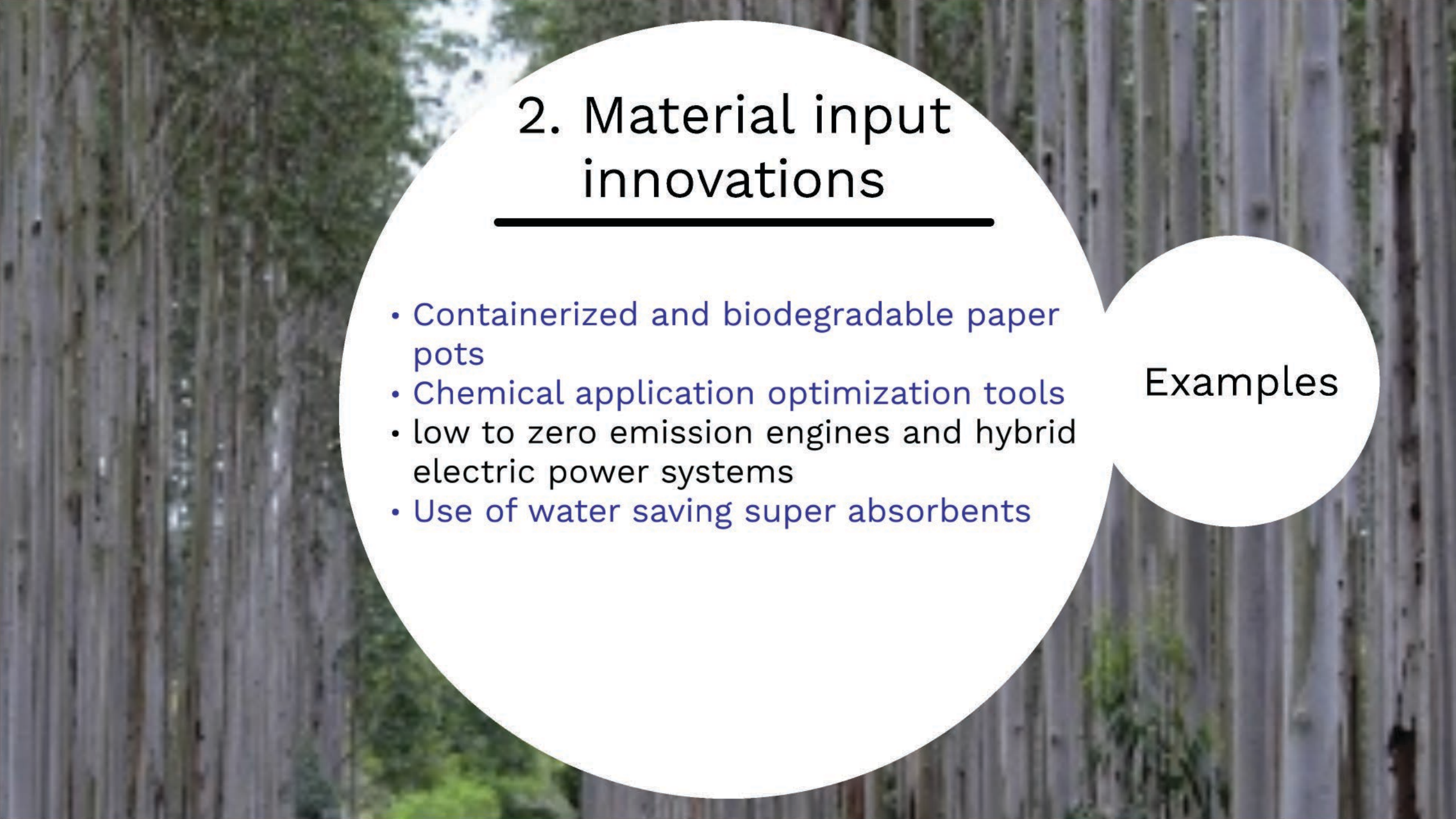
Examples

Examples

Image 1: Plantmax - integrated machine

Image 2: T-winch integrated to soil preparation excavator

Image 3: DJI drone - weeding activities



2. Material input innovations

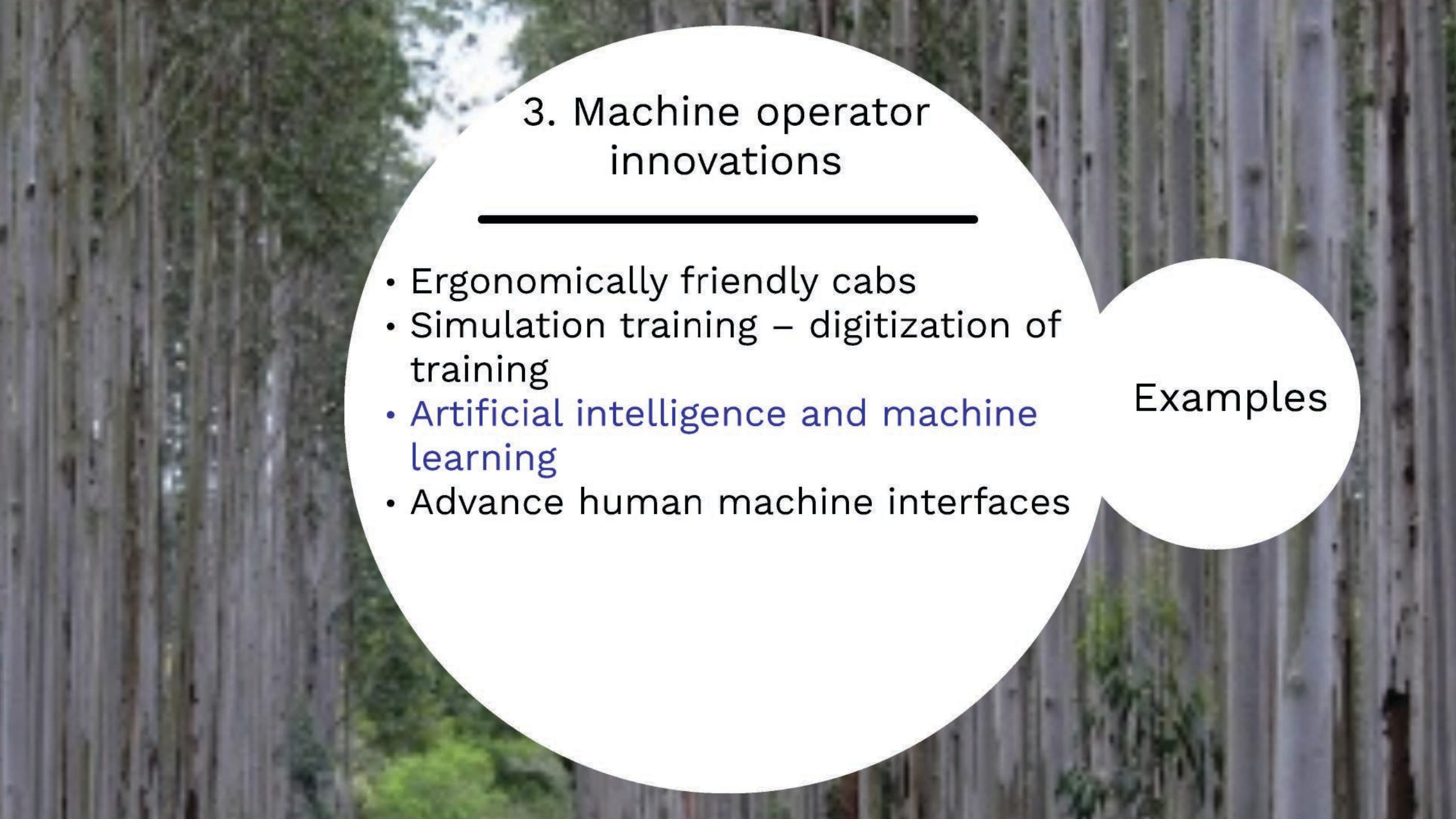
- Containerized and biodegradable paper pots
- Chemical application optimization tools
- low to zero emission engines and hybrid electric power systems
- Use of water saving super absorbents

Examples

Image 4: Propagation of plants for semi and mechanised (paper pots)

Image 5: Precision chemical application

Image 6: Super absorbent polymers

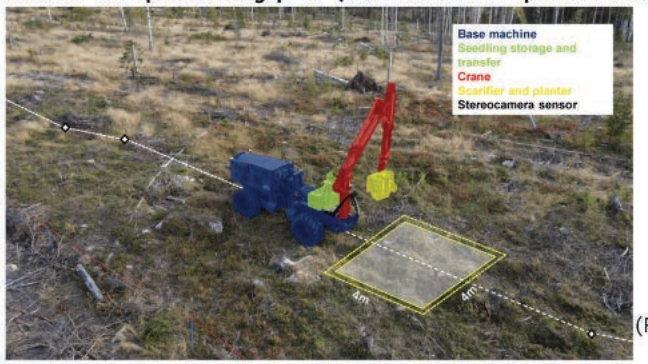


3. Machine operator innovations

- Ergonomically friendly cabs
- Simulation training – digitization of training
- Artificial intelligence and machine learning
- Advance human machine interfaces

Examples

Image 7: BraSatt 01 prototype (futuristic planting machine)



(Rossander and Lideskog, 2023)

Image 8: AutoPlant machine, with the planter mounted on the crane

Image 9: Automated irrigation technology

4. Digital technology applications

- Advance real time monitoring and management systems (telematics)
- Site specific and live stand assessment
- Operator behavior and performance monitoring
- Process and application of big data = efficiency
- Remote control operation of machines

Examples

Image 10: Telematics and dashboard monitoring

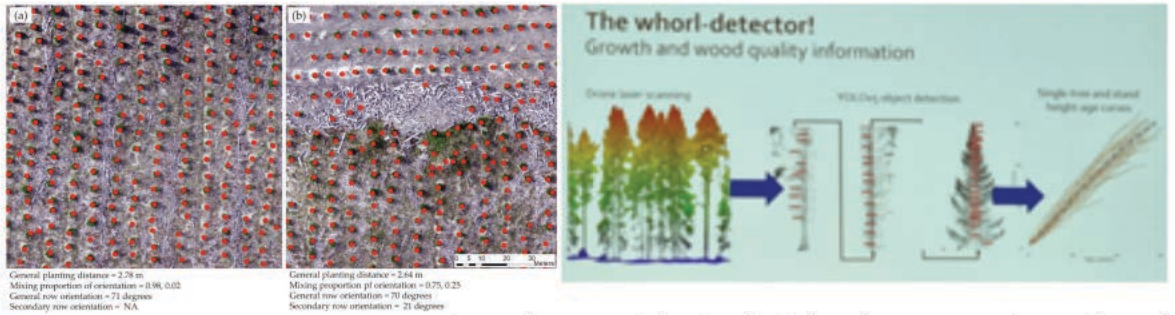


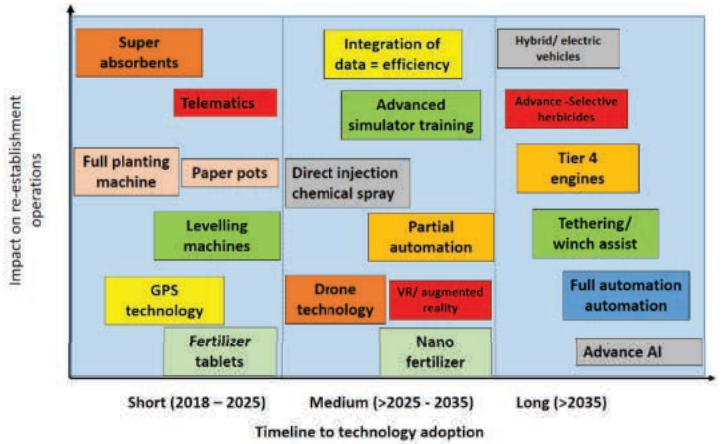
Image 11: Remote sensing data with individual tree point cloud

(Jayathunga et al 2023)

Image 12: Remote control of machines

Summary

1. Increased partial and integrated machines with difficult terrain functionalities
2. Integration and applicaton of drone technology
3. Advanced material inputs e.g. paperpots, chemicals
4. Increase precision silviculture - data driven > artificial intelligence, machine learning, deep learning, generative AI
5. Enhanced automation in propagation and operations



Where are we going? Global modern silviculture trends

Methods and Materials

Results

Introduction

Conclusion

Muedanyi Ramantswana

Modern Silviculture Symposium
Howick, KwaZulu-Natal
16 October 2024

Conclusion

How will silviculture operations look like in 2035?

- Globally, most silviculture operations are still manually orientated
- Various change drivers are influencing technology adoption and developments

- **What must you do about this:**
  1. Be well informed of technologies that exist
  2. Organisation must develop clear technology orientated strategies
  3. Quantify the benefits and adopt technologies that improve efficiencies
  4. Monitor impact through data collection
  5. Continously adapt and improve

Publication

Thank you

Journal publication

SCIENTIA FORESTALIS
ISSN 2318-1222 (online)

ORIGINAL ARTICLE

A forecast of future silviculture re-establishment technologies in plantation forestry

Previsão das tecnologias futuras na silvicultura de florestas plantadas

Muedanyi Ramantswana[1,2], Raffaele Spinelli[3], Michal Brink[1], Keith Little[2]

[1]University of Pretoria - UP, Pretoria, Gauteng, South Africa
[2]Nelson Mandela University - NMU, George, Western Cape, South Africa
[3]CNR IVALSA, Sesto Fiorentino, Italy

How to cite: Ramantswana, M., Spinelli, R., Brink, M., & Little, K. (2021). A forecast of future silviculture re-establishment technologies in plantation forestry. *Scientia Forestalis*, *49*(130), e3488. https://doi.org/10.18671/scifor.v49n130.08

Abstract

Technology is rapidly advancing and in forestry new innovations are increasingly being integrated into operations such as silviculture re-establishment (regeneration), harvesting and processing. The goal of this study was to identify eucalypt re-establishment technologies which will become important from 2018 to 2040 and to forecast the date on to when 50% of the technologies would be adopted in new forest machinery. The Delphi technique was used to systematically elicit expert opinion on possible future re-establishment technologies which have the highest probability of being adopted in operations. The process involved the distribution of a questionnaire to 24 experts in the field of silviculture re-establishment in plantation forestry. Results from the Delphi revealed that future technology development in re-establishment would be directed to four main areas, namely: (i) machine development (ii) material input innovations (iii) machine operator advances and (iv) computerized technology applications. Within these broad technology areas, 18 specific technologies were identified and forecasted. 15 technologies were forecasted to reach 50% adoption by 2025 and one technology was identified as already adopted. Two technologies were identified as highly unlikely to be adopted in future. Forecasting future technological advances in re-establishment is important because it enables forest growers to plan, strategize and take decisions to deal with future changing environments.

Keywords: Technology; Re-establishment; Adoption.

Resumo

A tecnologia está avançando rapidamente e as inovações florestais estão cada vez mais integradas às operações silviculturais, como a talhadia, colheita e processamento. O objetivo deste estudo foi de identificar tecnologias de condução florestal que serão importantes de 2018 até 2040, além de prever a data em que 50$ das tecnologias serão adotadas em novos equipamentos. A metodologia Delphi foi utilizada para obter, sistematicamente, a opinião de especialistas sobre a probabilidade de as novas tecnologias serem adotadas nas operações florestais. O processo envolveu a distribuição de um questionário a 24 especialistas em silvicultura de florestas plantadas. Os resultados do Delphy revelaram que o desenvolvimento de tecnologias futuras seria direcionado a quatro grandes áreas: (i) desenvolvimento de máquinas (ii) novos materiais (iii) aperfeiçoamento nos operadores de máquinas (iv) adoção de tecnologias computadorizadas. Dentro dessas grandes áreas, 18 tecnologias específicas foram identificadas e previstas. Quinze tecnologias foram previstas para atingir 50% de adoção até 2025 e, uma tecnologia foi identificada como já adotada. Duas tecnologias foram identificadas como altamente improváveis de serem implementadas no futuro. A previsão de futuros avanços tecnológicos na condução florestal è importante porque permite aos produtores, planejar, elaborar e tomar decisões num futuro com incertezas ambientais.

Palavras-chave: Tecnologia; Plantio; Adoção.

NELSON MANDELA
UNIVERSITY

Ndo livhuwa / Thank you!

Muedanyi Ramantswana
Muedanyir@mandela.ac.za
+27 78 464 7840

Where are we going? Global modern silviculture trends

Methods and Materials

Results

Introduction

Conclusion

Muedanyi Ramantswana

Modern Silviculture Symposium
Howick, KwaZulu-Natal
16 October 2024