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**Day 2, 2.05pm**

**Area of work:** Agriculture and Natural Resource Management

**Specialty:** Systems thinking, Participatory systems analysis, Decision Support and Bayesian Networks

### Take-home messages:

1. Stakeholders often disagree over actions and policies needed to achieve NRM goals. Systems thinking provides a mechanism for identifying root causes of NRM problems, and when combined with stakeholder participation, assists in creating a common understanding among stakeholders about these causes and the actions and policies needed to tackle them.
2. Bayesian networks are a flexible and visual system modelling tool, capable of integrating qualitative and quantitative data and accommodating uncertainty. This, in combination with their scenario and diagnostic capabilities, makes them well suited to use in participatory systems analysis activities.
3. When implemented within an adaptive management cycle, participatory systems analysis provides a learning environment in which stakeholders can evaluate their assumptions based on the outcomes of previously implemented actions and policies.

## Applying systems thinking to natural resource management

This presentation focuses on the application of participatory systems analysis (PSA) and Bayesian networks (BNs) as knowledge integration tools in natural resource management decision-making. PSA is a decision-making approach in which stakeholders participate in solving management problems using systems thinking to identify and relate factors that may affect management objectives. The PSA process involves setting management objectives, abstract modelling to explore the effect of decisions on these objectives, identifying preferred management interventions and monitoring to track the success of implemented management interventions.

Two applications of PSA are given in the presentation: the Queensland Parks and Wildlife Service identifying stumbling blocks to the adaptive fire management in conservation reserves; and in the Philippines where PSA was used to identify policy interventions for improving the quality of tree-seedling production and the effectiveness of tree nurseries.

The purpose of PSA in both cases was for decision support, policy assessment and the prioritisation of management interventions. Bayesian networks (BNs) are used for knowledge integration and a decision-support tool because their graphical nature makes them relatively easy for stakeholders and non-modellers to understand. BNs also use probabilities to relate system factors, giving users the ability to accommodate uncertainty in decision-making. These probabilities can come from several different sources: available data-sets, expert opinion and other models.

This makes BNs a good tool for integrating available knowledge in decision support. BNs can also be used to perform scenario and sensitivity analysis quite quickly and easily, allowing stakeholder groups to identify management intervention points and potential consequences of management and policy decisions.

The outcome of these two projects has been the creation of a common understanding among stakeholders regarding management and policy interventions that are most likely to lead to success.

This has allowed investment to be targeted at the most promising interventions and also facilitated the adoption and implementation of these interventions due to stakeholder agreement over what needs to be done. For natural resource management in Australia, PSA and BNs provide tools for tackling complex natural resource management problems with multiple stakeholders. PSA is an effective mechanism for engaging stakeholders, eliciting knowledge and developing a common understanding about the causes of problems and potential solutions.

BNs are an effective tool for integrating available knowledge, accommodating uncertainty and performing scenario analysis so that the most promising set of interventions and policies can be identified. If you're in the business of tackling complex NRM problems with scattered knowledge, multiple stakeholders, uncertainty and a need to achieve coordinated actions among stakeholders, then you will be interested in this work.

### Relevant publications

- Bosch OJH, King CA, Herbohn JL, Russell IW and Smith CS (2007). Getting the big picture in natural resource management – systems thinking as 'method' for scientists, policy-makers and other stakeholders. *Systems Research and Behavioral Science* 24, 217-232.
- Smith C, Howes AL, Price B and McAlpine CA (2007). Using a Bayesian belief network to predict suitable habitat of an endangered mammal – the Julia Creek Dunnart (*Sminthopsis douglasi*). *Biological Conservation* 139, 333-347.
- Smith C, Felderhof L, Bosch OJH (2007). Adaptive management: making it happen through participatory systems analysis. *Systems Research and Behavioral Science* 24, 567-587. (in press) (Accepted 26 April 2007).
- Bashari H, Smith C and Bosch OJH (2009). Developing decision support tools for rangeland management by combining state and transition models and Bayesian belief networks. *Agricultural Systems*, 99:23-34.
- Sinay L, Smith C and Carter RW (2008). Modelling indigenous cultural change in protected areas. In *Monitoring, Simulation and Management of Visitor Landscapes* (Eds R Gimblett and H Skov-Petersen). University of Arizona Press, Tucson. pp 213-238.

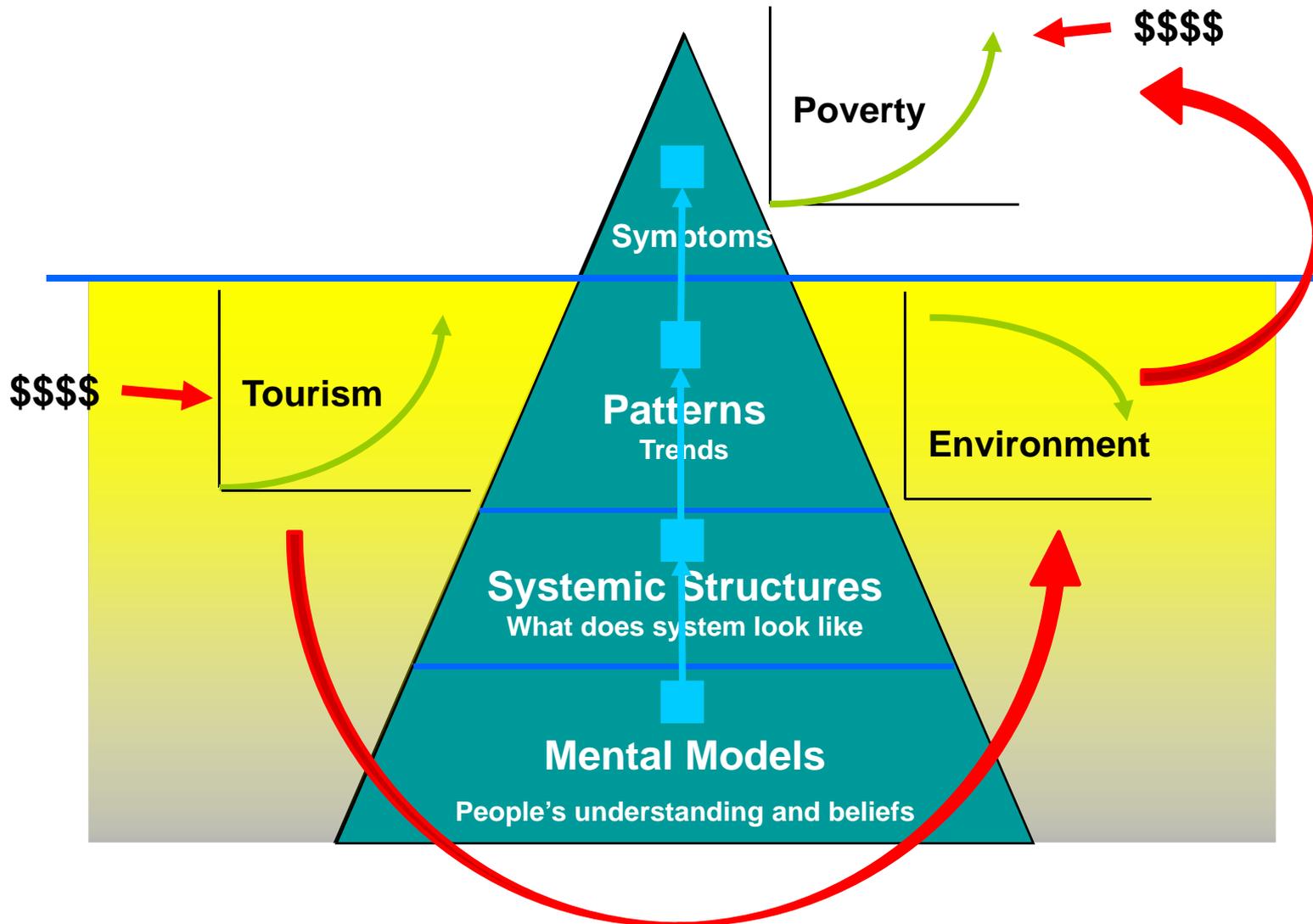
# Systems Thinking – its important

The biggest challenges of our time

- Climate Change
- Global Financial Crisis
- Global Poverty

Cause - Lack of systems thinking!

# Systems Thinking – the Guts



# Participatory Systems Analysis

- Systems Thinking with Stakeholders

## Why?

- Reveal peoples mental models, i.e. how they think
- Expose and share ideas and views – collaborative learning
- Avoid parachuting in solutions and being told to ‘Knock-Off’ – empower stakeholders, improve adoption

# Bayesian Networks

- Quite a handy tool for PSA

## Why?

- Visual – easy of non-modellers
- Flexible – can link both qualitative and quantitative factors
- Uncertainty – probabilities
- Scenario, Diagnostic and Sensitivity Analysis – performed rapidly

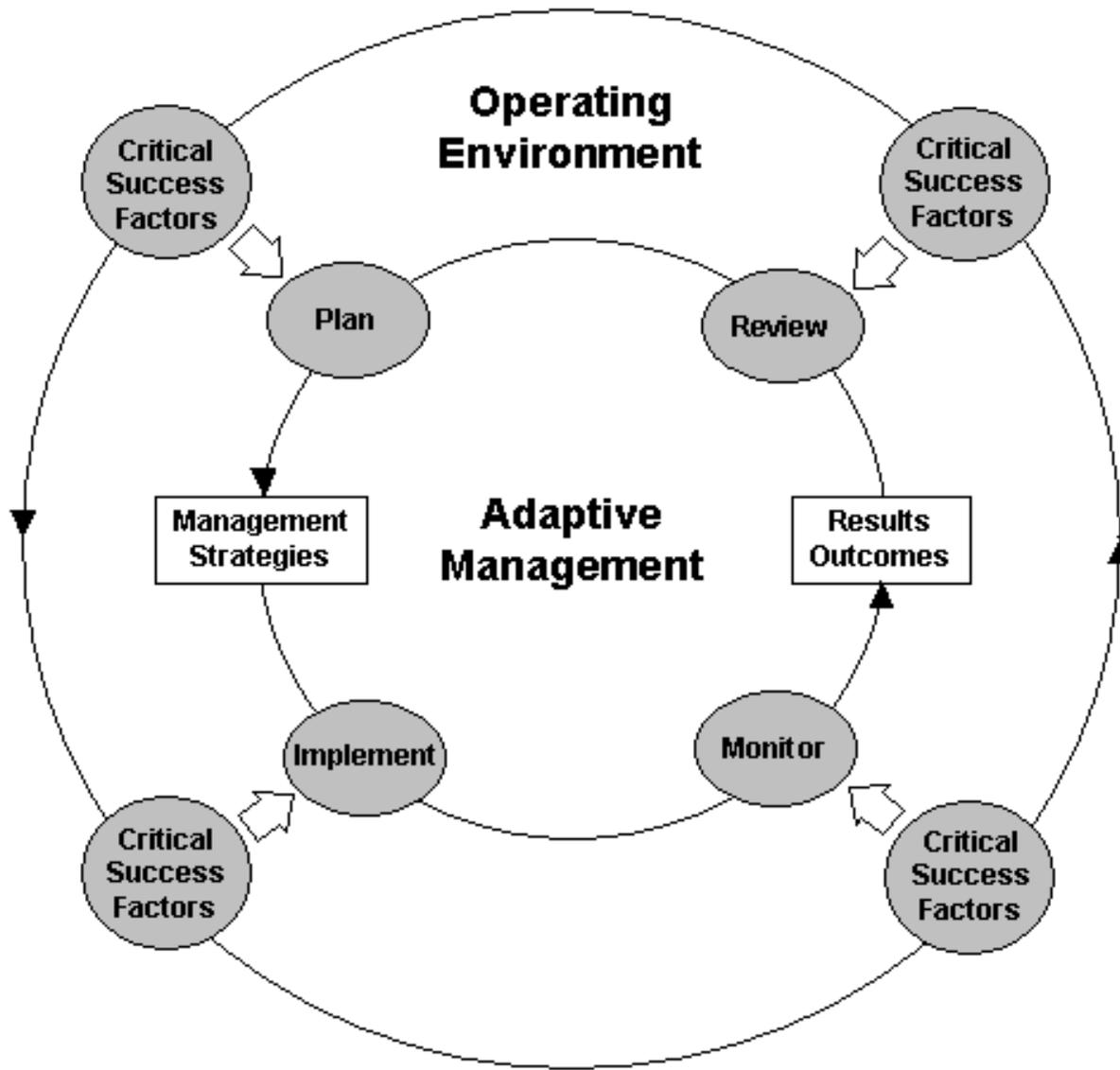
# Example 1 - QPWS

## The Problem:

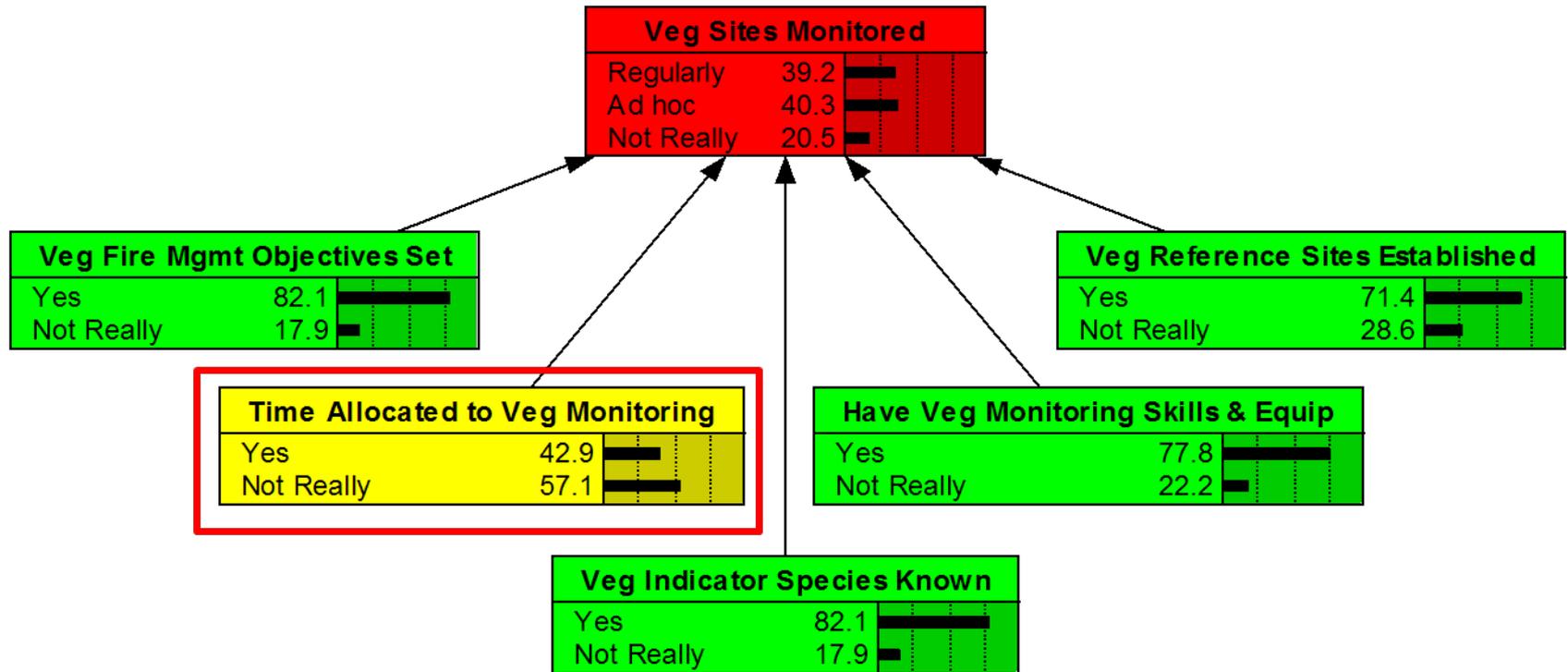
- Had a policy – Adaptive Management of Fire on conservation reserves
- Spent heaps and money on implementing this policy
- But Adaptive Management still wasn't happening

## What we did:

- Systems analysis with park rangers

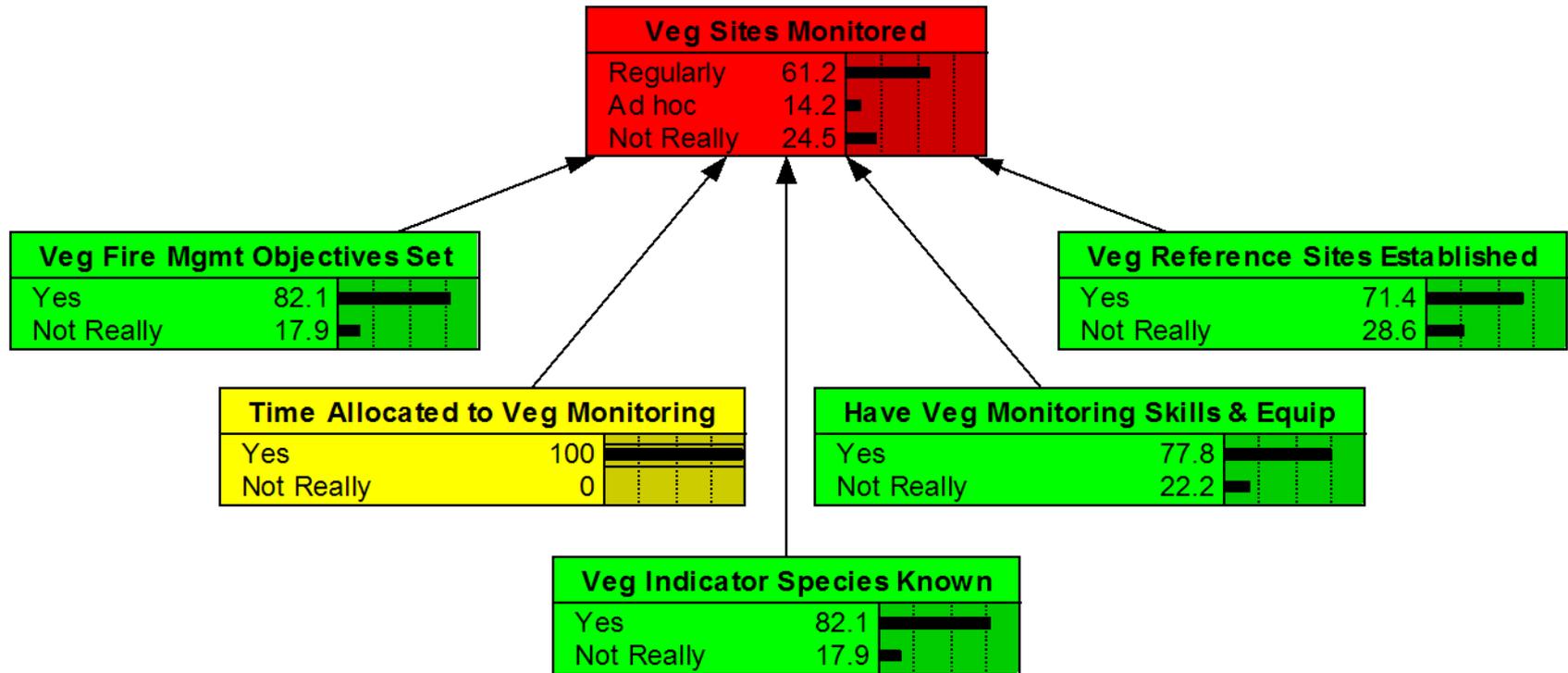


# Performance



**Too busy cleaning dunnies**

# Intervention Assessment



# Example 2 – Tree Seedlings Philippines

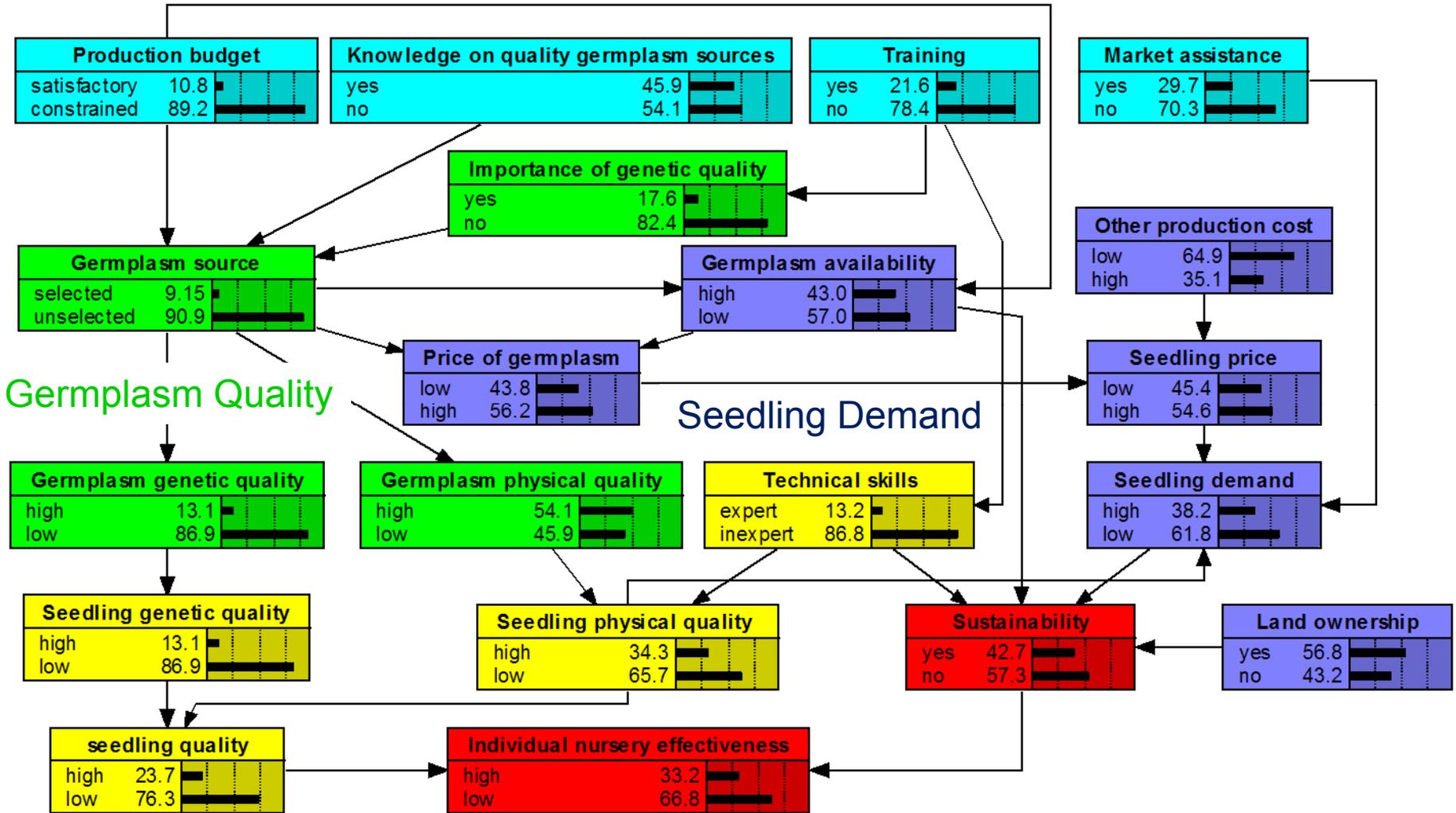
## The Problem:

- Poor seedlings – poor trees
- Low financial viability – not able to sustain nursery operations

## What we did:

- Systems analysis with nursery managers, extension officers and government

# Policy Interventions



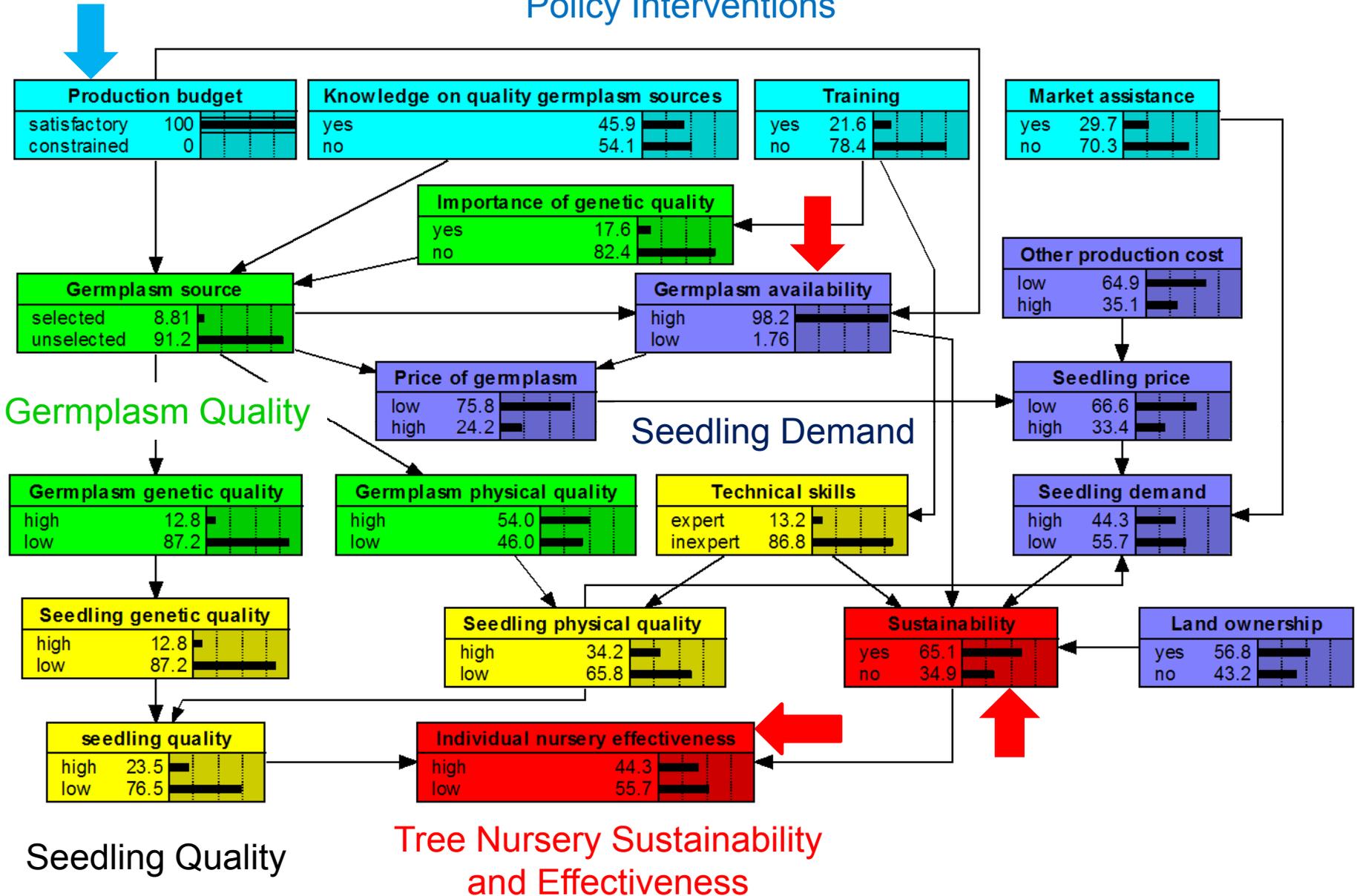
Germplasm Quality

Seedling Demand

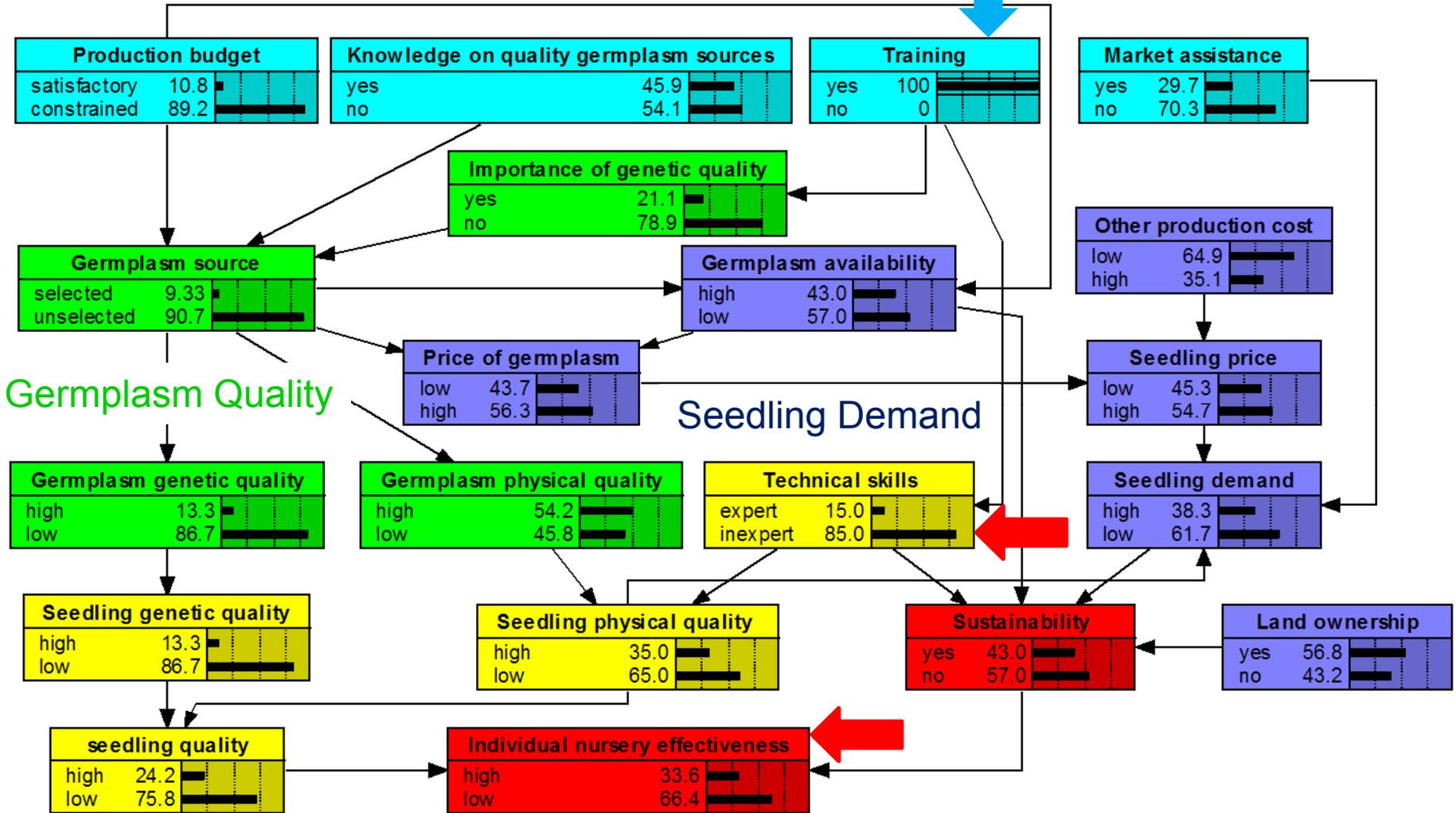
Seedling Quality

Tree Nursery Sustainability and Effectiveness

# Policy Interventions



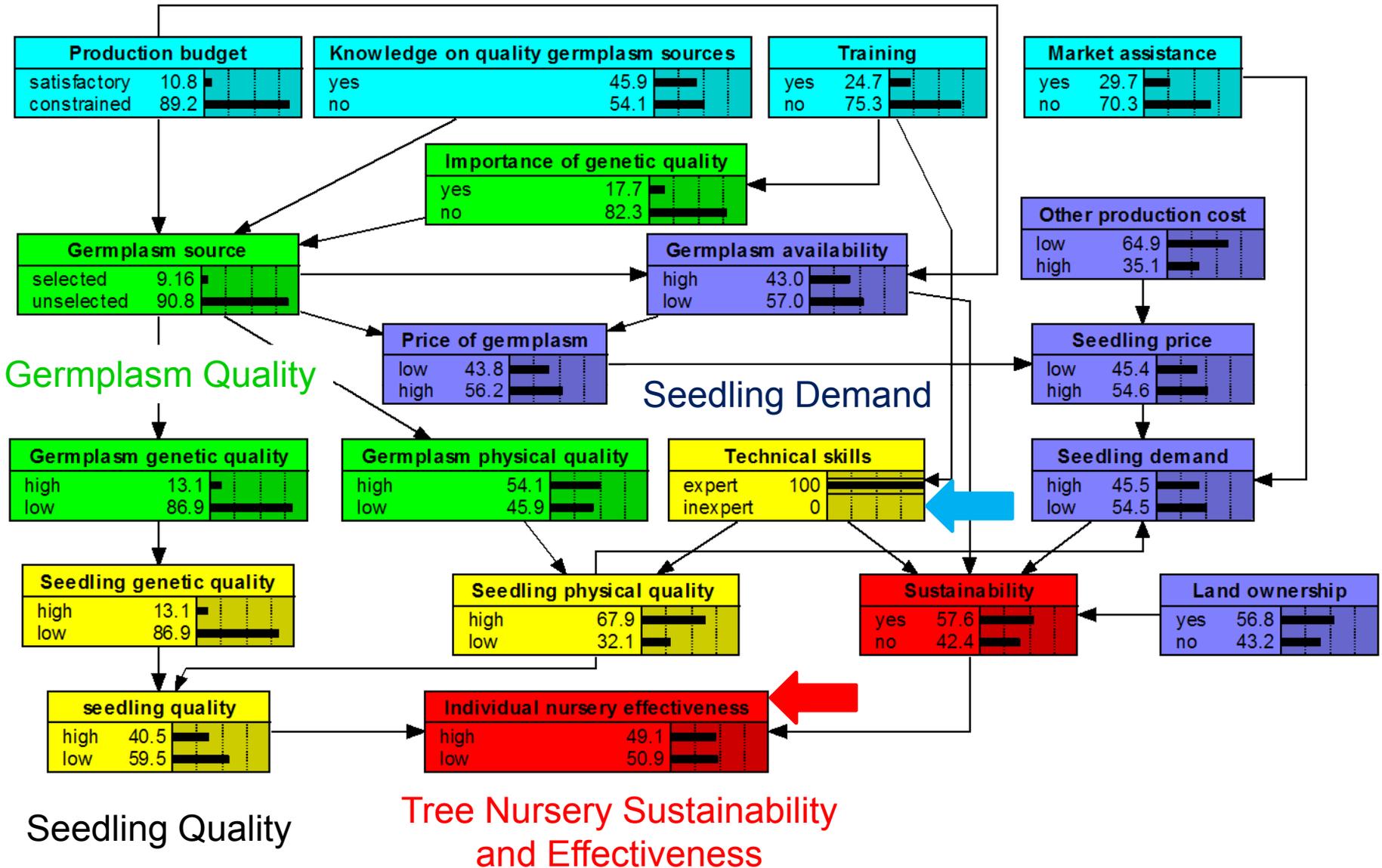
# Policy Interventions



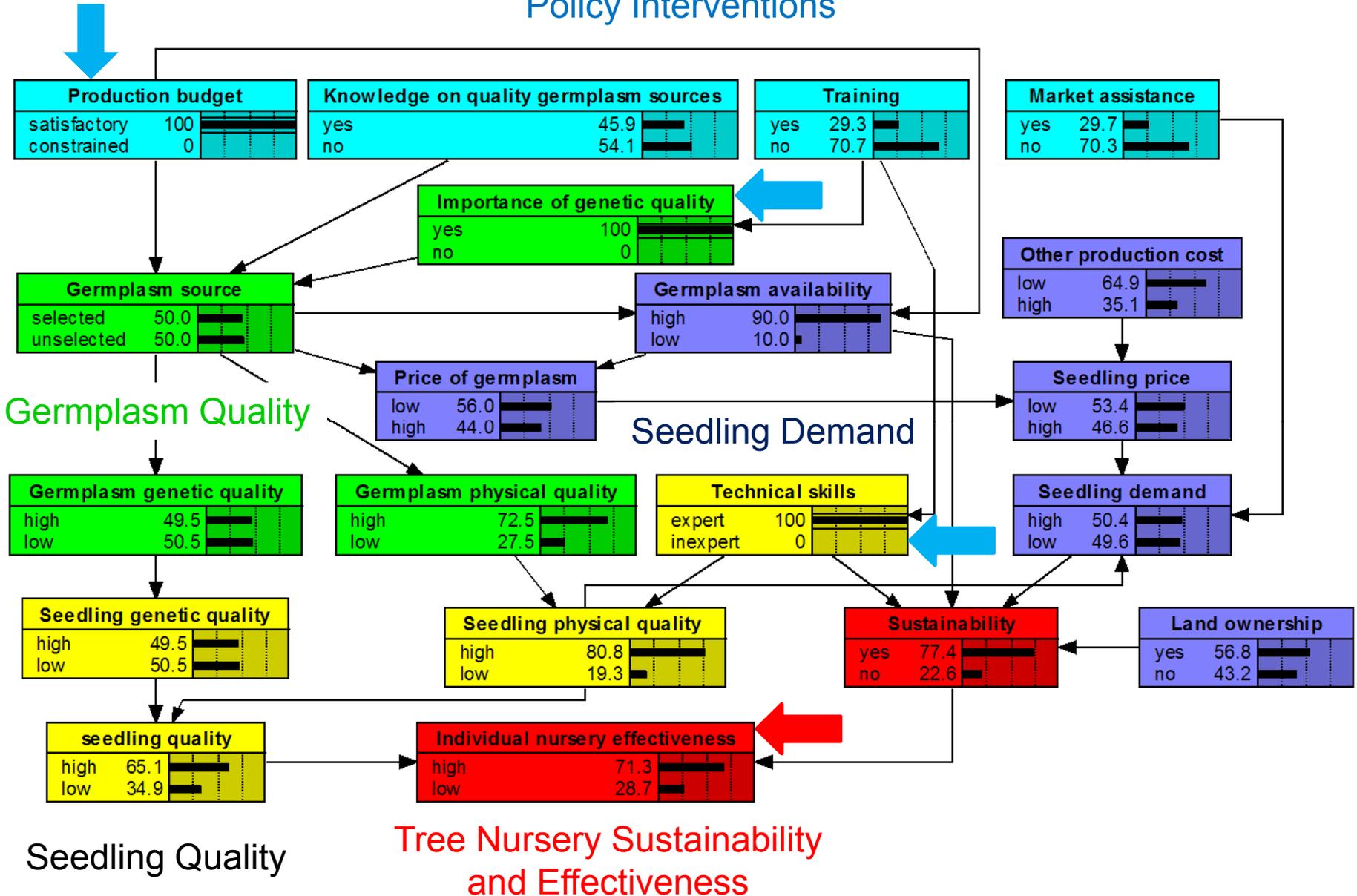
Seedling Quality

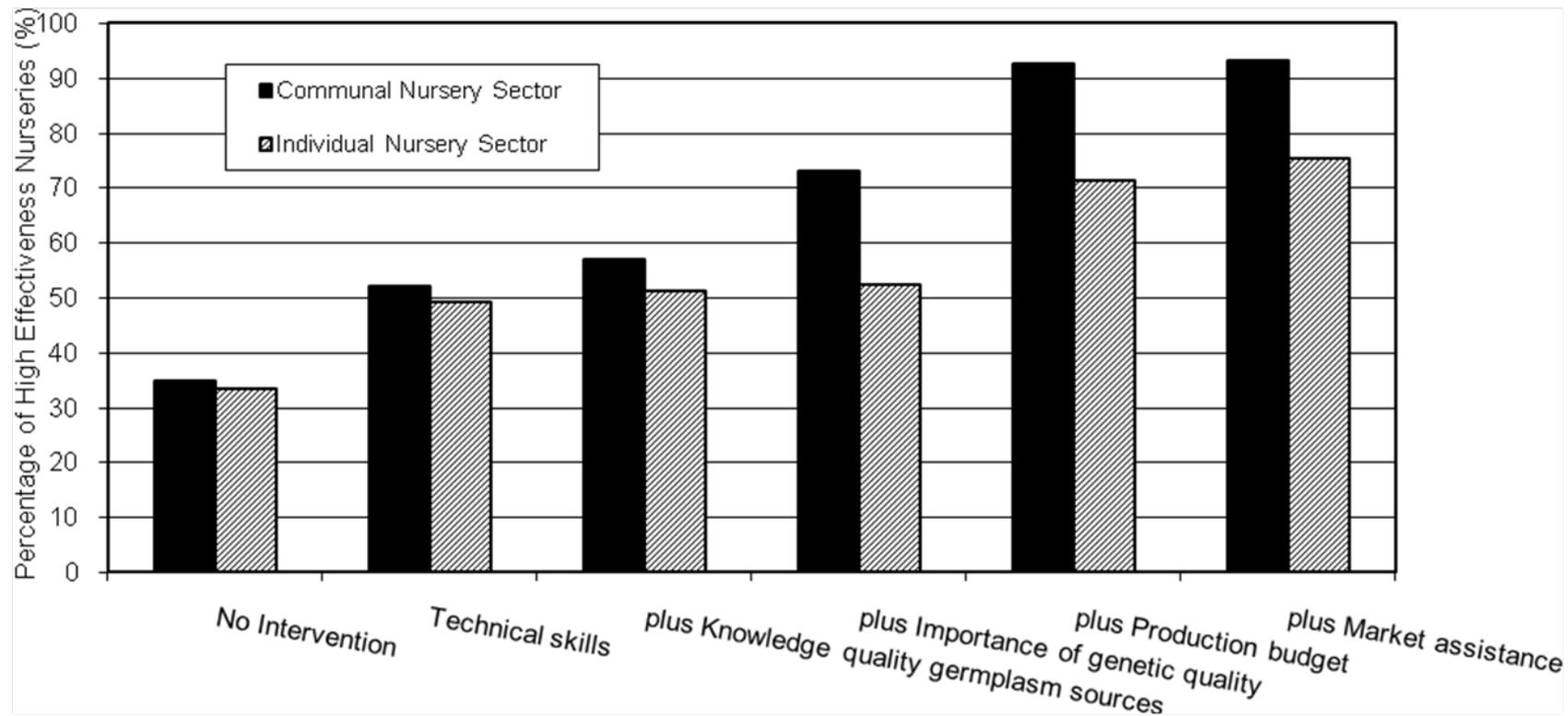
Tree Nursery Sustainability and Effectiveness

# Policy Interventions



# Policy Interventions





# Systems Analysis

Used to:

- Reveal and integrate critical success factors
- Identify areas of poor performance
- Assess policies and interventions

# Take Home Messages

- Systems thinking – mechanism for knowledge integration, stakeholder participation and intervention design
- Bayesian Networks a pretty handy tool
- Embedding these within an adaptive management cycle is a good idea – test interventions, review success

Too much time spent cleaning dunnies  
can send conservation down the toilet!