Triple Wins for Kenyan Agriculture - Capturing Synergies Between Agricultural Productivity, Climate Change Adaptation & GHG Mitigation

Claudia Ringler, IFPRI

on behalf of Elizabeth Bryan, Barrack Okoba, Jawoo Koo, Mario Herrero, and Silvia Silvestri

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Outline

1. Background and Conceptual Framework
2. Management Practices and Adaptation Strategies
3. Agricultural Mitigation and Productivity
4. Productivity and Profitability
5. Triple-Win Strategies

BACKGROUND & CONCEPTUAL FRAMEWORK

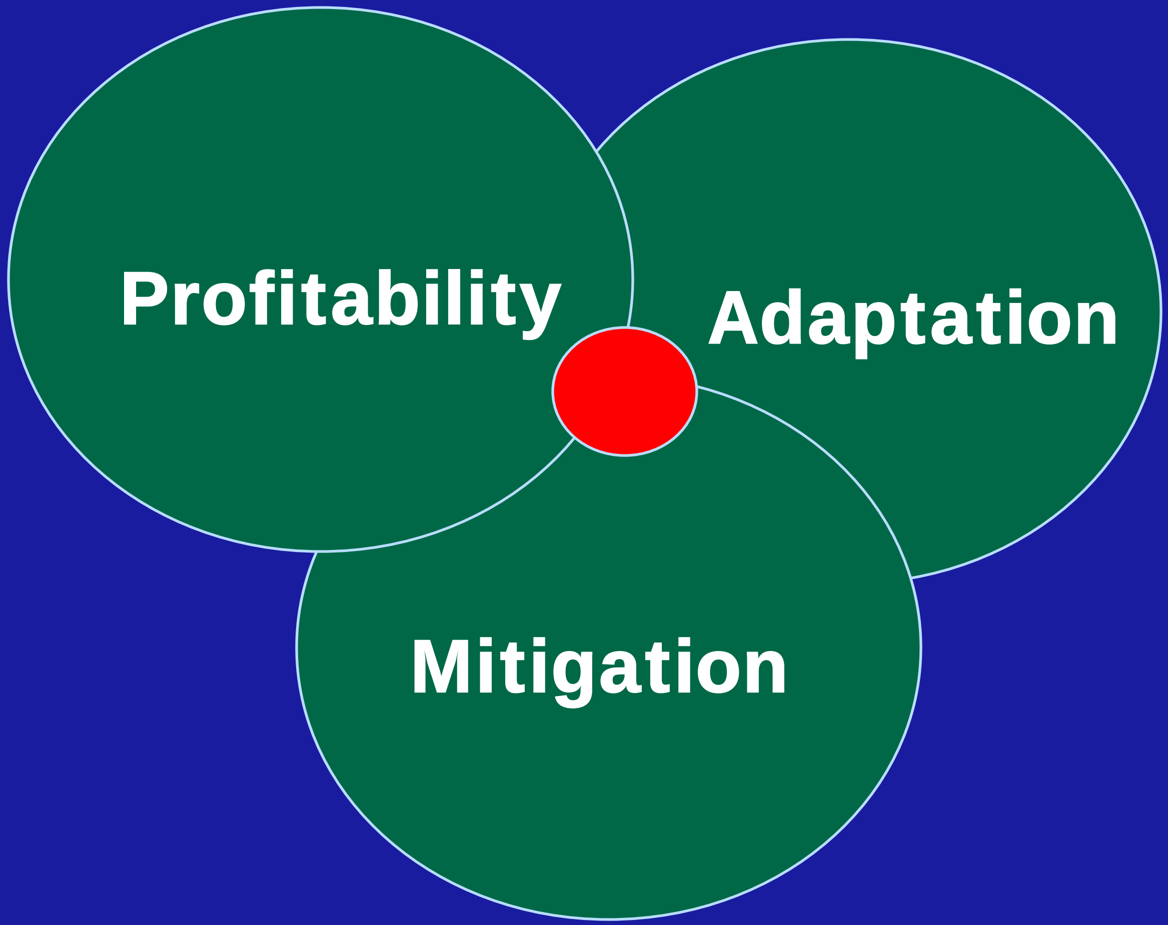
Synergies and Tradeoffs between Mitigation and Food Security

Mitigation Potential	Food Security Prospects: Low	Food Security Prospects: High
High	Second-generation biofuels Conservation tillage / residue management [when tradeoffs with livestock feed]	Integrated soil fertility management Improved seed Low-energy irrigation Conservation tillage / residue management Improved fallow
Low	Overgrazing Soil nutrient mining Bare fallow	GW pumping Mechanized farming

Food Security Prospects

Source: Adapted from FAO (2009)

SYNERGIES & TRADEOFFS



SYNERGIES: WHAT THE LITERATURE SUGGESTS

Management practices	Productivity		Variability	Adaptation	Mitigation potential
	short term	long term			
Improved crop varieties and/or types	↑	↑	↓	+++	Depends on variety/type
Changing planting dates			↓	+++	
Improved crop/fallow rotation/rotation with legumes	↓	↑		++	High, particularly for rotation with legumes
Use of cover crops	↑	↑		++	High
Appropriate fertilizer/manure use	↑	↑	↓	+++	High, particularly when underutilized as in SSA
Incorporation of crop residues	↑	↑	↓	+++	High
Reduced/zero tillage	↓	↑	↓	+	High
Agroforestry	↓	↑	↓	+	High
Irrigation/water harvesting	↑	↑	↓	+++ when well designed and maintained	Low to high depending on whether irrigation is energy intensive or not
Bunds, terraces, ridge and furrow, diversion ditches	↓	↑	↓	+++	Low, minus soil carbon losses due to construction
Grass strips	↓	↑	↓	+++	Positive mitigation benefits
Sources: FAO 2009, Smith et al. 2008					

STUDY SITES & DESIGN

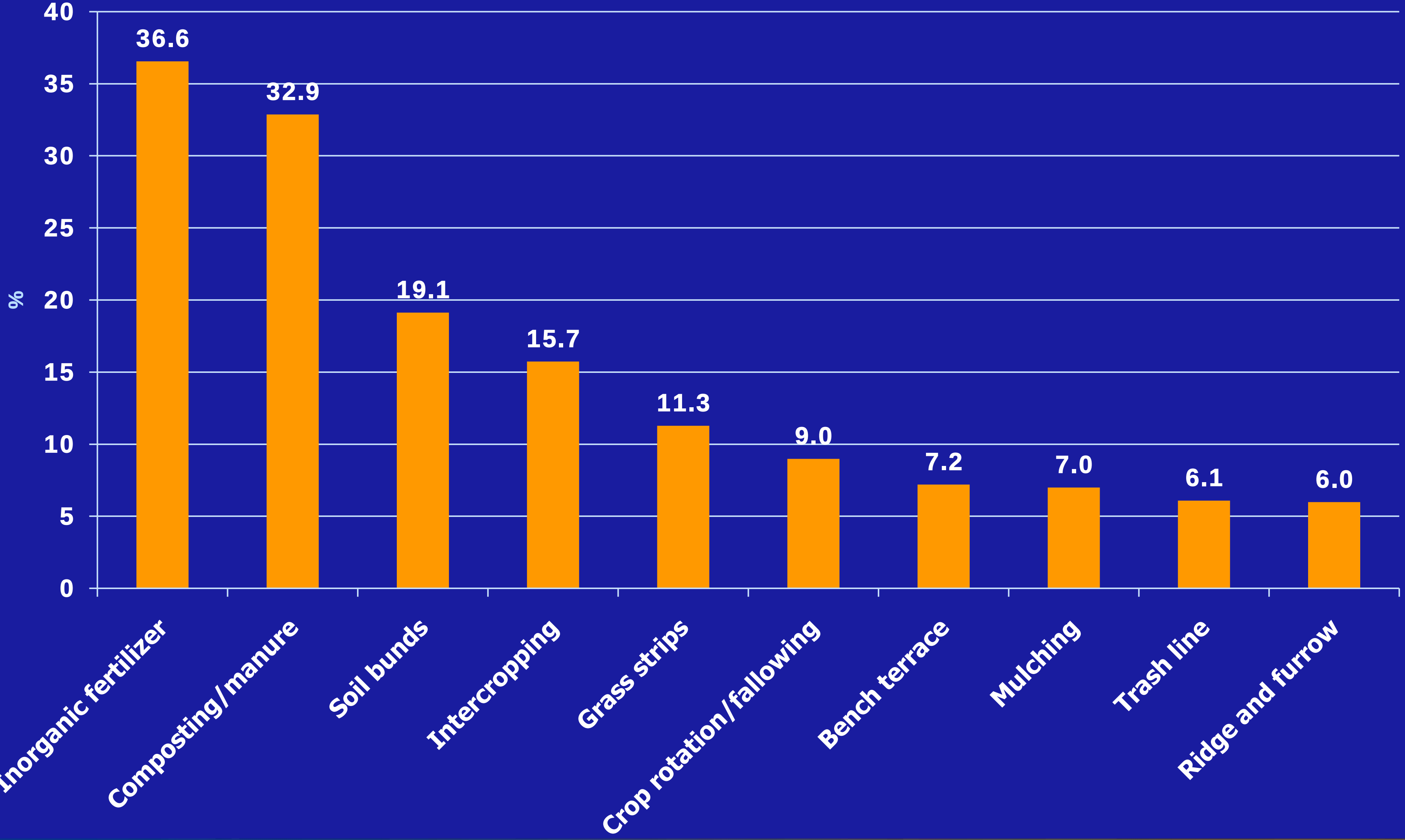
District	AEZ	Freq.
Garissa	Arid	134
Mbeere South	Semi Arid	97
Njoro	Semi Arid	104
Mukurweini	Temperate	95
Othaya	Temperate	88
Gem	Humid	96
Siaya	Humid	96
		710

METHODS TO ASSESS SYNERGIES/TRADEOFFS

- Descriptive analysis of land management practices and adaptation strategies
- Just and Pope production function to show yield and yield variability implications of management strategies
- The CERES-Maize 4.5 model and DSSAT-CENTURY module to simulate maize growth/yield and soil organic matter dynamics
- ILRI livestock simulation model

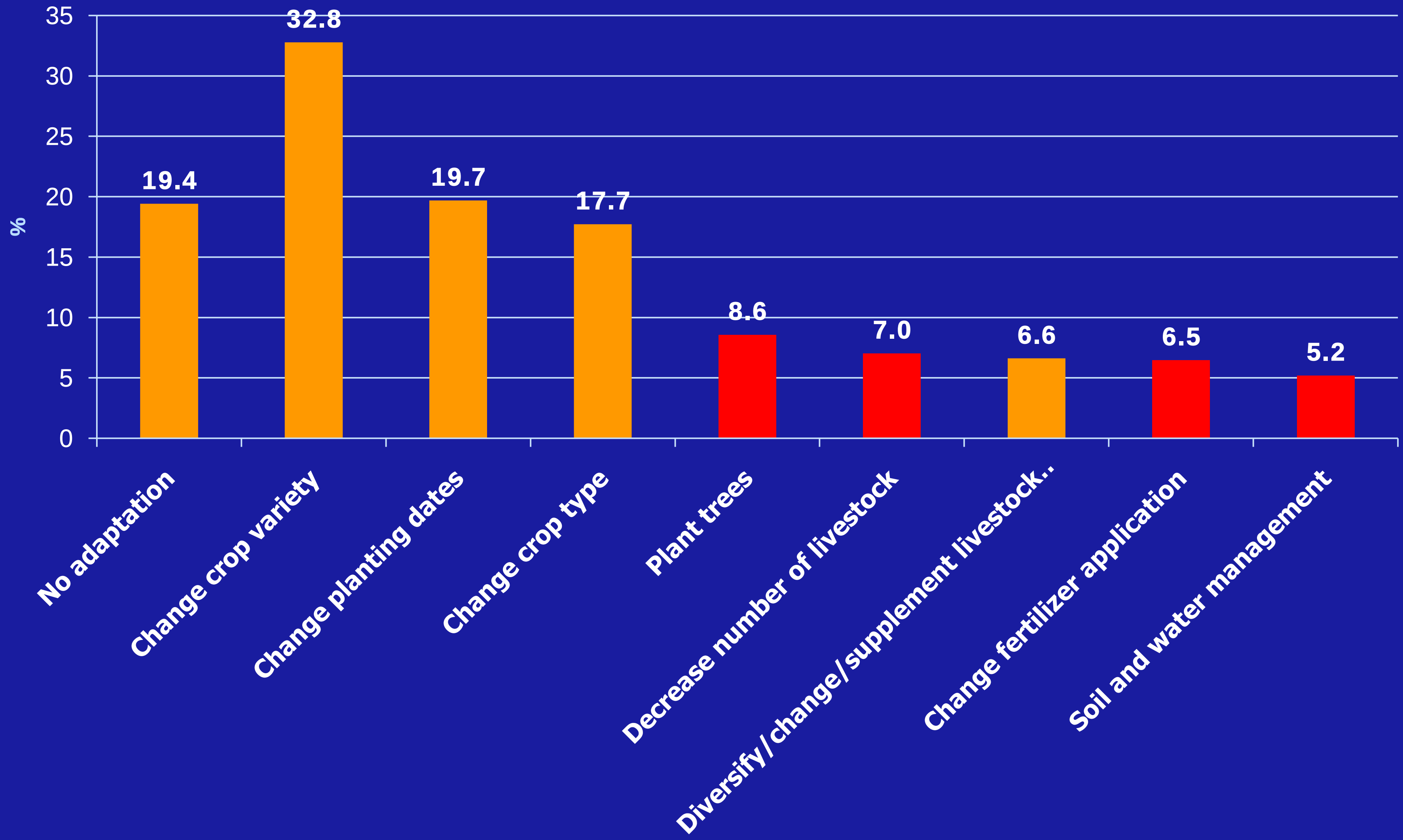
MANAGEMENT PRACTICES & ADAPTATION STRATEGIES

What land management practices are farmers using on cropland?



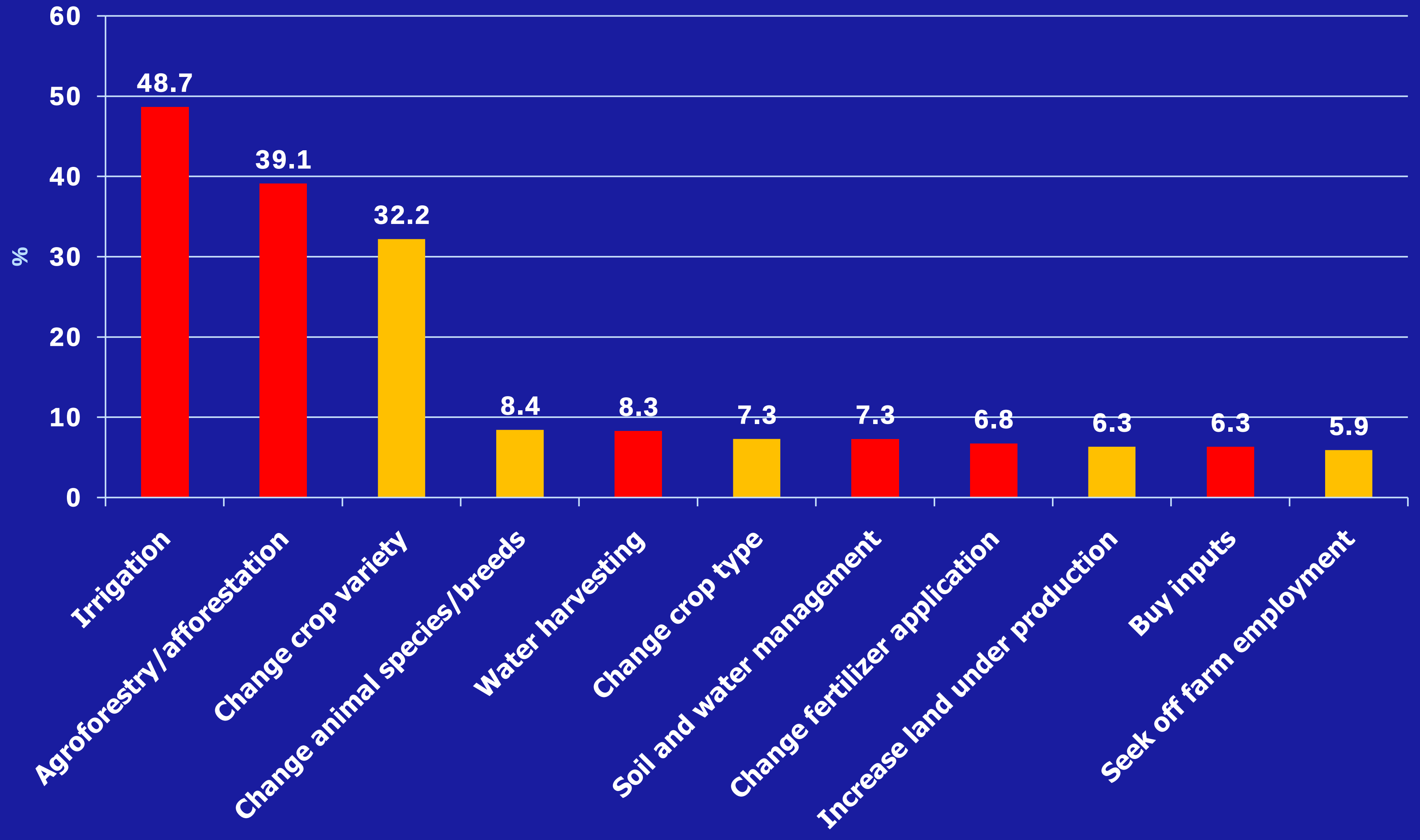
Source: IFPRI-KARI survey 2010

What adaptation strategies have farmers adopted?



Source: IFPRI-KARI survey 2010

WHAT ADAPTATION STRATEGIES WOULD FARMERS LIKE TO ADOPT?



Source: IFPRI-KARI survey 2010

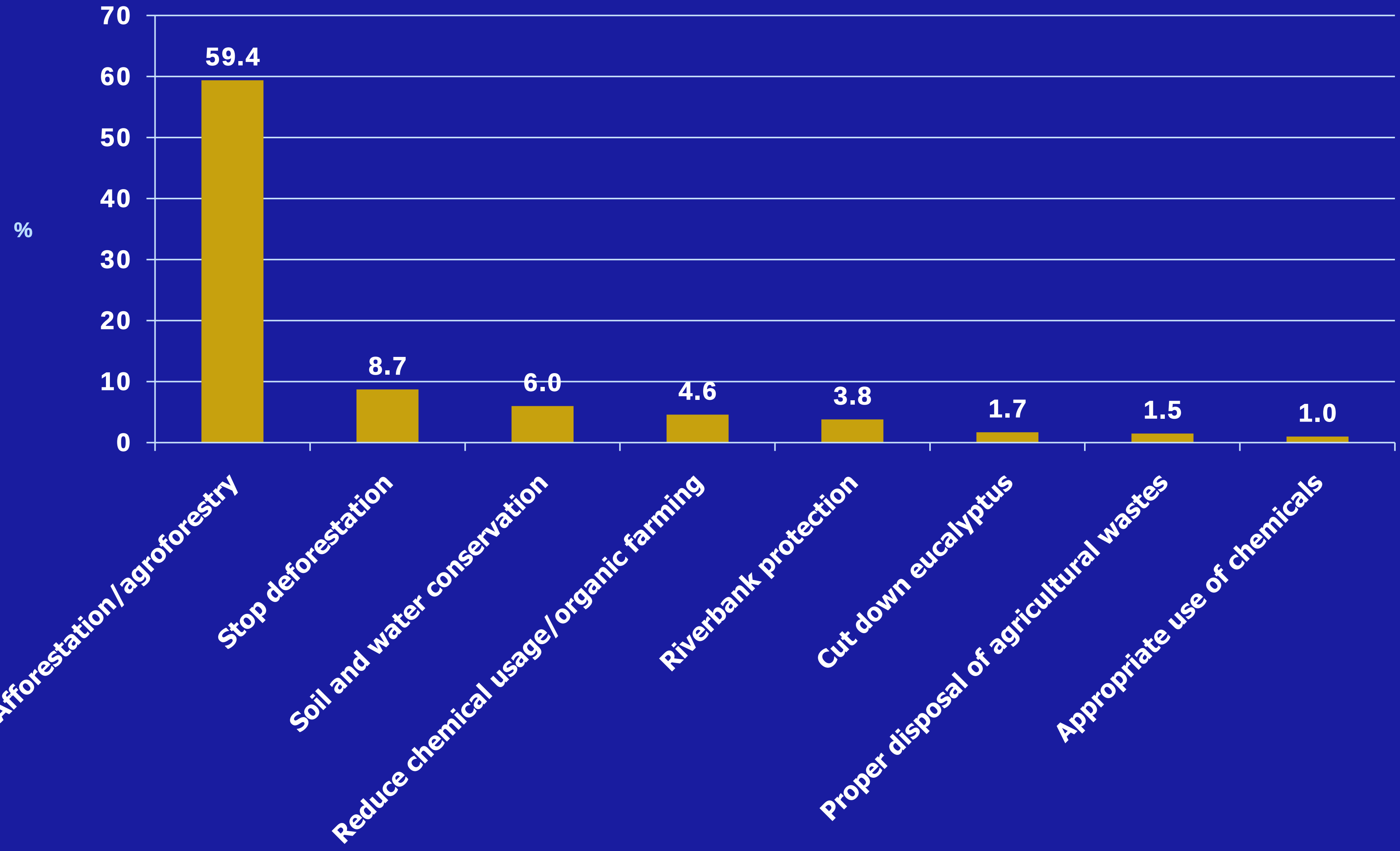
MITIGATION AND PRODUCTIVITY

Are farmers aware of the linkages between agriculture and climate change?

- 67% of farmers stated that they are aware of the link between agriculture and CC, possibly because of

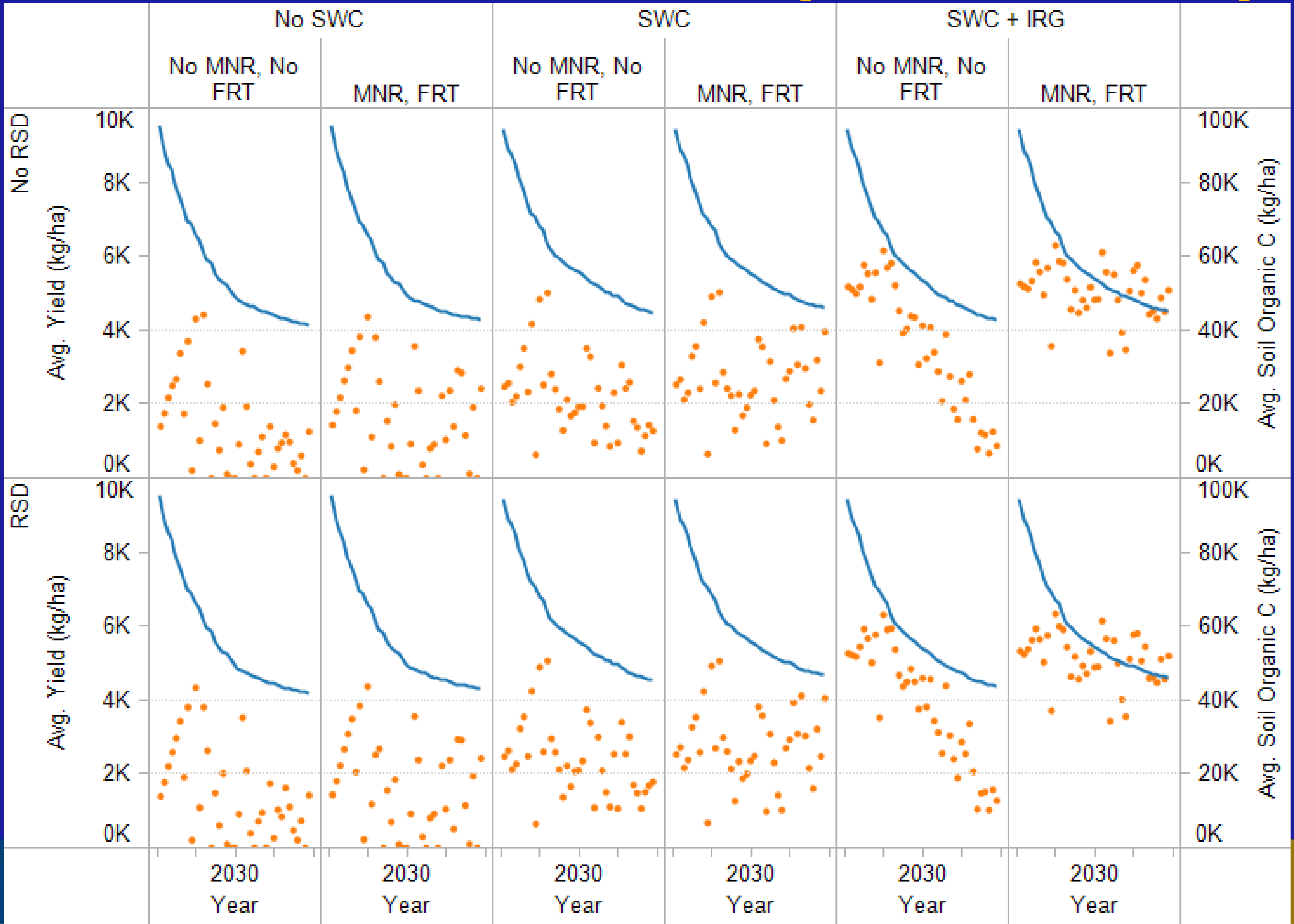
  - Extensive media reports
  - Government campaigns and speeches related to climate change
  - 1st Ag Carbon Mitigation project located in Kenya

Farmers' perceptions of agricultural practices that reduce climate change (%)

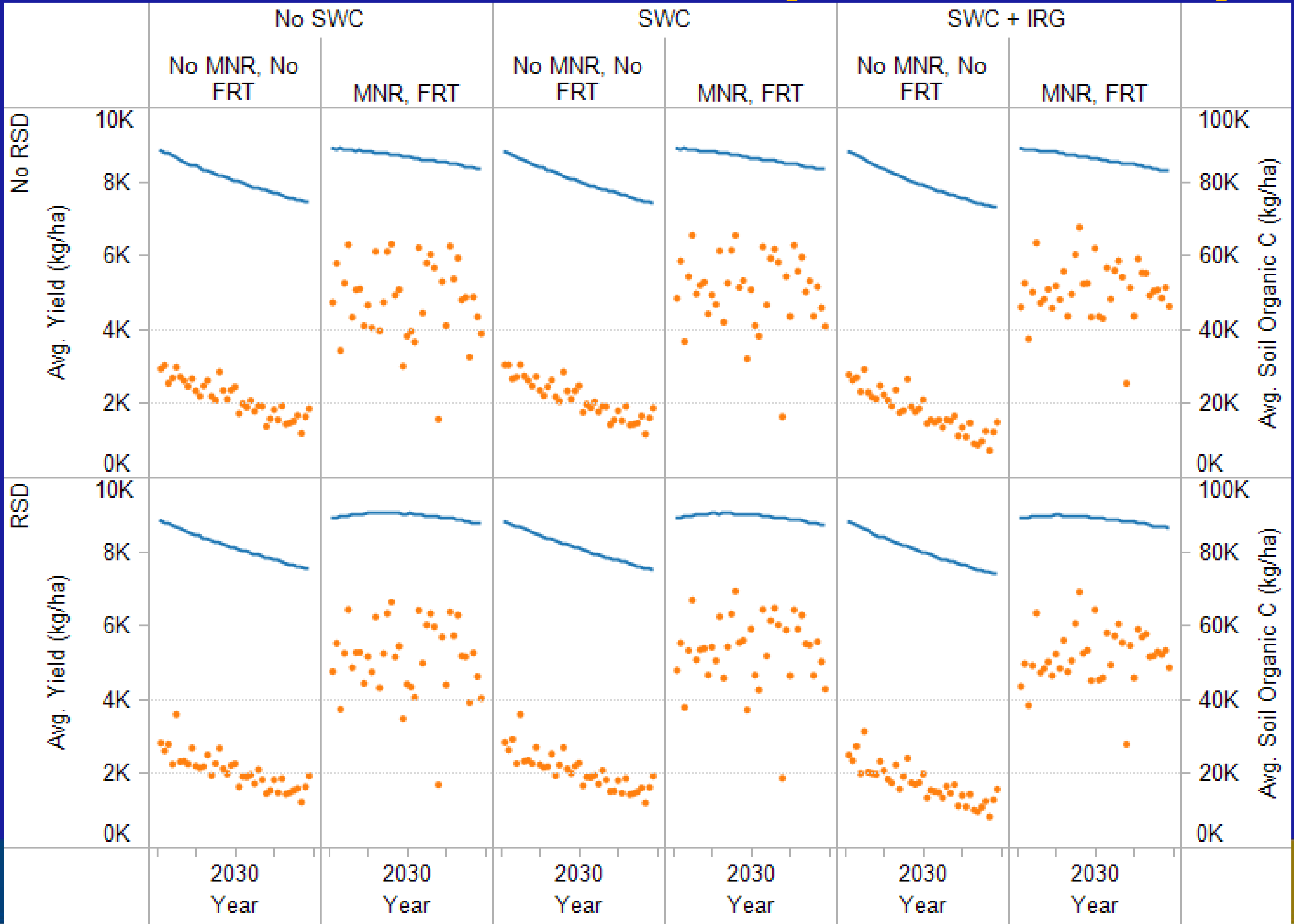


Source: IFPRI-KARI survey 2010

Yield and SOC under alternative Management strategies (Garissa-sand)



Yield and SOC under alternative Management strategies (Othaya-Loam)



Top 5 Maize Mitigation Practices for SOC

			OPV										HYB				
			MNR										MNR				
			No FRT					FRT					No FRT		FRT		
			No RSD		RSD			No RSD	RSD				RSD		RSD		
			SWC		No SWC	SWC		SWC	No SWC		SWC		SWC		No SWC		SWC
District	Soil	Climate	No ROT	ROT	ROT	No ROT	ROT	ROT	No ROT	ROT	No ROT	ROT	No ROT	ROT	No ROT	ROT	No ROT
Garissa	Clay	Dry		3			1	5				2		4			
		Wet			3	5	1			4		2					
	Sand	Dry	4			1					2		3				5
		Wet				2					1		3	5			4
Gem	Loam	Dry			5				1	2	3	4					
		Wet			5				1	2	3	4					
Mbeere	Loam	Dry			5				1	3	2	4					
		Wet			5				1	2	3	4					
	Sand	Dry							1	2	5				4	3	
		Wet							3	1		5			4	2	
Mukurweini	Loam	Dry			5				1	3	2	4					
		Wet							1	3	2	4				5	
Njoro	Clay	Dry			2				3	1	5	4					
		Wet			3				2	1	5	4					
	Loam	Dry			5				1	3	2	4					
		Wet			5				1	2	3	4					
Othaya	Loam	Dry			5				1	2	3	4					
		Wet							1	2	3	4				5	
Siaya	Loam	Dry			5				1	2	3	4					
		Wet			5				1	2	4	3					

MANAGEMENT PRACTICES THAT INCREASE SOC (DSSAT MODELING)

- Crop residues increase SCS considerably
- Inorganic fertilizer only increases SOC when applied with manure, mulching and/or crop residues
- Rotation of maize and beans—a key management practice used in much of Kenya—has only limited SCS benefits (insufficient biomass generation)

Management practices that increase SOC (DSSAT modeling)

- Soil water conservation technologies—represented as increased soil water availability prior to planting—show mixed results regarding carbon sequestration, even under a drier future, but are important in arid Garissa
- Results are similar under dry and wet climate scenarios

Livestock productivity and emissions with improved feeding

District	Scenario	Milk production	Manure production	Methane production	Methane per liter milk
	Prosopis				
Garissa	1.5 kg	64	0	-2	-40
	3 kg	136	0	-5	-60
	Desmodium				
Gem	1 kg	21	5	-3	-20
	2 kg	36	10	0	-26
	Napier grass				
Mbeere	2 kg	12	11	3	-8
	3 kg	17	16	2	-12
	Hay				
Njoro	1 kg	18	-5	6	-10
	2 kg	49	-5	18	-21
	Desmodium				
Mukurwe-ini	1 kg	9	11	2	-7
	2 kg	8	11	0	-7
	Hay				
Othaya	2 kg	9	11	2	-7
	4 kg	8	11	0	-7
	Napier grass				
Siaya	2 kg	42	0	12	-21
	3 kg	79	10	16	-35
7 districts	Average	36	6	4	-20

Note: Results are in percent deviations from the respective baseline (no improved feeding)

Improved feeding summary

- On average, the supplementation strategies increased milk production by 36%, and increased total manure and methane production by 6% and 4%, respectively
- However, methane production per kg of milk was reduced by 20%
- The largest improvements were in the districts that have the poorest diet quality (Garissa, Gem, Mbeere South, and Siaya)
- Producers could also engage in destocking to reduce overall methane emissions

PROFITABILITY/ PRODUCTIVITY

Do management practices increase productivity and/or reduce risk?

Variable	Maize		Beans		Coffee	
	Mean	Variance	Mean	Variance	Mean	Variance
Soil bunds				+		
Residues			--			
Rotation/fallowing		--				
Soil bunds*residues				--		
Intercropped plot		+				
Amount own seed	+		+	--		--
Amount purchased seed	+					
Improved seed variety	+		+			
Labor	+		+			
N fertilizer		--	--			--
P fertilizer	+		+			
K fertilizer		+				
N	931	931	788	788	53	53

Source: IFPRI-KARI survey 2010

40-year average annual net revenues from SOC and yield (USD/ha), 50% of residues in field

		Package 1		Package 2		Package 3		Package 4	
		RES50		RES50, FERT & MNR		RES50, FERT, MNR, SWC & ROT		FRT, MNR, RES50, SWC, ROT, & IRG	
AEZ	Soil	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)
Arid	Clay	1	-16	9	-195	15	7	24	1151
Arid	Sand	1	35	2	-221	10	241	8	892
Semi-arid	Loam	2	177	22	910	22	1072	21	1023
Semi-arid	Sand	2	116	8	231	6	309	5	162
Semi-arid	Clay	2	210	19	1626	19	1920	17	1947
Temperate	Loam	2	12	24	816	23	910	22	736
Humid	Loam	0	116	13	1431	12	1513	11	1061

Notes: incremental revenues compared to a baseline scenario with no management practices, assumes a carbon price of 10 USD per tCO2e, price per kg of maize is 0.375 USD, includes livestock costs (for feed replacement and manure), 50% of residues left on the field

Source: IFPRI-KARI survey 2010

40-year average annual net revenues from SOC and yield (USD/ha), 75% residues in field

		Package 1		Package 2		Package 3		Package 4	
		RES75		RES75, FERT & MNR		RES75, FERT, MNR, SWC & ROT		FRT, MNR, RES75, SWC, ROT, & IRG	
AEZ	Soil	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)	Revenue from carbon (USD/ha)	Net revenue from yield (USD/ha)
Arid	Clay	1	-10	2	-269	11	177	9	866
Arid	Sand	2	-1	9	-198	16	14	27	1180
Semi-arid	Loam	4	168	26	933	25	1099	25	1025
Semi-arid	Sand	3	108	9	197	7	296	6	155
Semi-arid	Clay	2	392	21	1746	21	2011	19	1782
Temperate	Loam	3	-16	28	817	26	916	25	722
Humid	Loam	2	57	16	1384	15	1472	14	1016

Notes: incremental revenues compared to a baseline scenario with no management practices, assumes a carbon price of 10 USD per tCO_2e, price per kg of maize is 0.375 USD, includes livestock costs (for feed replacement and manure), 75% of residues left on the field

Source: IFPRI-KARI survey 2010

Profitability of improved feeding practices

	Baseline feeding		Improved feeding		
District	Net revenue (USD)	Net revenue per liter of milk (USD)	Scenario	Net revenue (USD)	Net revenue per liter of milk (USD)
			Prosopis		
			1.5 kg	104.1	0.23
Garissa	92.1	0.33	3 kg	118.8	0.18
			Desmodium		
			1 kg	172.3	**0.26**
Gem	62.2	0.11	2 kg	169.2	**0.23**
			Napier grass		
			2 kg	150.8	**0.16**
Mbeere S.	31.3	0.04	3 kg	146.2	**0.15**
			Hay		
			1 kg	279.9	**0.19**
Njoro	175.8	0.14	2 kg	357	**0.19**
			Desmodium		
			1 kg	547.4	**0.24**
Mukurweni	383	0.18	2 kg	511	**0.23**
			Hay		
			2 kg	348.8	**0.16**
Othaya	311.1	0.15	4 kg	233.2	0.11
			Napier grass		
			2 kg	239.1	**0.24**
Siaya	109.6	0.16	3 kg	169.2	**0.23**

Summary – Profitability of management practices

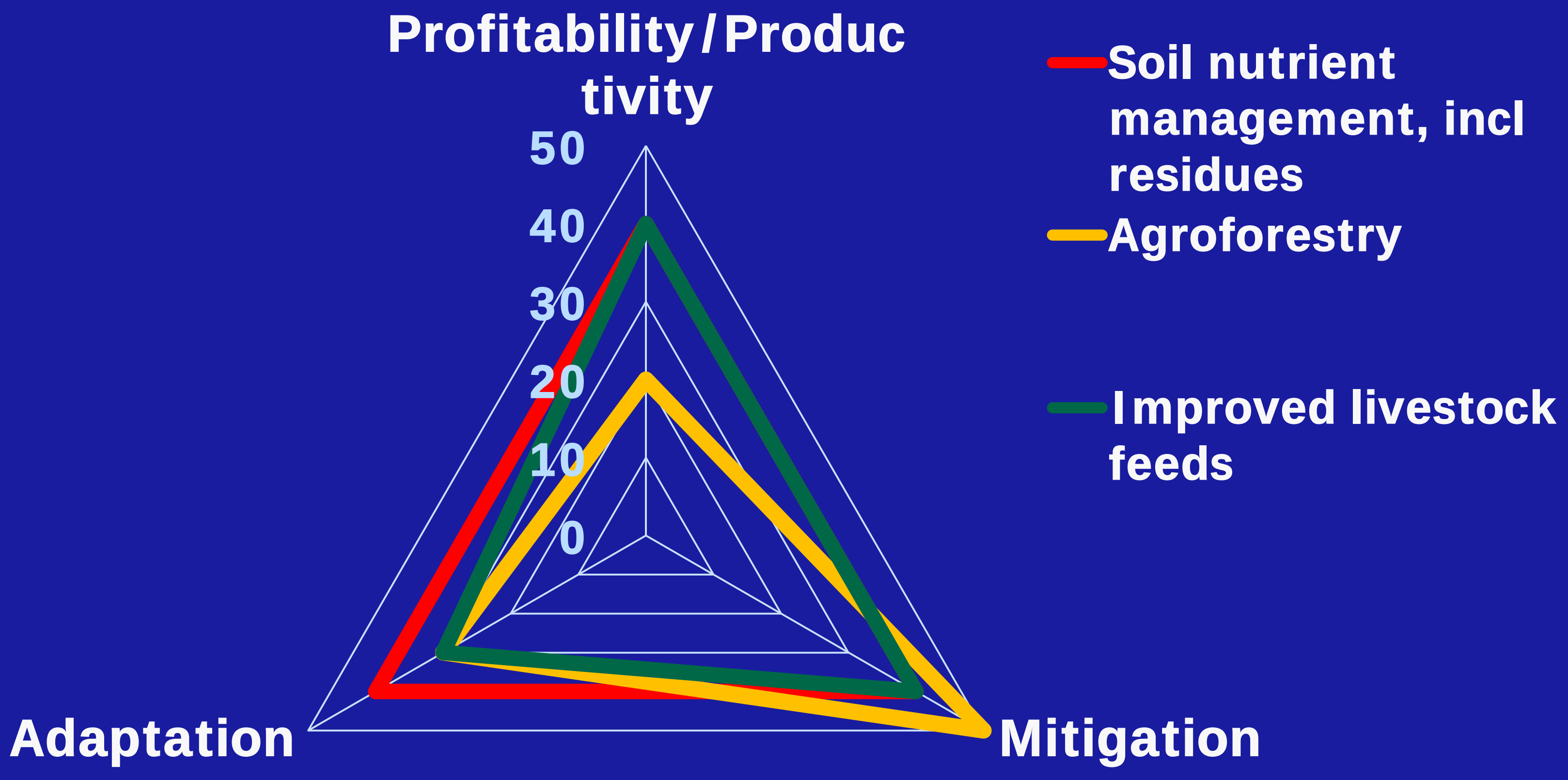
- Most cropland management packages increase net profits even including costs for livestock (replacement feed and manure)
- Exceptions are packages 1 and 2 in arid areas with clayey soil and package 2 in arid areas with sandy soil. In these scenarios, the costs outweigh the benefits from increased productivity
- Net revenues still increase with management packages including 75% residue retention in most scenarios compared to the baseline (no management)
- However, there are more cases where the management packages with 75% residues are less profitable than the same packages with 50% residues

Summary – Profitability of management practices

- In most cases, improved feeding practices increase productivity and net profits per liter of milk
- Exceptions: Garissa and Othaya—due to the large cost of purchasing replacement feed
- These producers would need additional incentives to adopt improved feeding practices

WIN-WIN-WIN STRATEGIES

WIN-WIN-WIN STRATEGIES



Synergies among adaptation, mitigation, and productivity/profitability

Management practices	Adaptation benefits[a]	Mitigation potential[b]	Productivity/Profitability
Cropland management			
Improved crop varieties and/or types	positive	mixed	unclear
Changing planting dates	positive	unclear	unclear
Improved crop/fallow rotation/rotation with legumes	positive	mixed	mixed
Appropriate fertilizer/manure use	positive	positive	positive
Incorporation of crop residues	positive	positive	positive [c]
Water management			
Irrigation/water harvesting	positive	mixed	positive
SWC	positive	mixed	mixed [d]
Livestock/grazing land management			
Improved livestock feeding	positive	positive	positive
Destocking	positive	positive	positive

[a] As reported by farmers
[b] As calculated with DSSAT and livestock mitigation models
[c] Tradeoff with livestock feed in certain areas
[d] Positive impacts in areas where soil moisture is a constraint, depends on combination of technologies

Policy Implications

- ✓ Win-win-win strategies among adaptation, mitigation, and profitability do exist, but have yet to be strategically exploited
- ✓ To do so will require capacity building at national level to ensure that agricultural productivity and food security strategies and policies explicitly include climate change adaptation <u>and</u> mitigation aspects (including NAMA preparation)
- ✓ Better dialogue between Ministry of Agriculture and Ministry of Environment (UNFCCC focal point) can support triple-win strategies

Policy Implications

To exploit agricultural mitigation potential requires

- Financial support for early action and capacity building (are existing funding options sufficient?)
- Innovative financing instruments might push triple-wins and reduce adoption barriers
- Further enhance knowledge base
  - Impacts of climate variability and change on agricultural systems
  - Generation of triple-win technologies

Policy Implications

Some options for financial support:

- Carbon markets
- Adaptation funds
- Mitigation funds/NAMAs with less strict MRV requirements
- Financial instruments such as guarantees/loans to private sector (and other institutions)
- Micro-finance

Policy Implications

To exploit agricultural mitigation potential requires

- Development of capacity on MRV systems and agriculture baseline
- Dissemination of triple-win technologies
- Advice to farmers based on demand-driven approaches