

Economic Analysis of Invasive Species: African Tulip Tree in Fiji

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



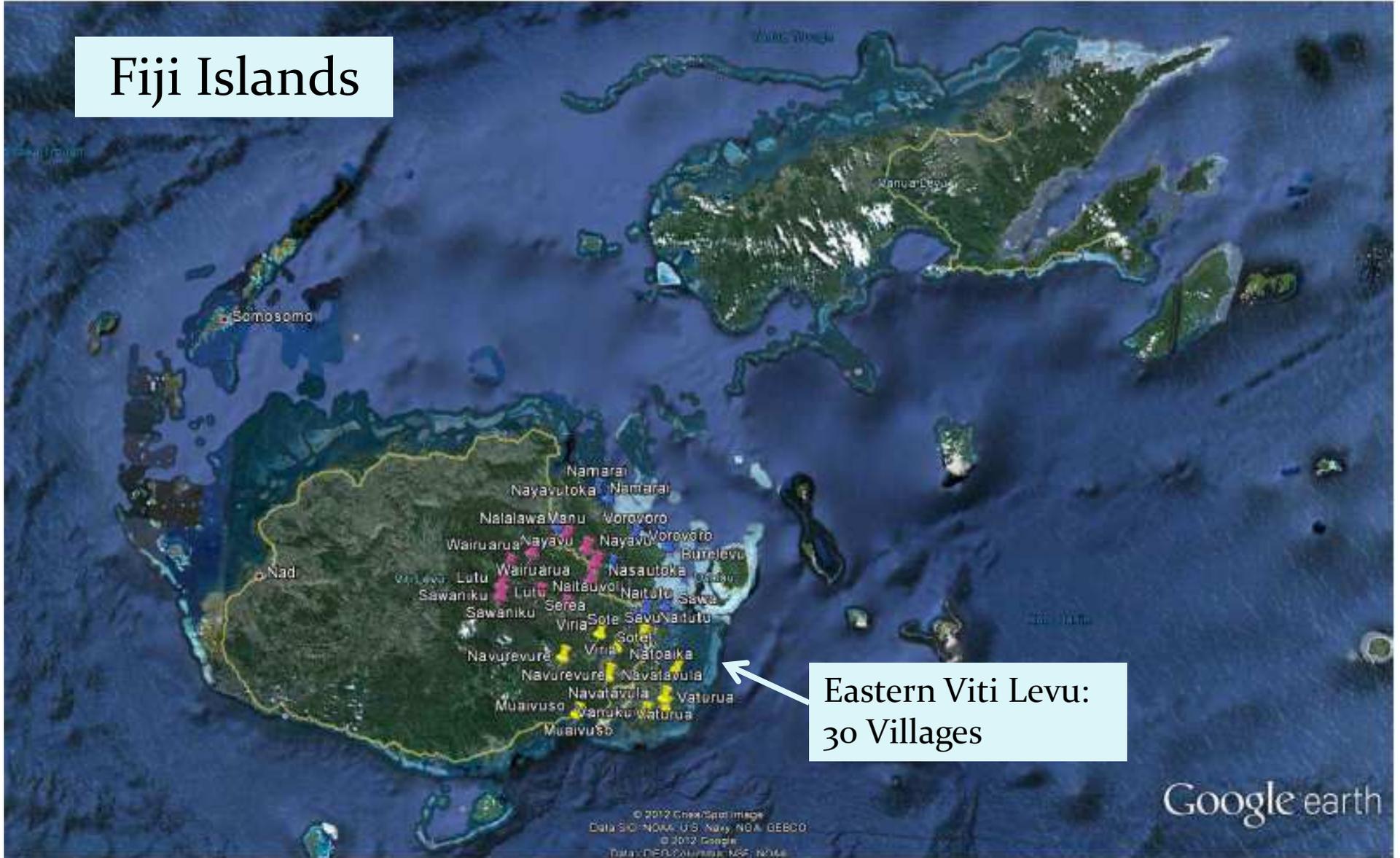
7. Prepare recommendations



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

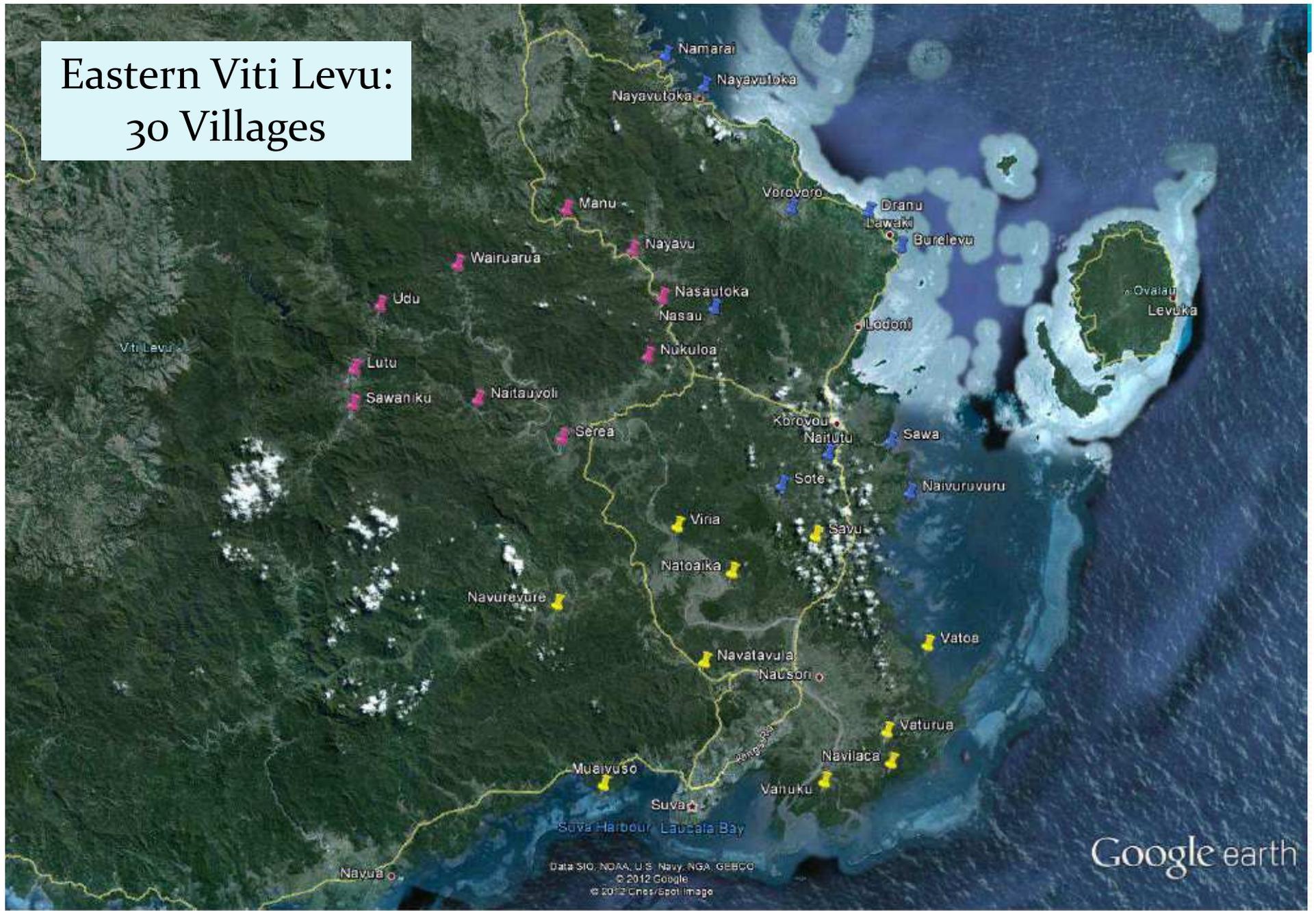




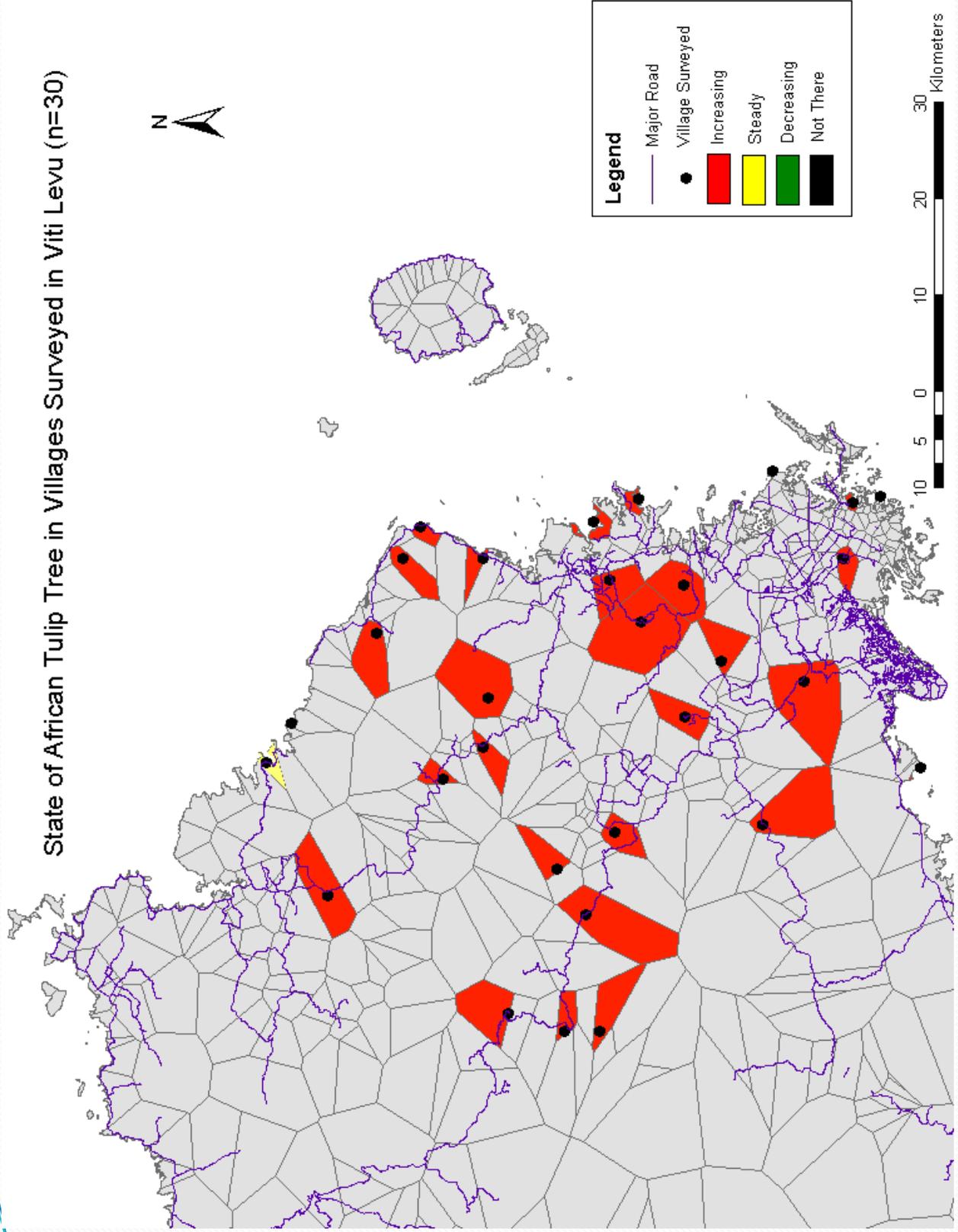
Key Data Source - Survey

- 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



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

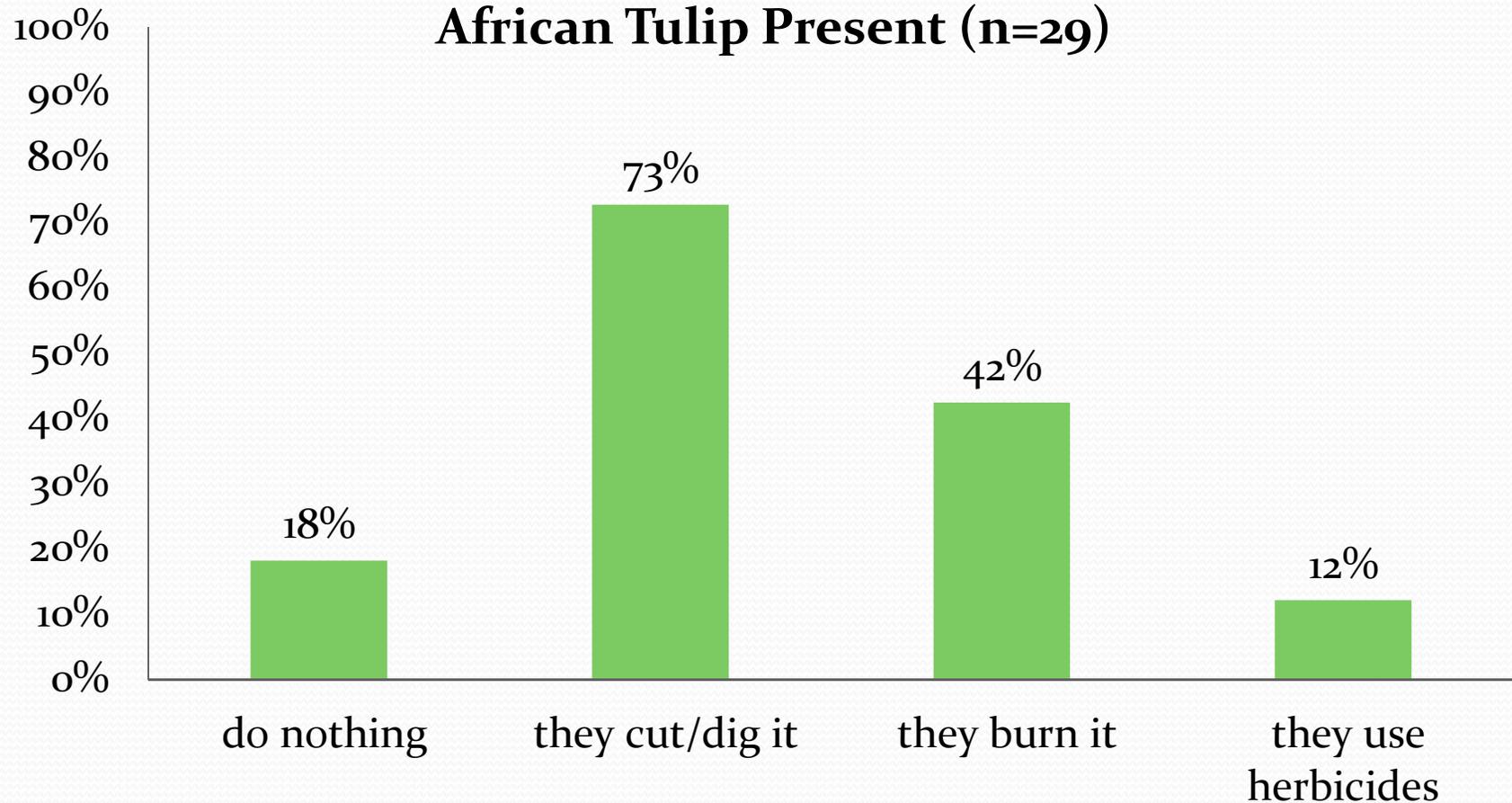


Management and Adaptation

- 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

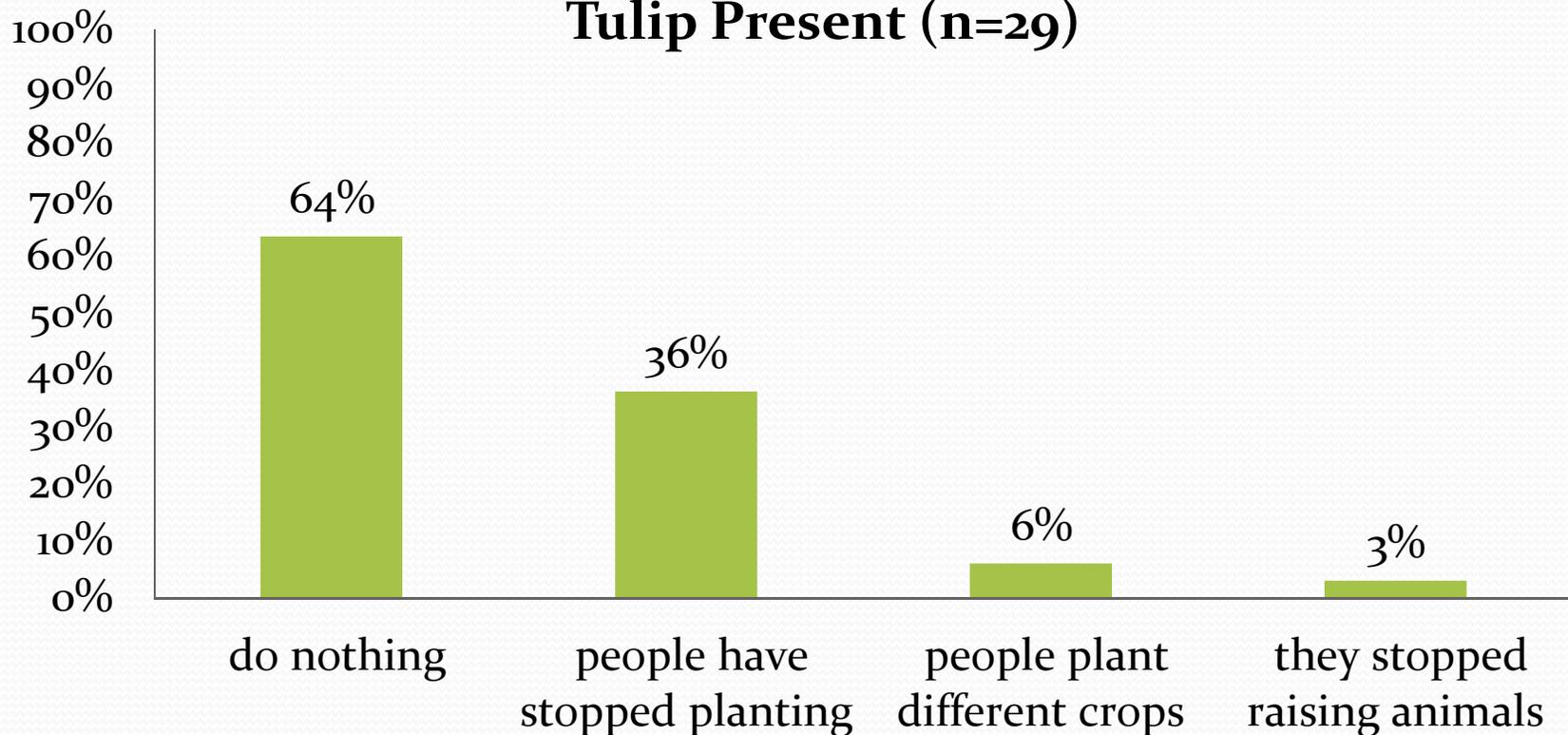
Village-level Management

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



Village-level Adaptation

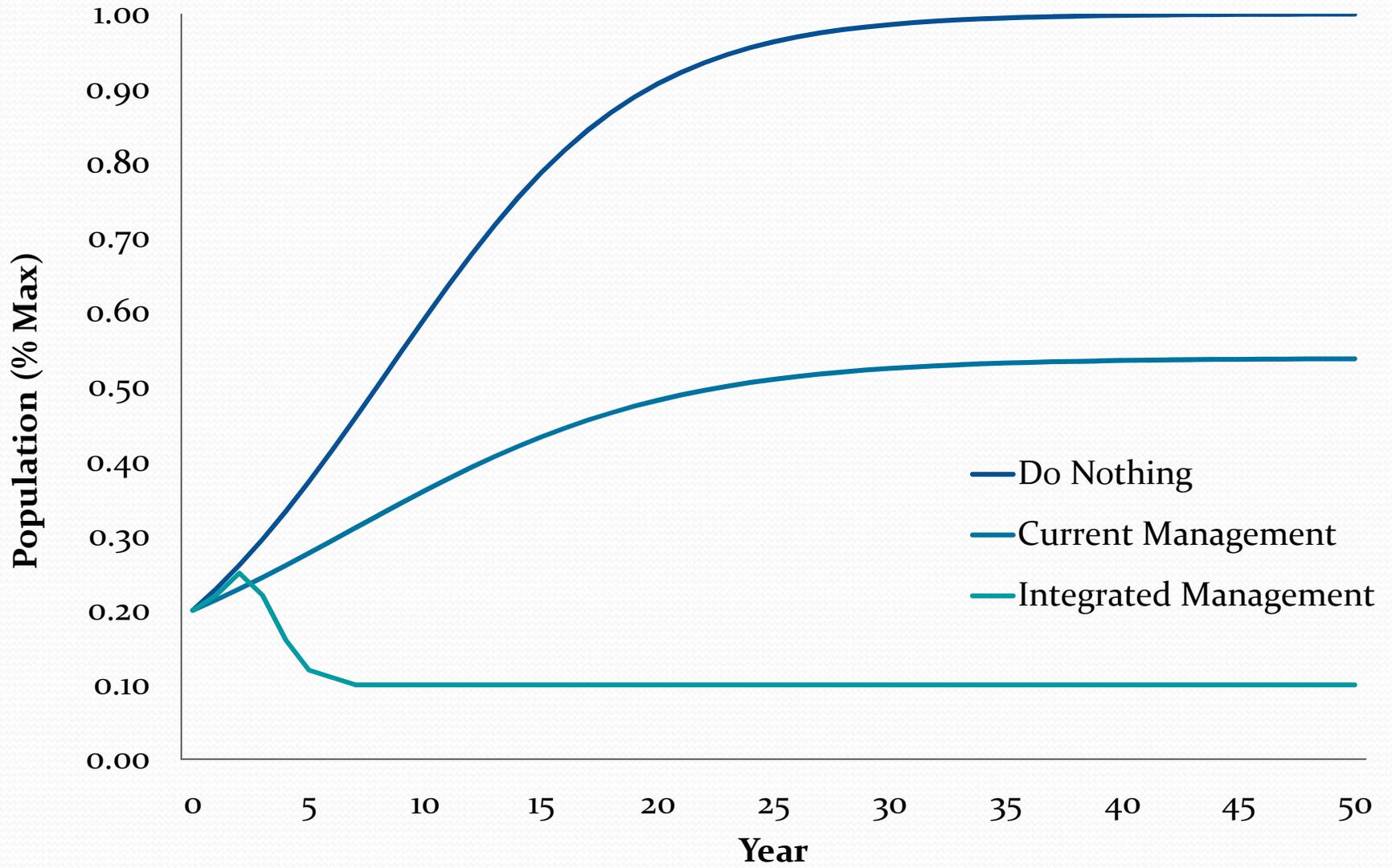
Percent Villages with Specific Reaction if African Tulip Present (n=29)



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

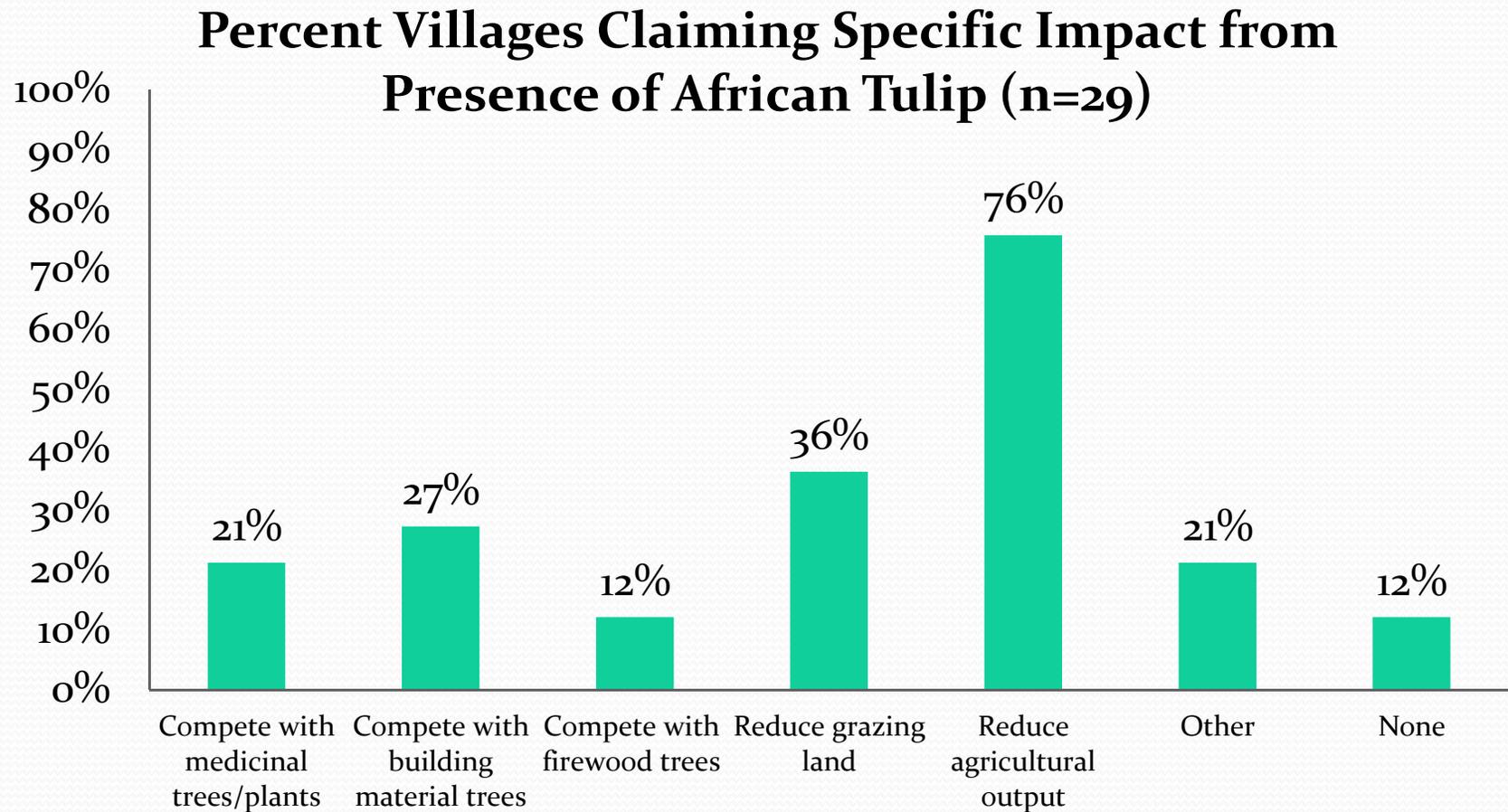


Impacts from presence*

- 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, Kouvula 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



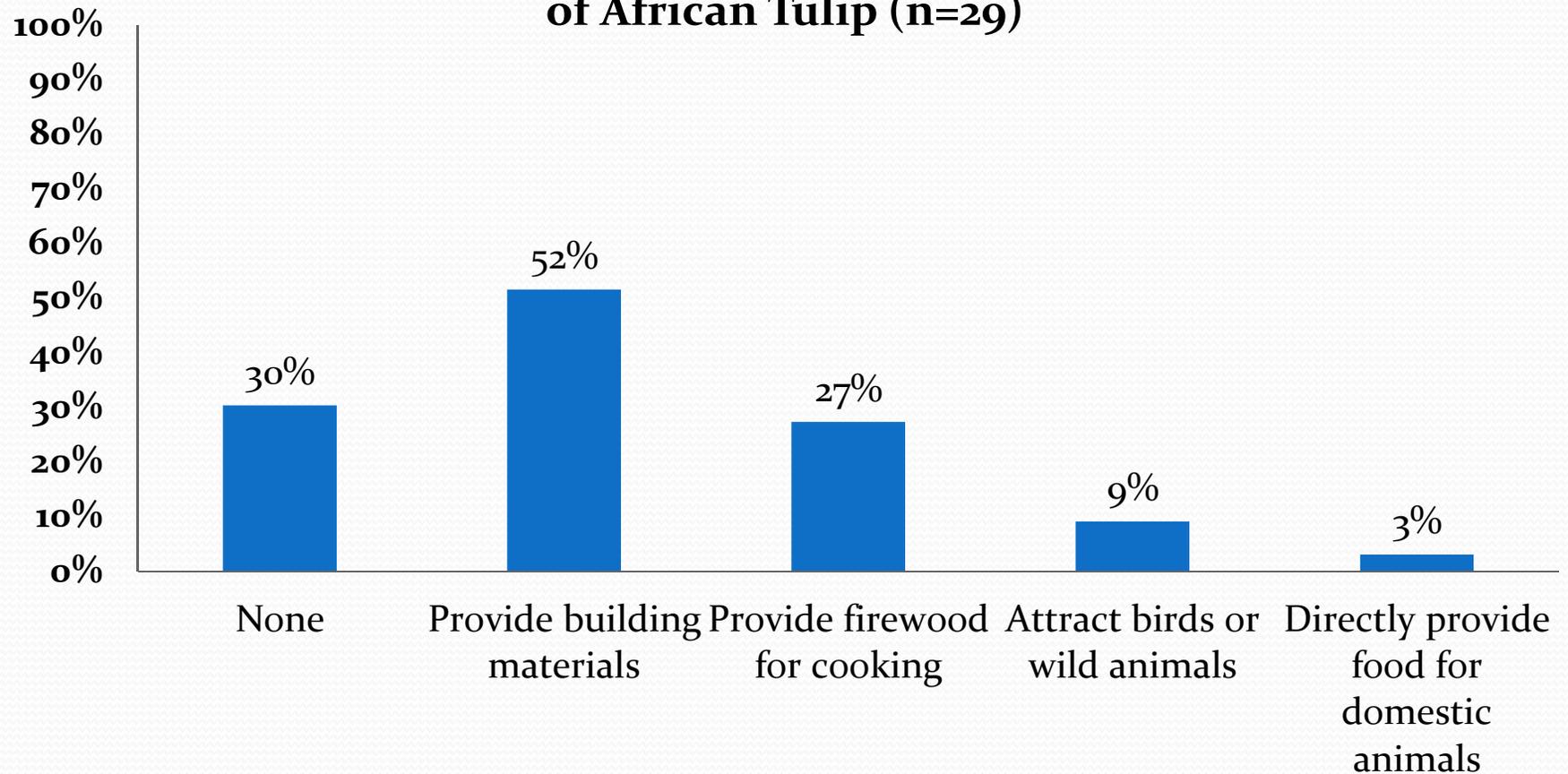


Benefits of African Tulip

- 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

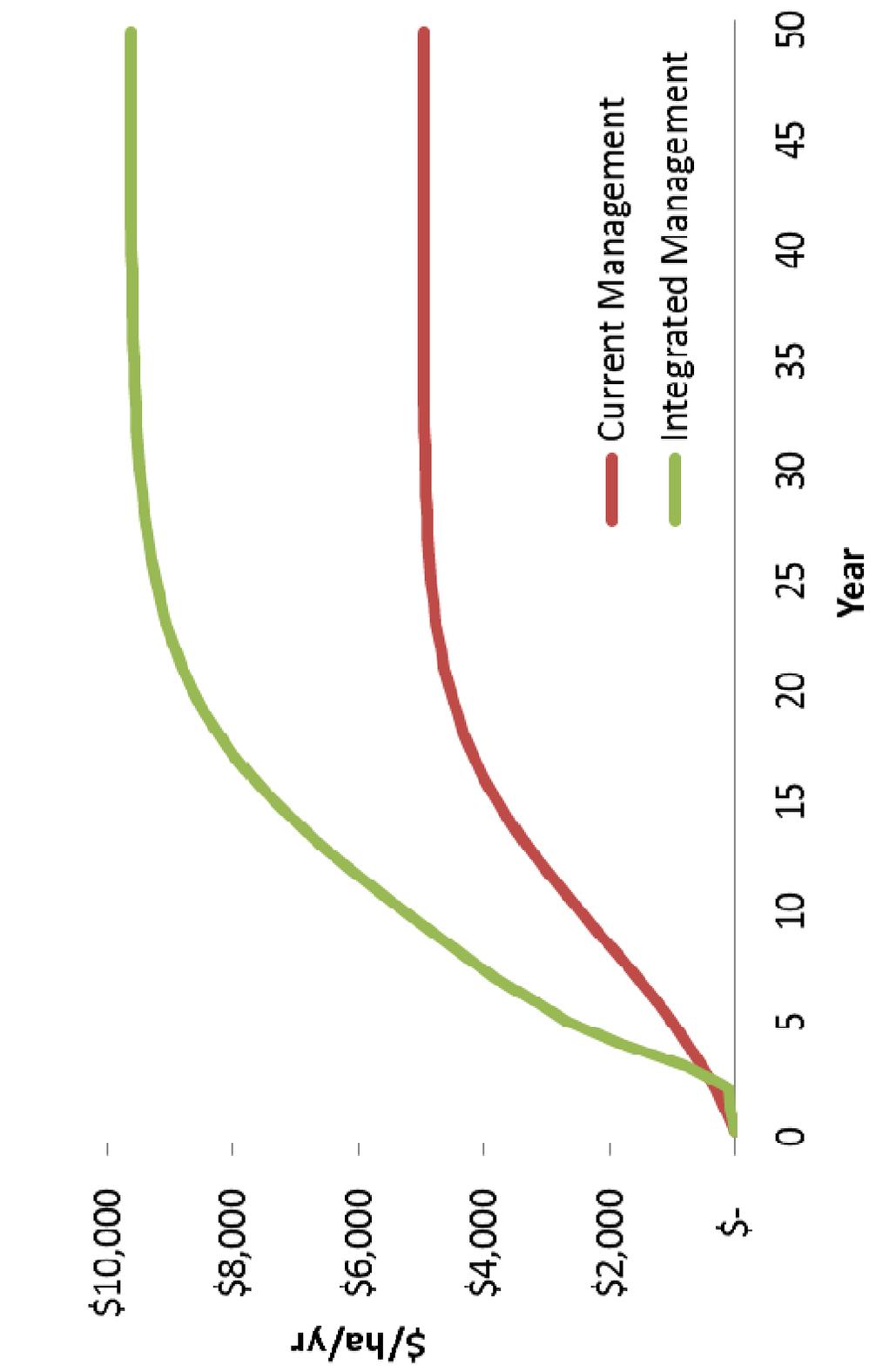
Cost/Benefit Category	Category	Unit Measurement	Unit Value (\$/units)
Benefits	Crop value	\$/kg	1
	Livestock value	\$/kg	1
	Forestry value	\$/m ³	35
	Native Vegetation	ha	0

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

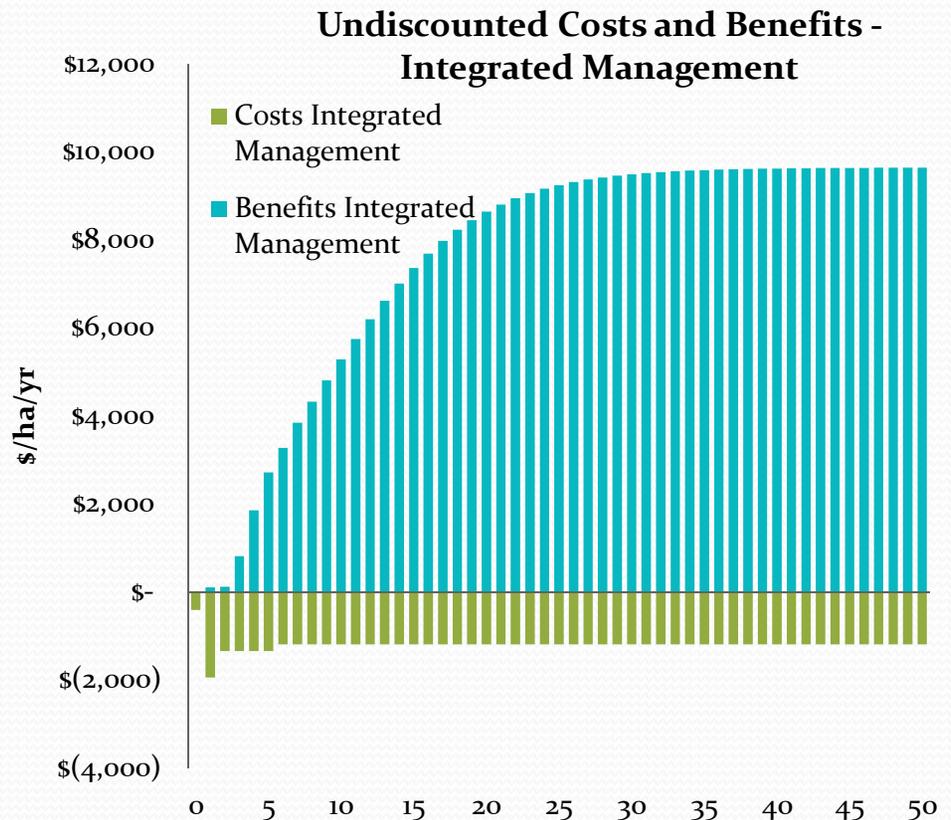
- The monetised costs can be estimated by multiplying unit costs incurred in each year by the physical values of each input
- Annual costs: labour, herbicides, machine rental
- Initial capital costs: machete, sprayer, drench gun

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

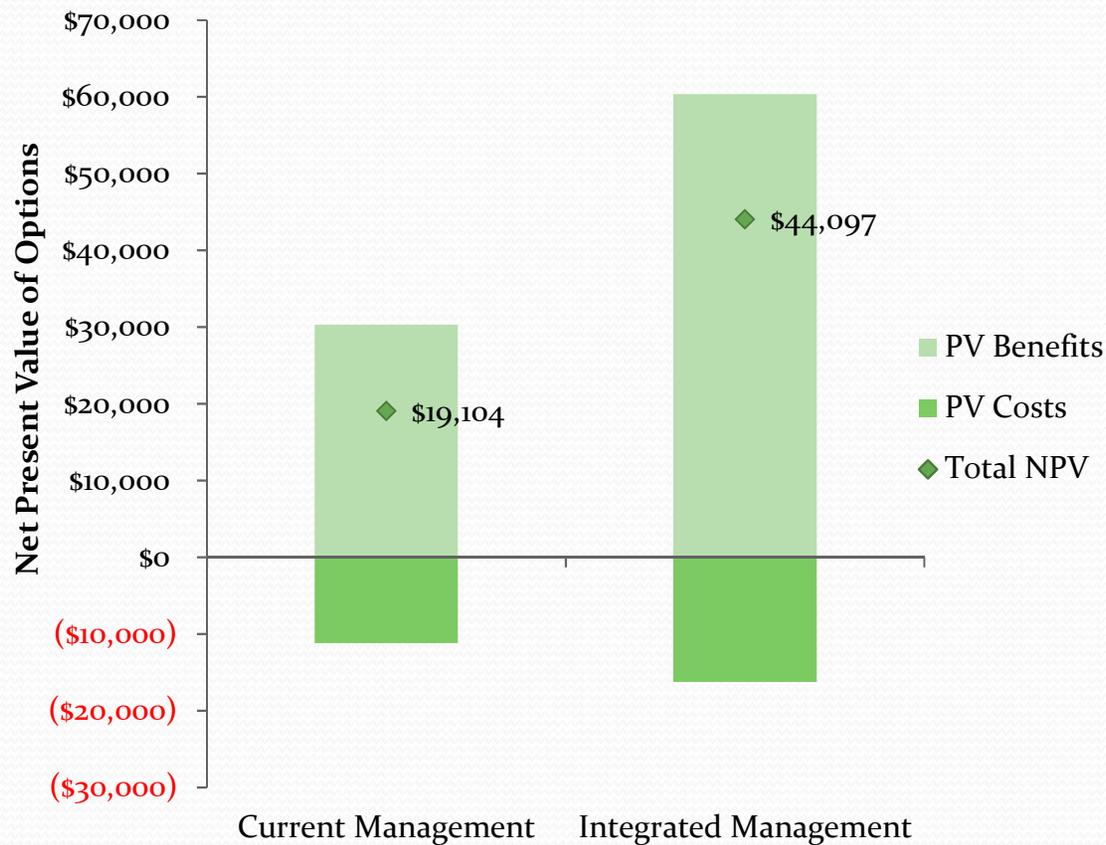
- Discount rate = 8%
- Time periods = 50 years
- Project area = 1 hectare

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



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