

# Economic Analysis of Invasive Species: African Tulip Tree in Fiji

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# Overview



Invasive name:

- African Tulip (*Spathodea campanulata*)

Study Location:

- Eastern Viti Levu and Taveuni, Fiji

How it got there:

- Invasive introduced to Fiji in 1936 as an ornamental plant.

Spread and current state of invasive:

- Quickly escaped suburban gardens and now dominates disturbed lands throughout much of the country.

Why a concern:

- Impacts agricultural yields and can quickly take over fallow land



# Overview

- Impacts (i.e., damages)
  - Invades agricultural areas, forest plantations, and natural ecosystems, smothering other trees and crops as it grows to become the prevailing tree in these areas.
- Benefits of use
  - Building materials, habitat provision, carbon sequestration, and erosion control.
- Note: The African tulip tree has high water content and hence is not a particularly desirable source of firewood.



# Overview: Economic Analysis

- Approach used: Cost-Benefit Analysis
- Discount Rate: 8%
- Timeframe: 50 years
- Other key assumptions:
  - Economic well-being metric: Wealth
  - project size: 1 ha (but can be scaled up to village area)
- Sensitivity Analysis
  - Management effectiveness
  - Initial population
  - Discount rate

# 7 Steps of a CBA

1. Determine the objectives of the Cost-Benefit Analysis



2. Identify costs and benefits



3. Value costs and benefits



4. Aggregate costs and benefits



5. Perform sensitivity analysis



6. Consider distributional impacts



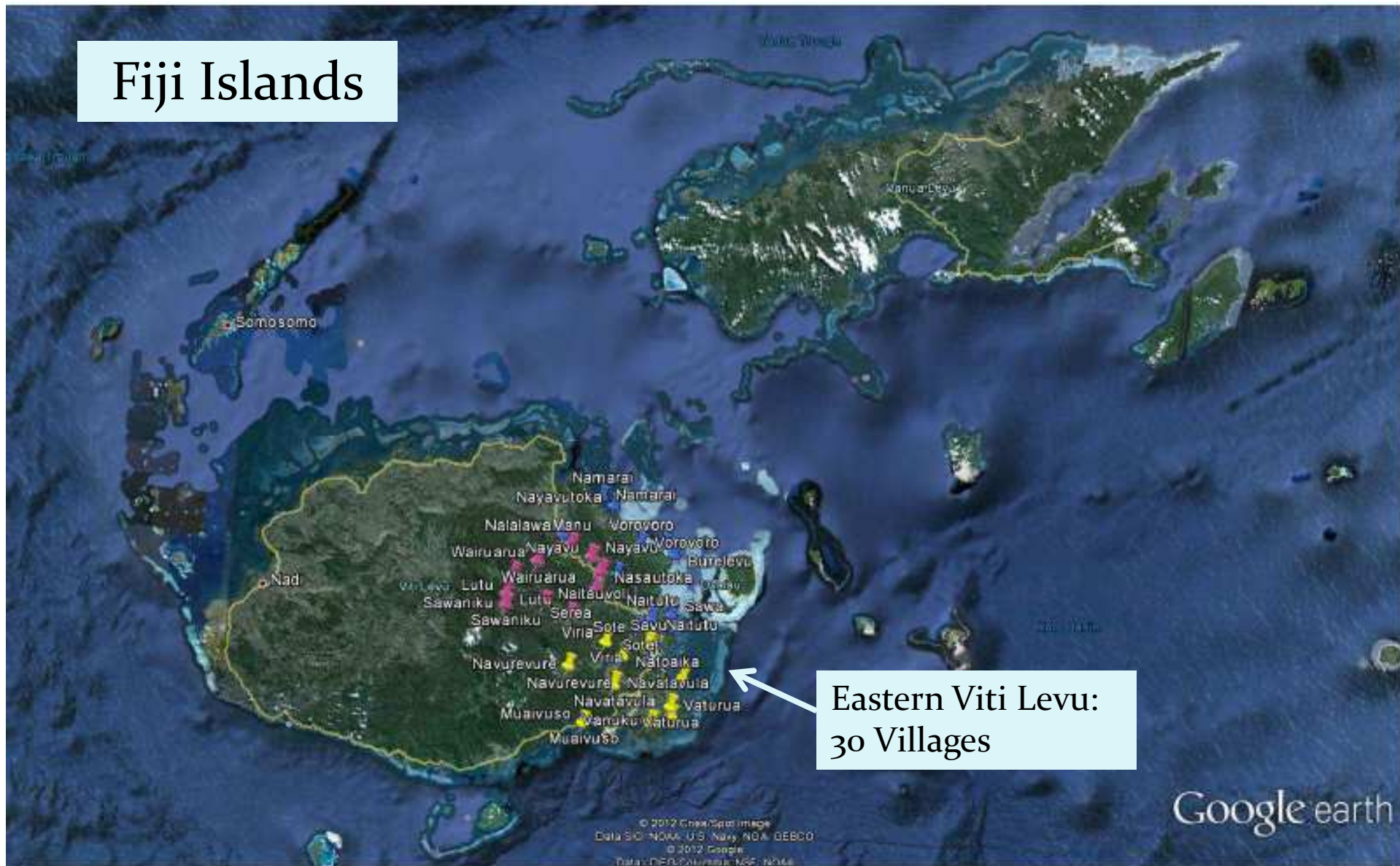
7. Prepare recommendations



# Step 1. Objective

- The purpose of this cost-benefit analysis is to estimate the economically efficient options to manage the African tulip tree (*Spathodea campanulata*) at the village-level in Eastern Viti Levu, Fiji.
- Due to prevalence and ability to spread and establish itself, eradication is not likely

# Fiji Islands



Eastern Viti Levu:  
30 Villages

Google earth

miles | 100  
km | 200





# Key Data Source - Survey

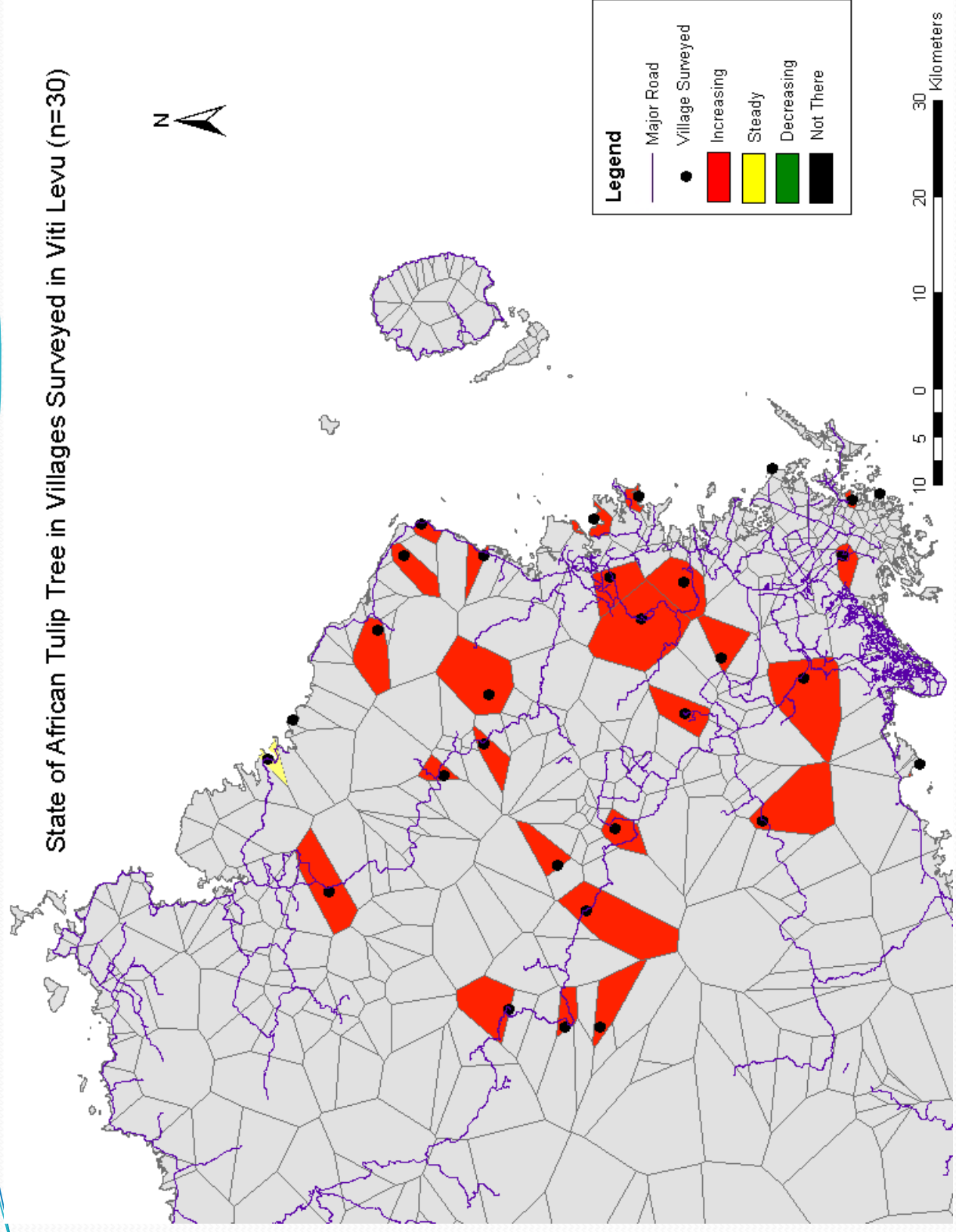
- Site: Eastern Viti Levu, Fiji
- Survey conducted in 30 villages
- 1 community survey + 12 household survey per village
- Total of 360 households

Eastern Viti Levu:  
30 Villages

Google earth



# State of African Tulip Tree in Villages Surveyed in Viti Levu (n=30)



# Key Summary Statistics

**key economic indicators for households in villages surveyed**

Variable	Obs*	Mean** (FJD)	Std. Dev. (FJD)	Min (FJD)	Max (FJD)
Annual Income	30	\$12,530	\$9,260	\$4,510	\$41,480
House Value	30	\$10,070	\$4,530	\$2,500	\$20,000

\* Average of 12 household surveys from each of 30 villages

\*\* 1 FJD = 7.75 Mexican Pesos = 0.46 USD

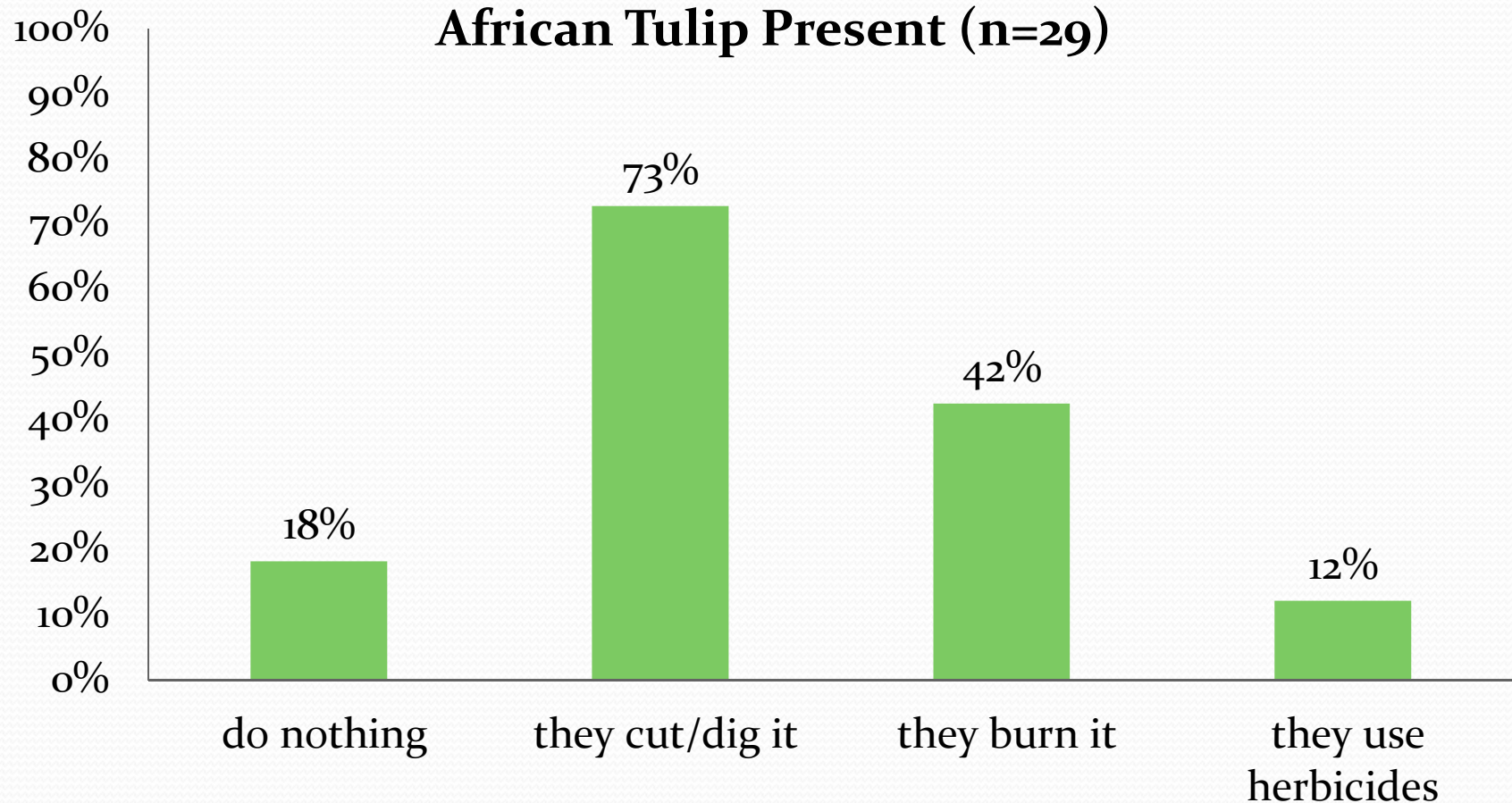


# Management and Adaptation

- Management
  - Cut the trees and burn them, or place dry grass around the stems and then burn
  - Use diesel and herbicide to kill it (varied results)
  - Dig up small plants when seen.
  - Hire a tractor or digger to get rid of the tree
  - There is nothing you can do to get rid of it
- Adaptation
  - Leave land idle for 1-2 years after they kill the tree
  - Shift cultivation areas

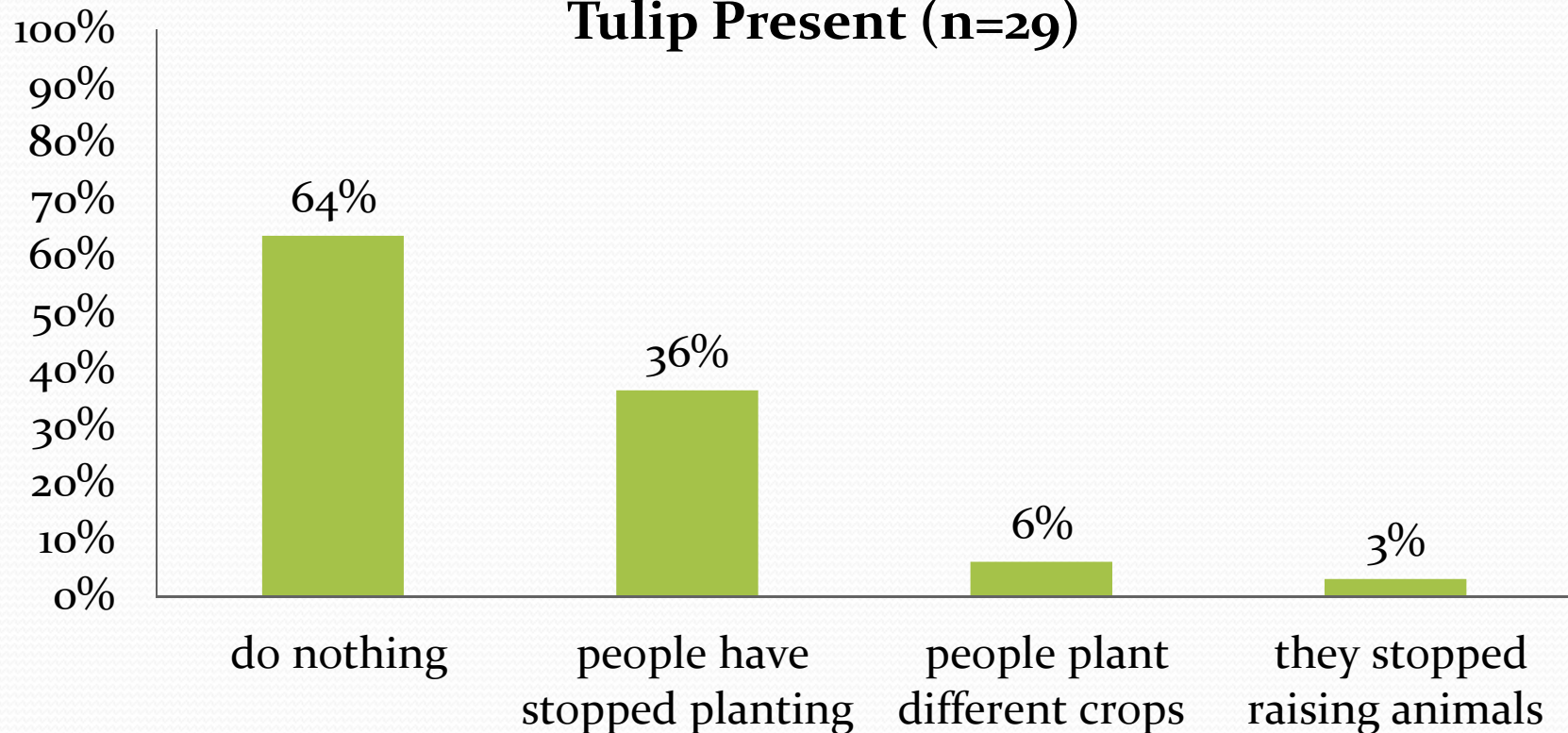
# Village-level Management

**Percent Villages with Specific Management if  
African Tulip Present (n=29)**



# Village-level Adaptation

**Percent Villages with Specific Reaction if African Tulip Present (n=29)**

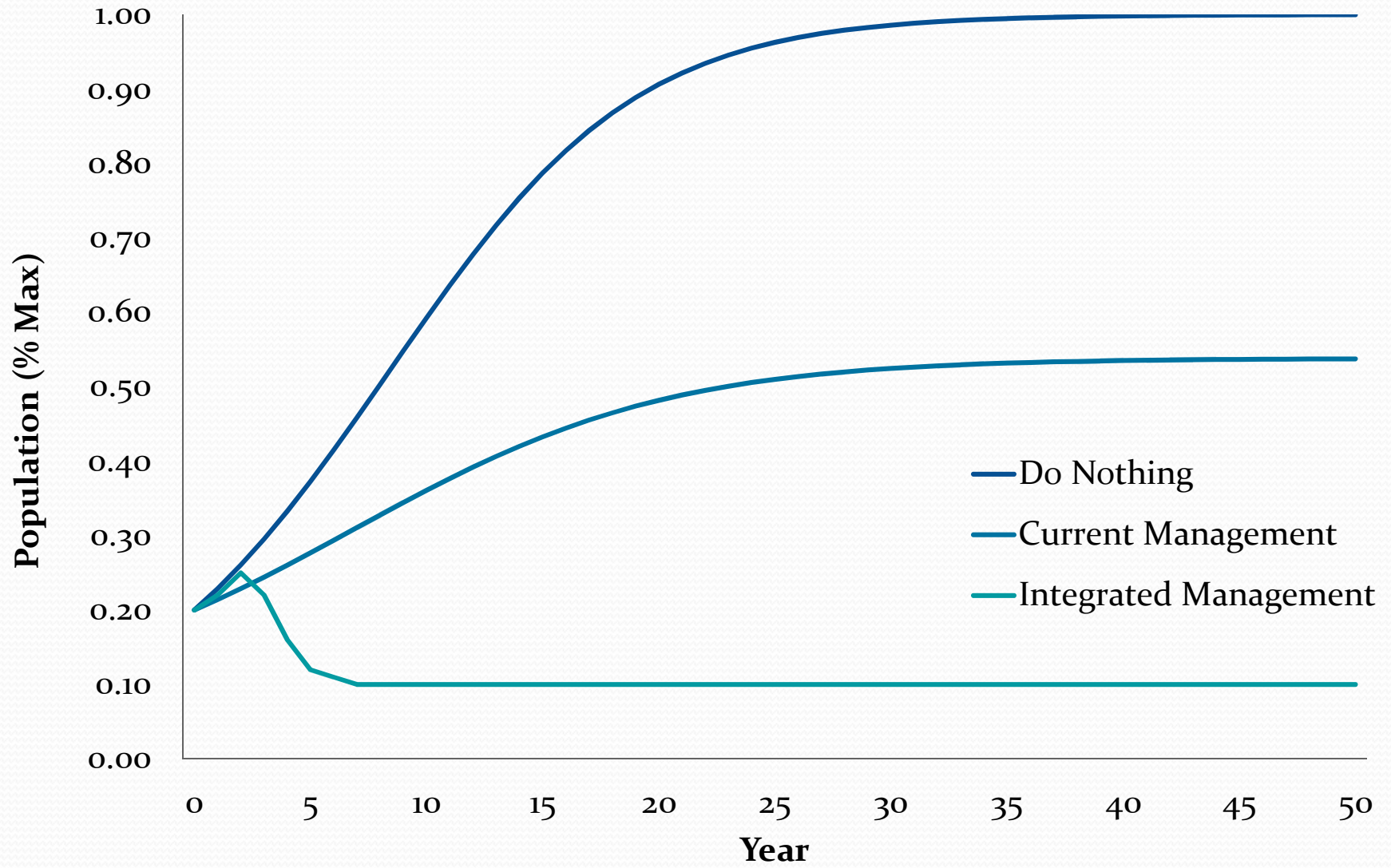




# Options Evaluated

1. Do Nothing/Status Quo
  - Allow the tulip tree to spread at natural rate
  - Initial population density at 20% of carrying capacity
2. Current management
  - Spend an average of 3.7 hours per week clearing the tree
  - Mix of Cutting, digging, burning
  - Population density (and impacts) still increasing, but at slower rate than 'do nothing'
3. Integrated Management
  - Mix of cutting, digging, burning
  - More effort, greater effectiveness (reduce to 10% of capacity)
  - Higher initial cost, but more persistent benefits

## Invasive Population (% Maximum)





## 2. Identify Costs and Benefits

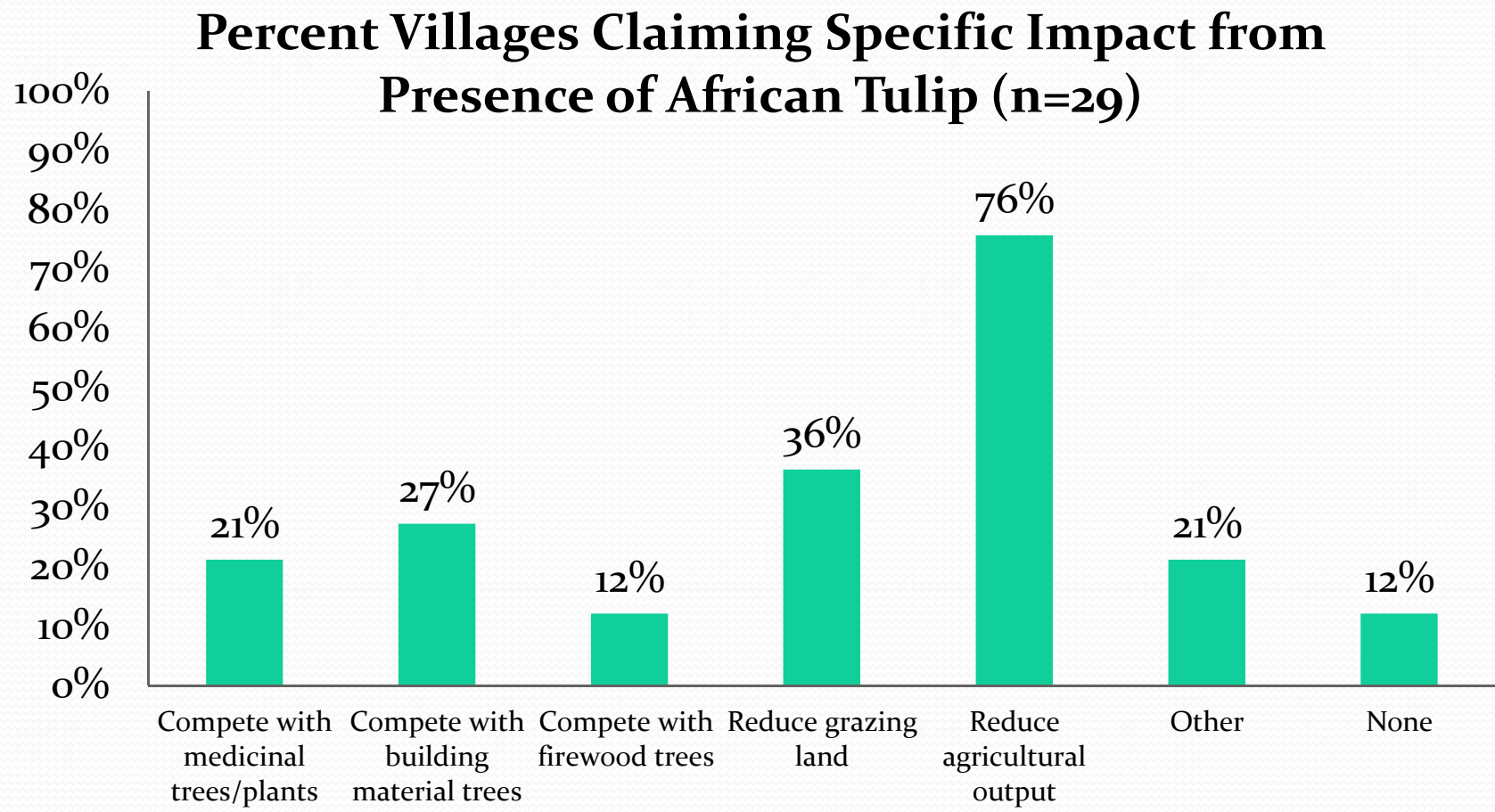


# Impacts from presence\*

- Reduces water yield and soil fertility
- Competes with dalo, cassava, yams, yaro and yaqona
- Takes up space from grazing land
- Outcompetes native species including Kura, Vesi, Kuvula and Dakua
- Makes shifting cultivation impossible
- Compete with yaqoyaqona and yavuwavu which are used as medicinal plants
- Competes with native trees used as building materials

\* Impacts can be used to value benefits of avoided damages from management

# Impacts of African Tulip



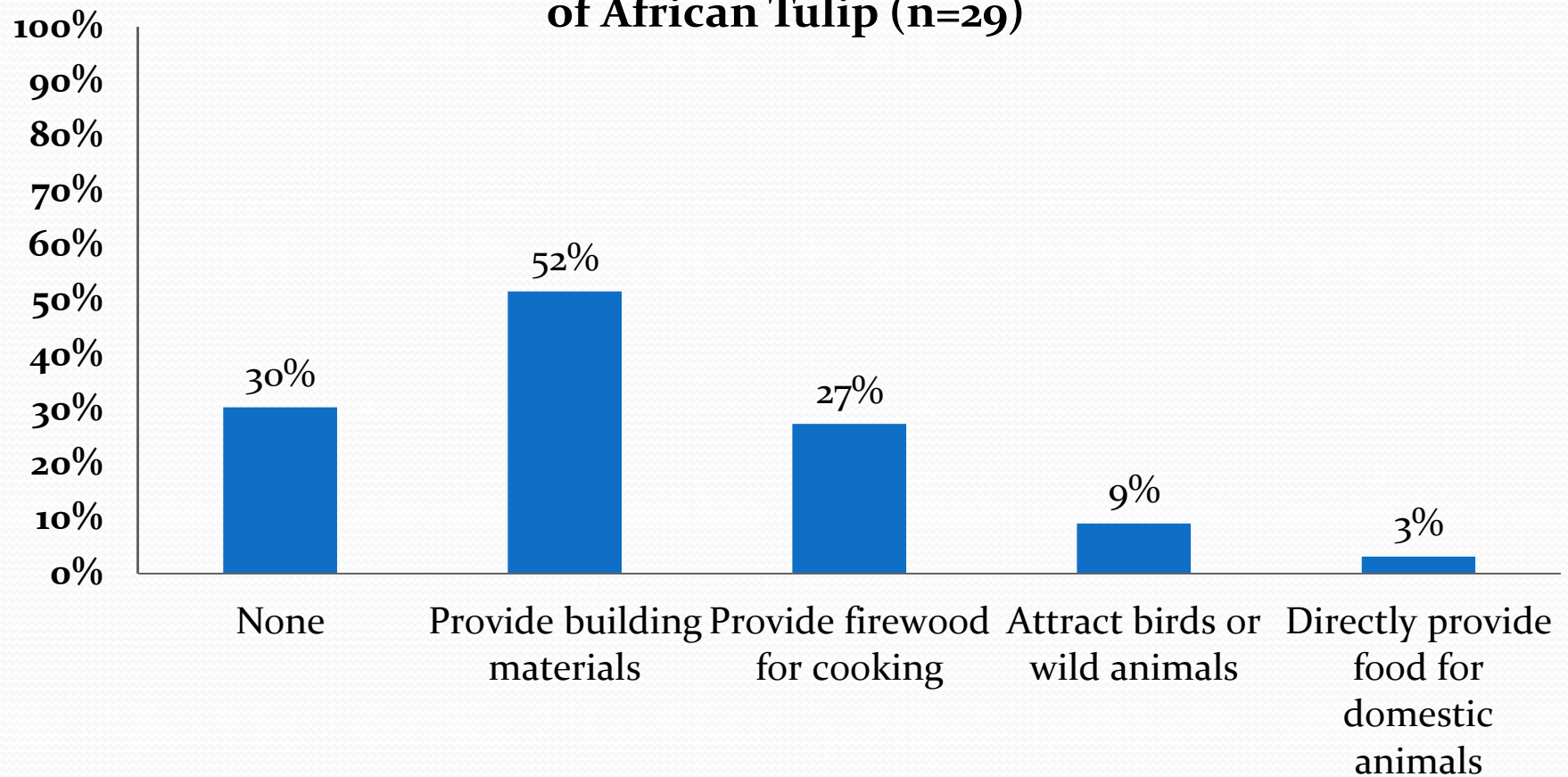


# Benefits of African Tulip

- Used to build sheds, houses, fences, flooring, structural posts
  - “The wood is light and easy to use for building materials and ladders”
- Hollowed out for boats and canoes
- The colour beautifies the forest
- Provides food for domestic animals
- Provides for birds and bats
  - “Bats feed on the seeds and the seeds are also eaten by parrots when they are young and soft”
  - “Seeds are eaten by grass carp when they fall in the river”
- Used for firewood when no other wood available

# Benefits of use

**Percent Villages Claiming Specific Benefit  
of African Tulip (n=29)**





# 3. Valuing costs and benefits

# Valuing Benefits

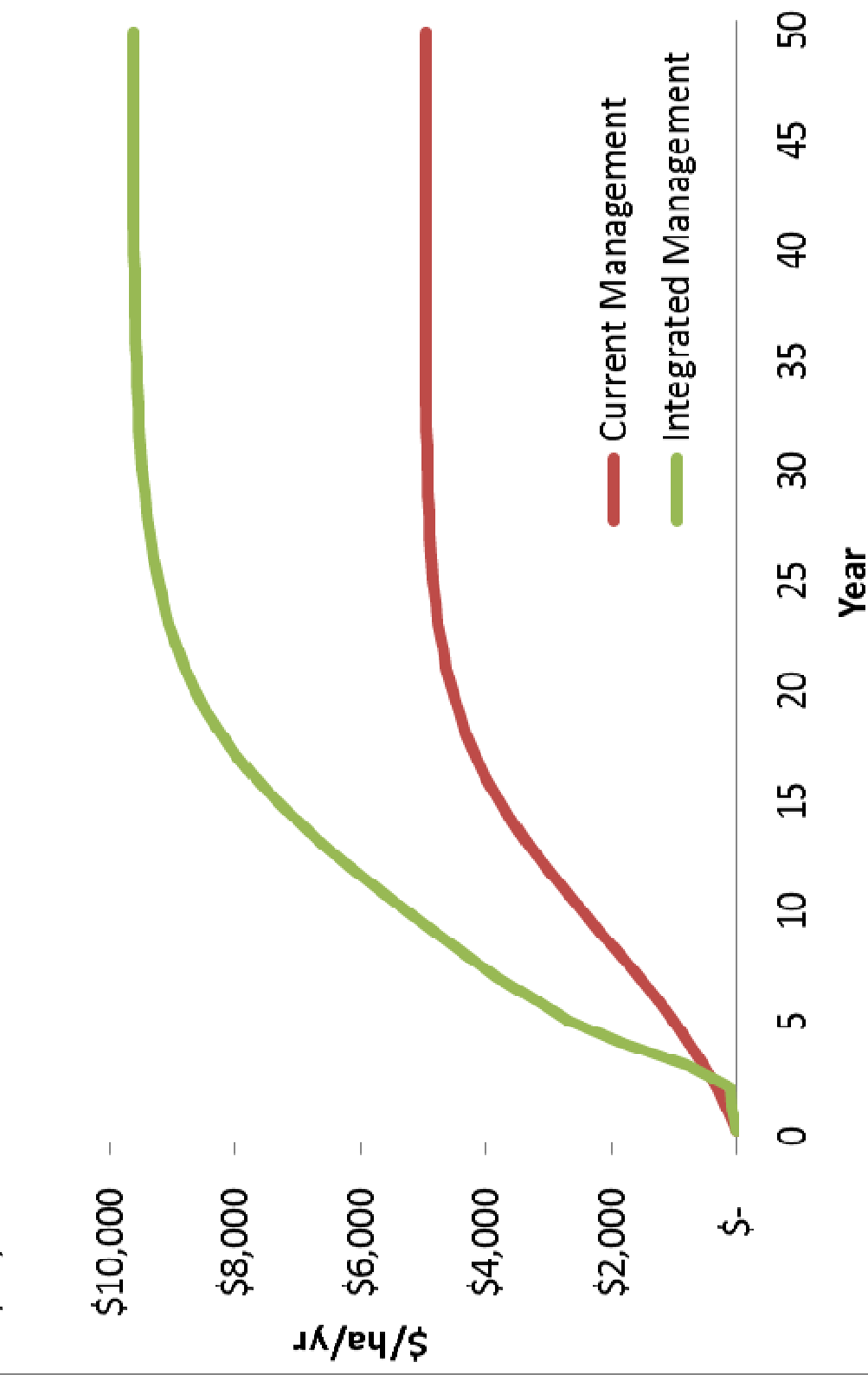
Cost/Benefit Category	Category	Unit Measurement	Unit Value (\$/units)
Benefits	Crop value	\$/kg	1
	Livestock value	\$/kg	1
	Forestry value	\$/m <sup>3</sup>	35
	Native Vegetation	ha	0

# Initial Period Values for Estimating Damages from Invasive

Cost/Benefit Category	Category	Do Nothing	Current Management	Integrated Management
Benefits*	Crop value	2,000	2,000	2,000
	Livestock value	106	106	106
	Forestry value	1	1	1

\* These are the 'losses' in benefits due to damages relative to a scenario where there is no invasive

## Monetary Benefits from Avoided Damages (\$/ha/yr)



# Valuing costs

Category	Unit Measurement	Unit Value (\$/unit)
Glyphosate herbicide	\$/litre	\$ 15
2,4 D + dicamba herbicide	\$/litre	\$ 125
Triclopyr herbicide	\$/litre	\$ 45
Labour	\$/man day	\$ 30
Bulldozer or digger hire	\$/day	\$ 300
Machete, gloves, and hand saw	\$/item	\$ 75
Knapsack sprayer	\$/item	\$ 210
Precision drench gun	\$/item	\$ 120



# Valuing costs

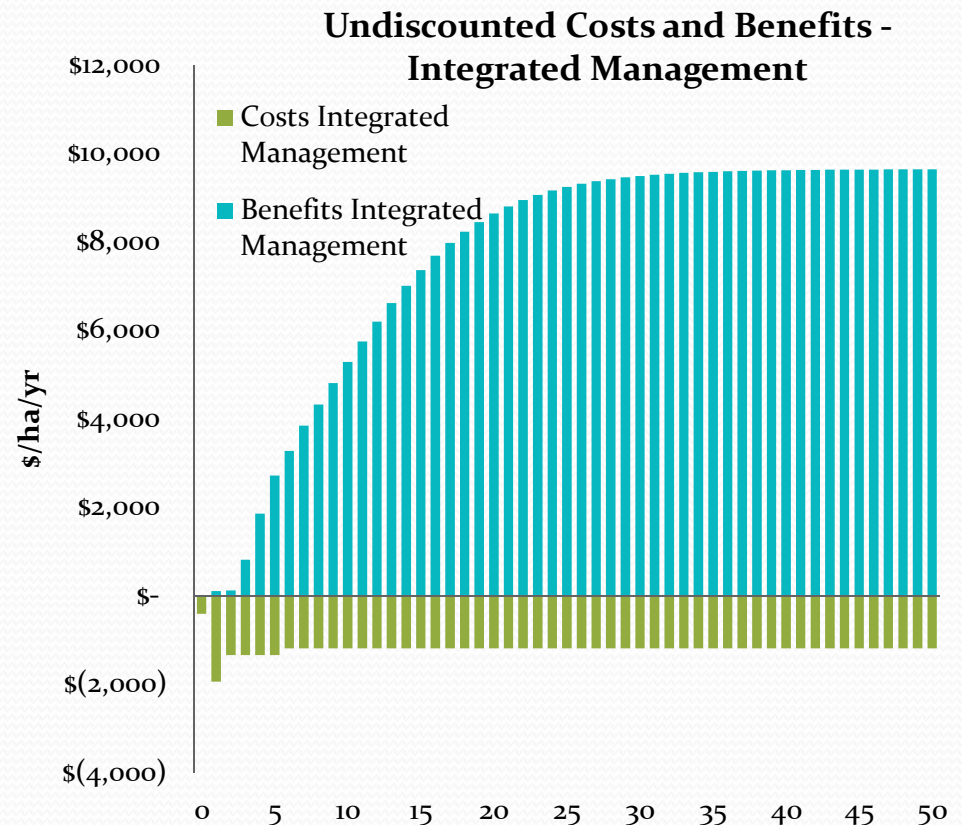
- The monetised costs can be estimated by multiplying unit costs incurred in each year by the physical values of each input
- Annual costs: labour, herbicides, machine rental
- Initial capital costs: machete, sprayer, drench gun

Option	Year 0	Years 1-5	Years 6-50
Do Nothing	\$0	0	0
Current Management	-\$300	-\$1,472	-\$722
Integrated Management	-\$420	-\$1,950	-\$1,200

## 4. Aggregate costs and benefit

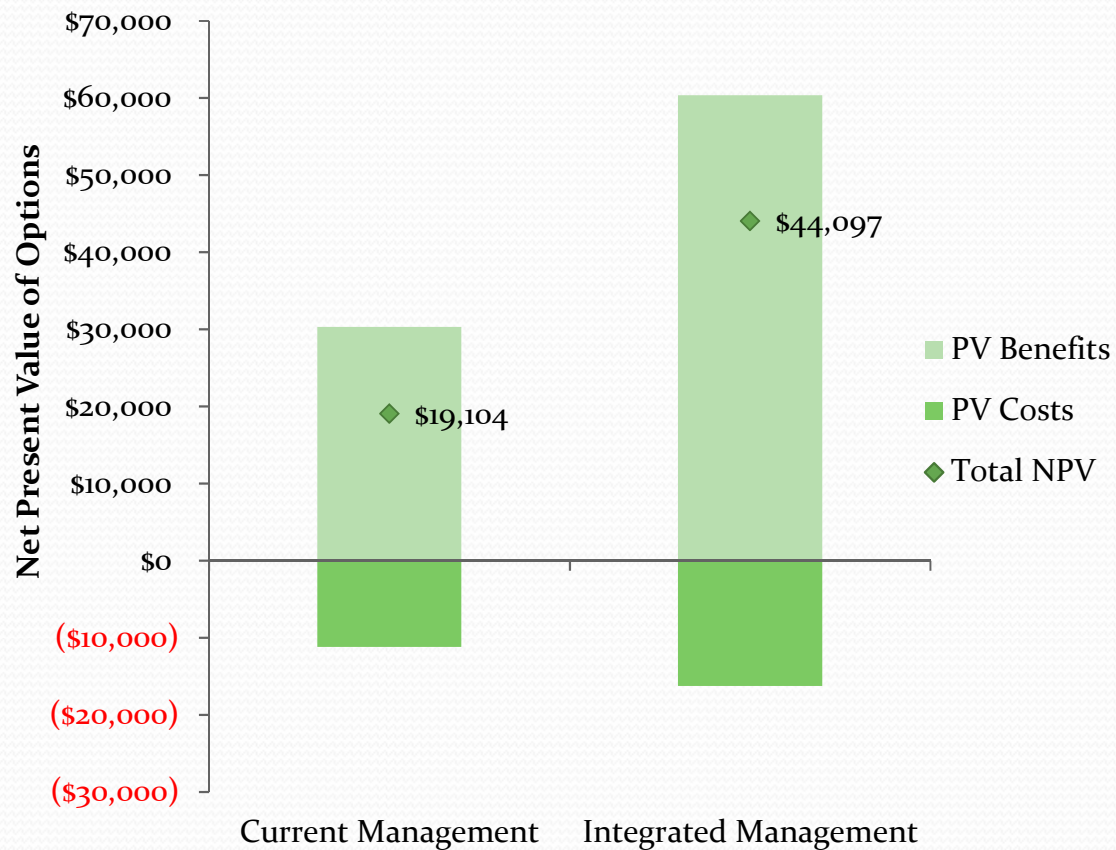
- Discount rate = 8%
- Time periods = 50 years
- Project area = 1 hectare

$$NPV = \sum_{t=1}^T \frac{B_t - C_t}{(1+r)^t}$$



# NPV and BCR

Net Present Value (per ha) - African Tulip Control



Option	Benefit-Cost Ratio
Do Nothing	1.0
Current Management	2.7
Integrated Management	3.7



## 5. Conduct Sensitivity Analysis

1. Initial population (as % of max) – 0.5 and 2 times base assumption.
  - This changes the initial population of the African tulip tree from 20 to 10% or 40%.
2. Effectiveness of management – 0.5 and 2 times base assumption.
  - This adjusts the pathway of the population growth curves for the two intervention options.
  - An option that is assumed to be twice as effective means that the species is controlled in about half the time as the initial assumption.
3. Discount rate – 4% and 12%

# Sensitivity Analysis

Net Present Value with Varying Effectiveness and Initial Population

Option	Effectiveness	Initial Population (relative to max)		
		10%	20%	40%
Current Management	0.5 x base	\$11,899	\$8,320	\$8,827
	1.0 x base	\$18,748	\$19,104	\$27,472
	2.0 x base	\$26,371	\$31,258	\$49,334
Integrated Management	0.5 x base	\$16,490	\$34,445	\$28,973
	1.0 x base	\$30,158	\$44,097	\$64,553
	2.0 x base	\$35,063	\$47,858	\$73,147

Both options preferred over 'do nothing' as  $NPV > 0$   
Integrated management has highest NPV for all cases

# Sensitivity Analysis

Net Present Value with Varying Discount Rates

Option	4%		8%		12%	
Do Nothing	\$	-	\$	-	\$	-
Current Management	\$	50,229	\$	19,104	\$	8,031
Integrated Management	\$	106,951	\$	44,097	\$	21,184

Both options preferred over 'do nothing'  
Integrated management has a higher NPV



## 6. Consider Distributional Impacts

- Key stakeholders
  1. Indigenous Fijians
  2. Indian Fijians
  3. Government
- Qualitatively, all stakeholders would see net benefits from management
  - Increased productivity
  - Reduced population (and spread)
  - Costs would be incurred by both villagers (labour and inputs) and government (extension and coordination)



## 7. Policy Recommendation

- The benefit-cost analysis estimated three options to manage the African tulip tree:
- The integrated approach to managing the African tulip tree was estimated to yield the highest net present value of all management options investigated in this study
  - benefits of management outweighed costs by a ratio of almost 4 to 1.
  - estimated NPV of \$44,000/ha with discount rate of 8%
  - scales up to net benefit of more than \$1.3 million/village
  - it is the preferred option, provided that the resources are available



## 7. Policy Recommendation

- The current management approach was not as effective, although it still yielded positive net benefits for landowners
  - Benefit-cost ratio of 2.7:1 and NPV of \$19,000/ha
  - Scales up to village net benefit of \$500,000
  - Should thus be considered a viable option over the do nothing approach, particularly if herbicides and machinery are difficult to obtain