Measuring field losses in US vegetable production

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Agriculture represents North Carolina's most valuable industry, at 84 billion (USD), and employs 686,000 people.

Over 60,700 hectares in vegetables, melons and sweet potatoes.

Ranked #1 in sweet potato production

<u>Ranked in the top 10 states of US production for:</u>
Cabbage, squash, watermelon, cantaloupe, blueberry, strawberry, tomato, cucumber, bell pepper, apple, grape, and pumpkin

(Source: USDA-NASS and NCDA&CS, 2017)

North Carolina (US) ⇄ England ↺ %

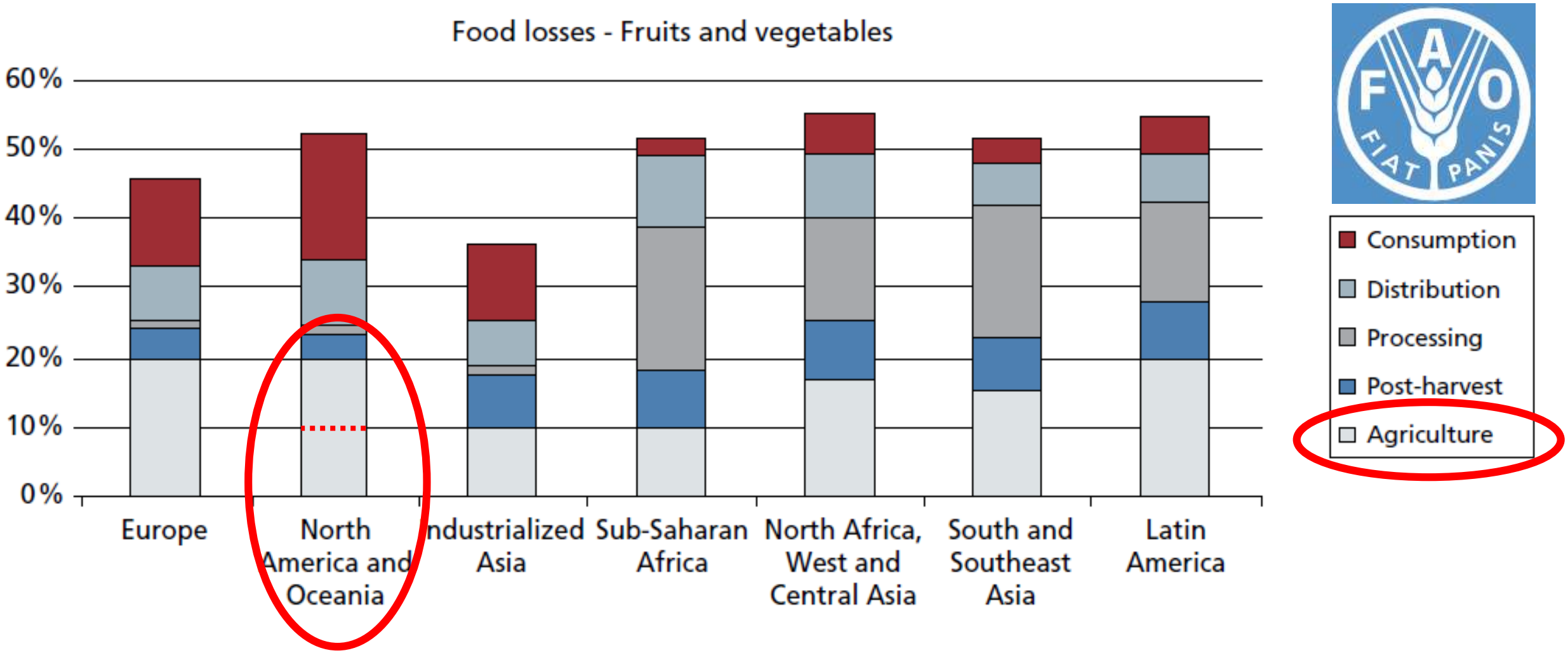
North Carolina (US) (53,864 mi²) is **1.07** times as big as England (50,347 mi²).

Why put time, money, and effort into measurement?

(Especially when losing crops on the farm results in little economic loss, and is less environmentally damaging)

- Really don't have very strong data yet
- Can't set effective targets without a baseline, what is the 'food loss' reduction target?
- Starting with accurate estimates prompts development of solutions at scale
- Analysis reveals opportunity for societal benefit
- Analysis reveals economic opportunity for growers

Figure 6. Part of the initial production lost or wasted at different stages of the FSC for fruits and vegetables in different regions



This estimate carries forward the 20% figure from approximations for pathogen-based losses from the 1960's.

(Cappellini and Ceponis, 1984; Golumbic, 1964; Harvey, 1978; Kader, 2005; LeClerg, 1964; Parfitt et al., 2010)

Further…

Marketing Assumptions:

Projected Base Yields	96,646	lbs/acre
Marketable		
Percent of Base Yield	80.0%	
Pounds	77,317	
25 lb Boxes	3,093	
Jumbo and XL fruit	33,301	
Large fruit	24,748	
Medium and small fruit	19,078	
Culled		
Percent of Base Yield	20.0%	
Pounds	19,329	
Market Prices $/25 lb Box		
Jumbo and XL fruit	$9.50	
Large fruit	$8.15	
Medium and small fruit	$7.00	
Culled Fruit		
$/Pound	$0.00	

Source: Cost of Producing, Harvesting and Marketing Field Grown Tomatoes in the Southeastern United States. (2012) O. Sydorovych, F. Louws, and C. Gunter

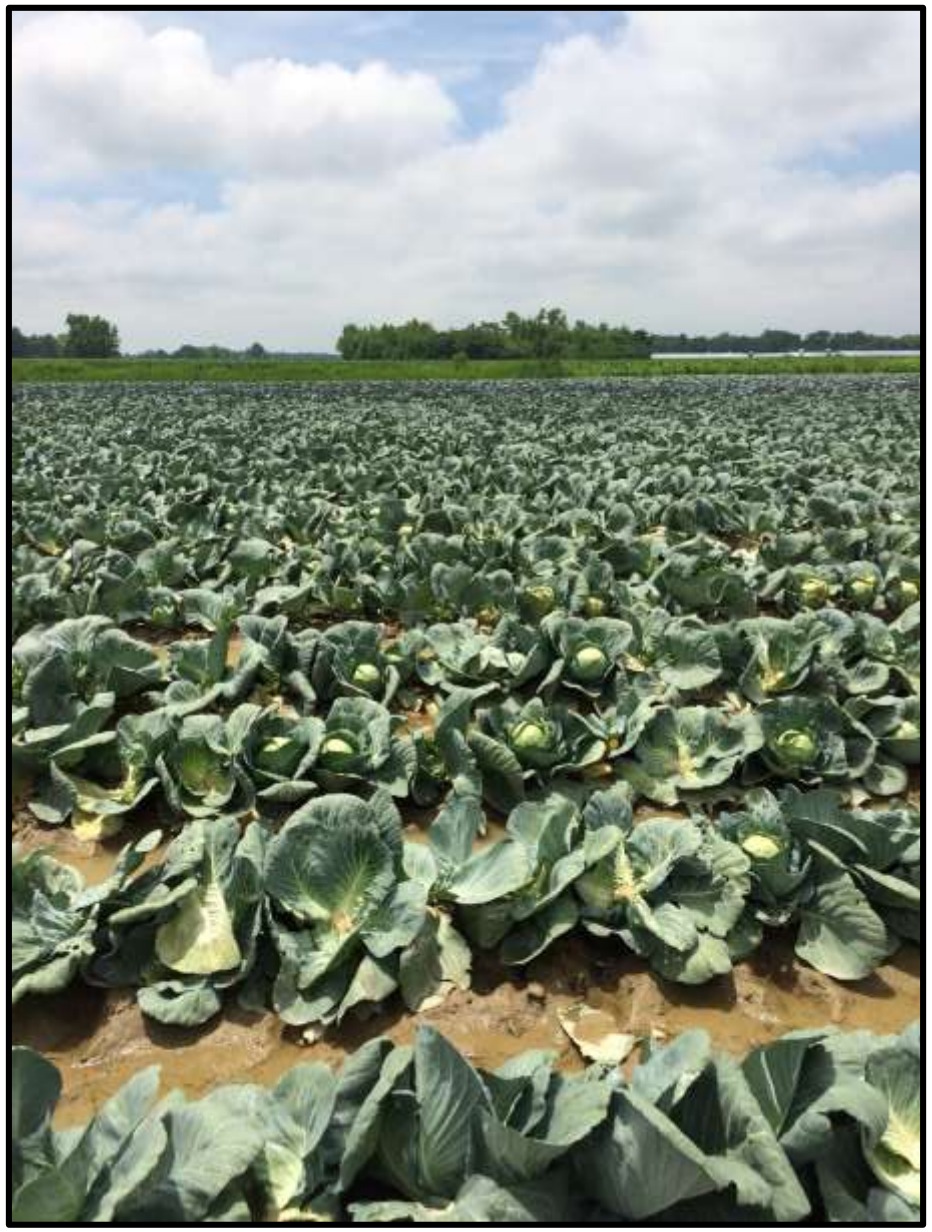
Survey- and interview-based estimates:

- Neff et al. (2018) reported that small, diversified farms in Vermont leave **16%** of edible vegetables unharvested in the field.
- Head lettuce left in the field according to grower interviews on large commercial farms in California was estimated at **4 – 10%** (Milepost, 2012).
- Minnesota small farmers estimated that the rate of cosmetic imperfections on most vegetable crops was **1 – 20%** (Berkenkamp and Nennich, 2015).

In North Carolina: <u>Six out of seventeen growers felt comfortable reporting</u> an estimate of unharvested crops: ranged from *1 – 20%* of the marketed crop with three out of the six estimating 20%.

Getting these results made me lose confidence in survey and interview-based estimates.

How are field losses perceived by growers?



Low volume or low value

No measurement in field

Majority of NC participants did not want to provide an estimate of losses

"if you need a percentage, probably 10%, something like that. 15% maybe. And there again, it's just a lot of what's going on in the marketplace. It's hard to figure."

"We know you leave a lot of potatoes in the field. At what percent? If I told you a number, it would just be something I'm pulling out of the air."

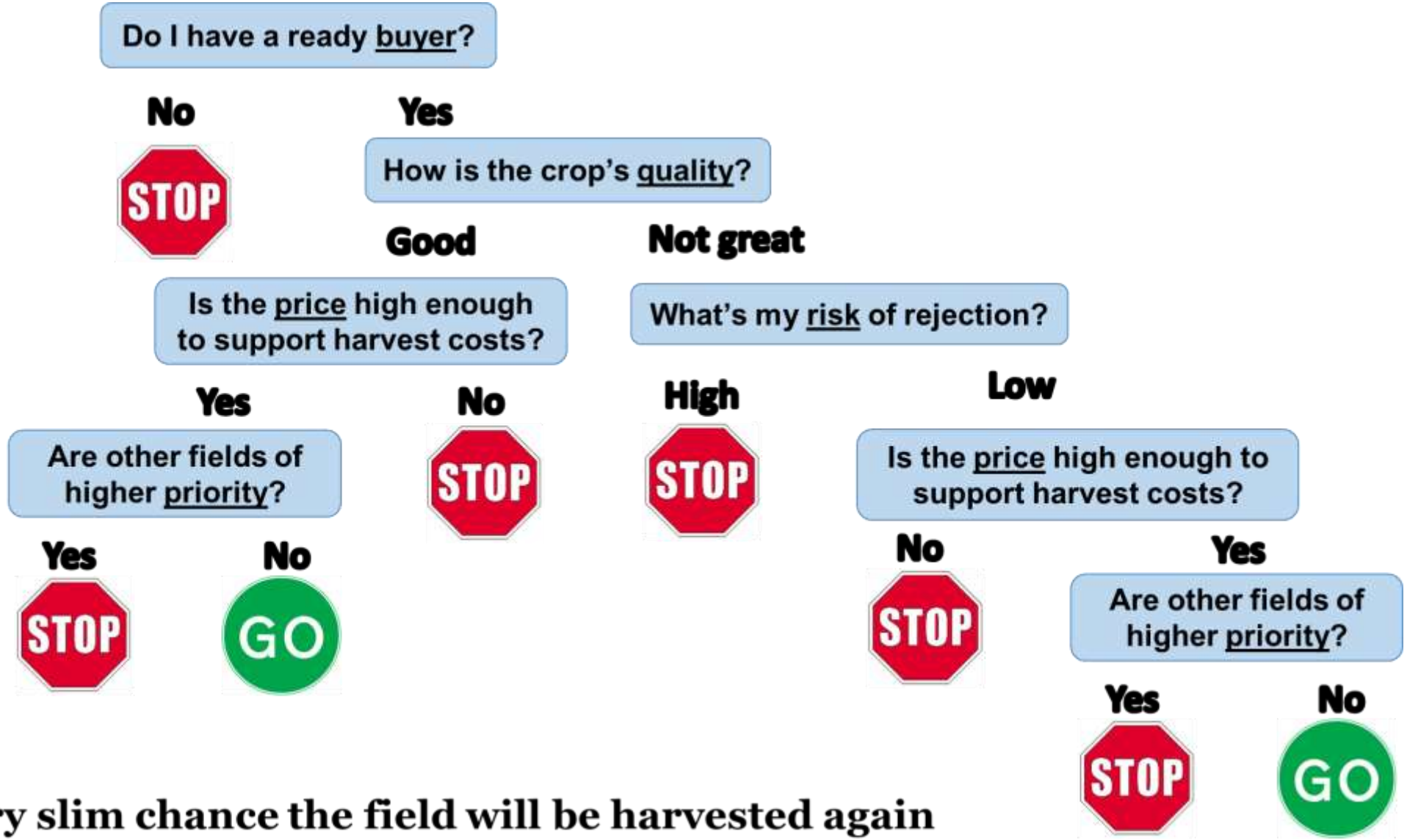
Underreporting is a common problem when using grower estimates. (Franke et al., 2016, WRAP, 2017)

How much is lost in-field?

Identifying growers willing to participate in measurement:

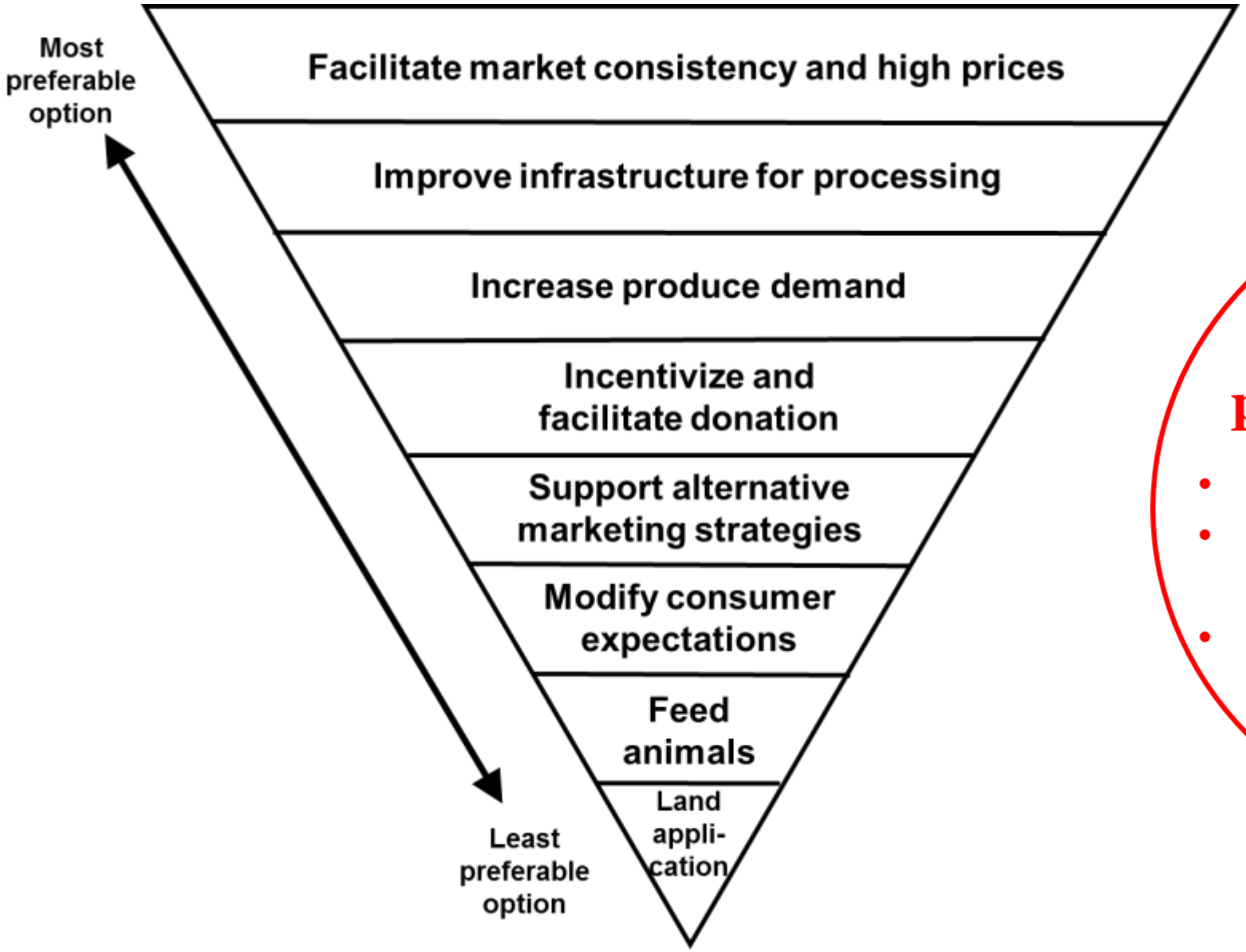
- Used surveys at off-season grower conferences to open the conversation
- Targeted commercial producers selling through wholesale channels
- Interviewed growers managing almost 20% of sweetpotato, melon, and vegetable acreage in the state
- Semi-structured interview style using open-ended questions
- Number of participants reduced at each step of engagement
- Finally arrived at growers willing to participate in measurement

Along the way, determined how growers decide when to stop harvesting fields:



Very slim chance the field will be harvested again

Also, found grower strategies for reducing field losses are not aligned with strategies influenced by the downstream supply chain:



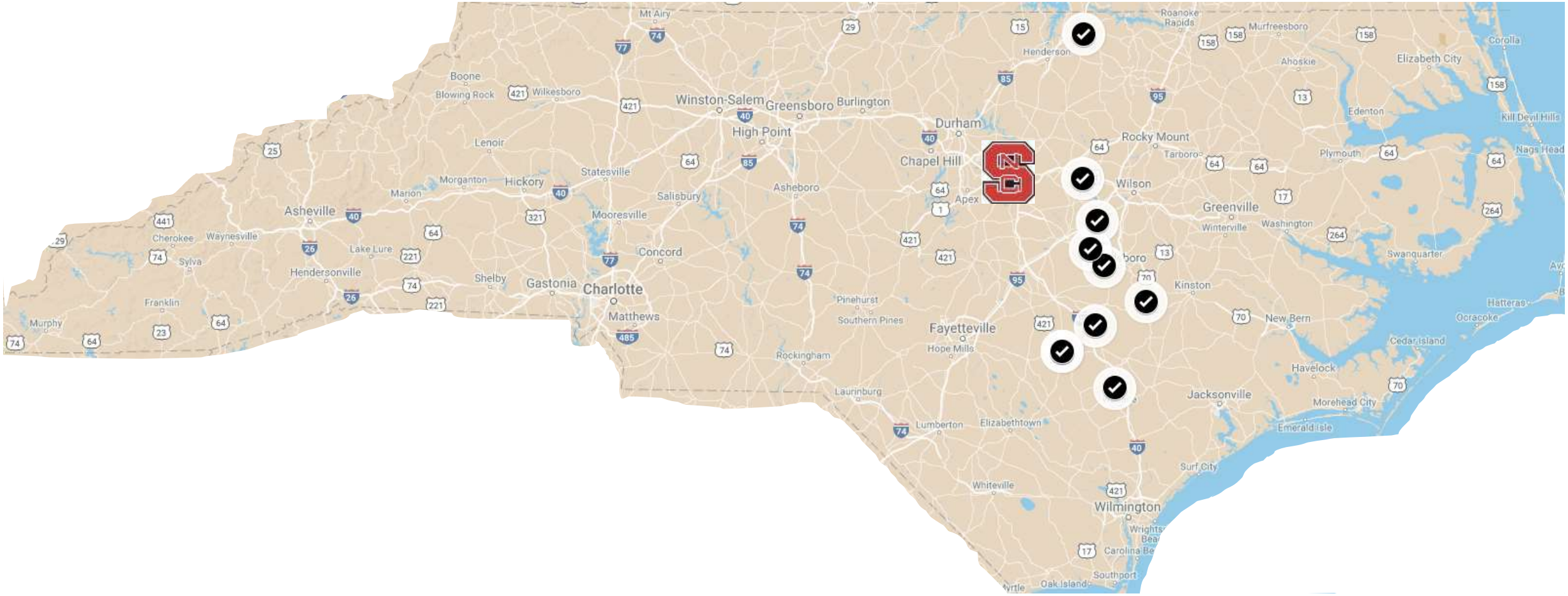
Solutions often promoted for growers:

- Reducing overproduction
- Facilitating donation through infrastructure & policy changes
- Supporting alternative markets

(ReFED, 2016; Gunders, 2012; EPA, 2015)

2017 Measurement study: Growers primarily in eastern North Carolina

Farms participating in measurement managed 6.8% of production area



What is left in the field after the harvest is ended?

Meets current buyer specifications for quality, but unharvested due to market constraints.

Off-size, blemished, misshapen, or miscolored but not under or over mature. Nutritious and safe.

Damaged, diseased, decayed or over mature. Not suitable for human consumption

End of season harvest potential protocol:

1. Note information and gather equipment
2. Mark rows randomly in the field
3. Harvest rows separately
4. Sort samples into categories
5. Weigh and record sample in each category
6. Calculate estimate of potential in field

In a 4-ha field, three rows of 15.23 m

Sampling :

	Fields sampled (*n*)	Farm locations	Mean field size (ha)	Portion of field area sampled (%)
Cabbage	7	3	2.51	0.36
Summer Squash	12	4	2.82	0.69
Cucumber	9	3	2.54	0.40
Bell Pepper	9	3	5.12	0.19
Sweet Corn	4	2	1.07	0.78
Winter Squash	4	2	11.13	0.06
Watermelon	10	4	8.17	0.19
Sweetpotato	13	4	5.29	0.14

July 4

July 11

July 14

July 24

July 31

Aug 4

Aug 8

7 dates
10 fields
3 farms

Average of 5,116 kg edible crop left unharvested *per hectare*

	Marketable (kg/ha)			Edible (kg/ha)			Unfit (kg/ha)		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Cabbage	0.0	695.4	307.4	328.1	9547.1	3407.1	191.5	7624.4	3693.9
Summer Squash	0.0	331.8	88.9	17.9	1366.5	871.2	1096.2	10598.2	6095.1
Cucumber	0.0	3179.5	1887.3	4696.7	16319.9	8124.5	561.2	37839.7	7996.6
Bell Pepper	1494.6	6022.4	3212.1	2238.8	5994.7	3394.4	1429.5	5336.1	2464.0
Sweet Corn	77.0	4956.1	2089.2	1060.9	4659.0	3064.7	1877.1	5016.9	3719.6
Winter Squash	0.0	3973.2	1427.0	681.6	3357.0	2198.1	3687.8	30943.7	12721.7
Watermelon	0.0	37360.5	12425.3	649.9	39467.1	11572.1	9653.2	36794.0	20493.9
Sweetpotato	1346.5	8412.5	3577.2	620.1	6419.0	2153.0	0.0	1652.3	365.4

Marketable bell pepper: 3,212 kg/ha = 283 boxes per hectare left …

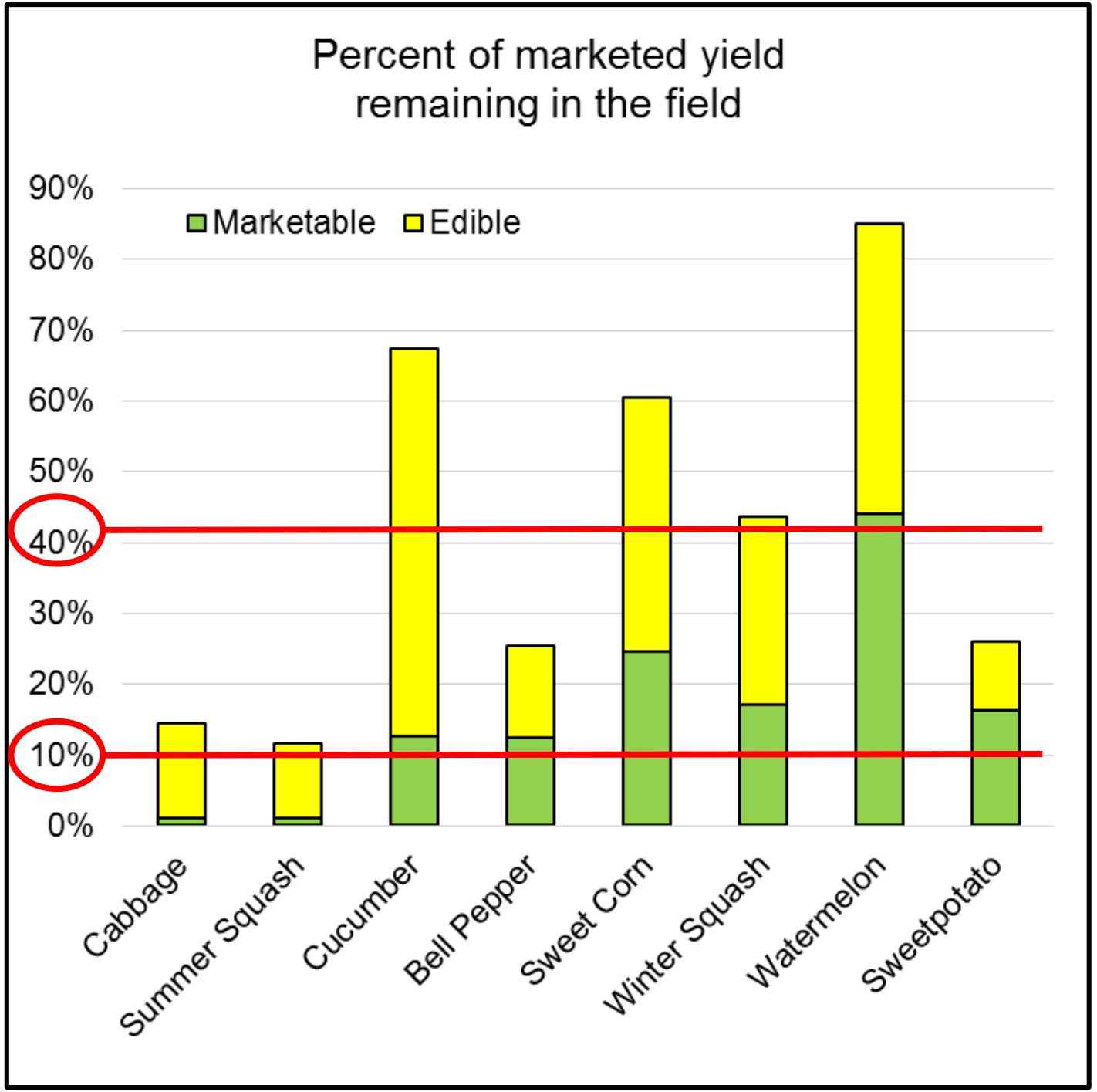
Harvest 4 hectares once more for another truckload

Comparing losses with three year average marketed yields in NC

This snapshot study suggests the estimate should be higher.

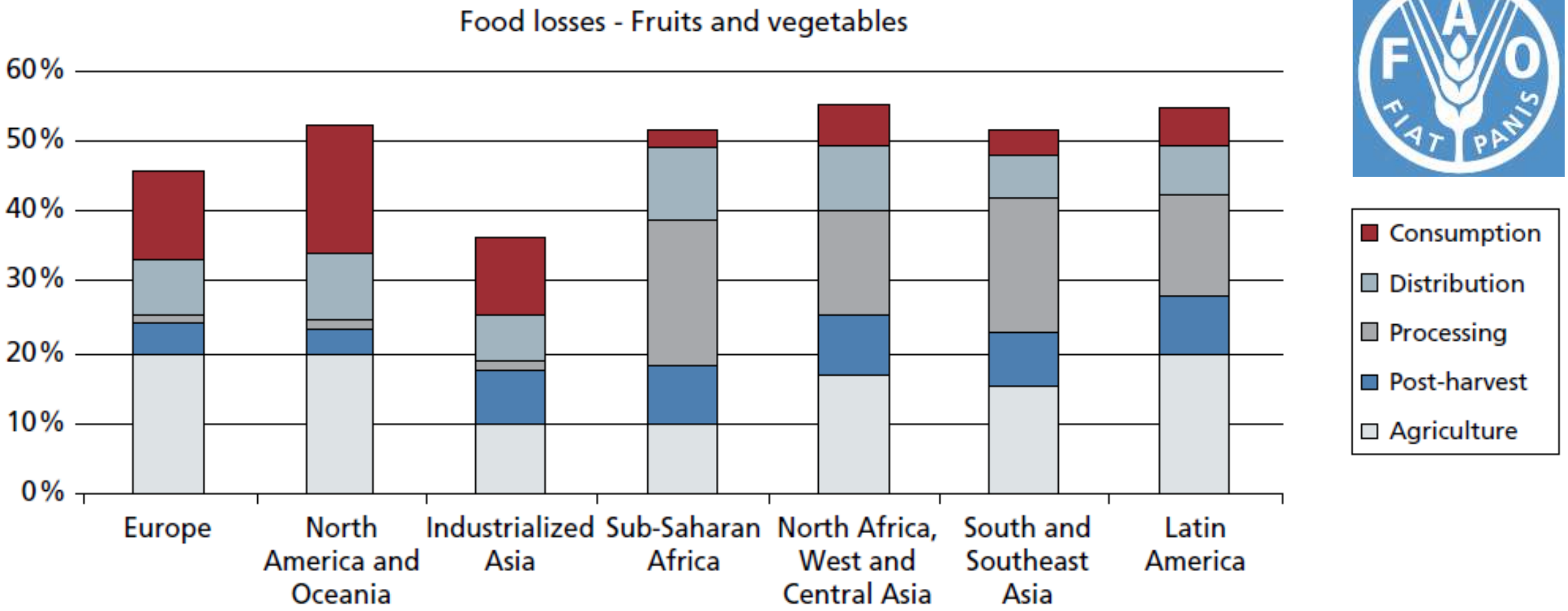
42% grand mean lost in the field.

Probably a good idea to reevaluate our current estimates.

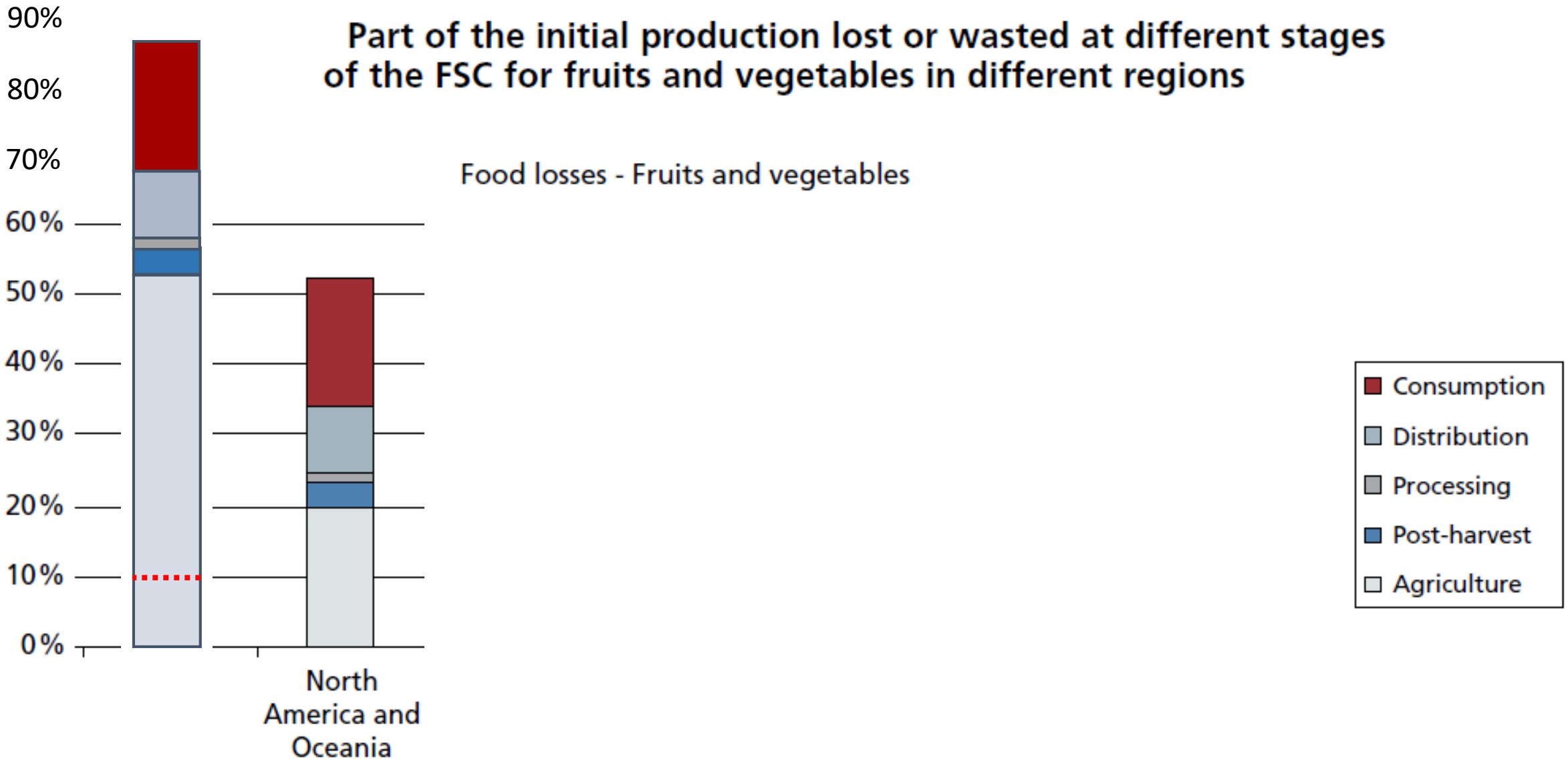


(Source of yield data: USDA-NASS and NCDA & CS, 2016; 2017).

Part of the initial production lost or wasted at different stages of the FSC for fruits and vegetables in different regions



National estimates need reevaluation using field measurement



How could these quantities impact food insecurity?

Cabbage	1,052 ha	X	3,715 kg/ha	=	3,907,651 kg
Summer squash	923 ha	X	959 kg/ha	=	885,570 kg
Cucumber	4,249 ha	X	10,011 kg/ha	=	42,538,575 kg
Bell pepper	971 ha	X	6,605 kg/ha	=	6,413,619 kg
Sweet corn	2,135 ha	X	5,154 kg/ha	=	11,003,577 kg
Winter squash	49 ha	X	3,625 kg/ha	=	177,630 kg
Watermelon	2,711 ha	X	23,997 kg/ha	=	65,056,951 kg
Sweetpotato	36,421 ha	X	5,730 kg/ha	=	208,684,507 kg

338,668,080 kg in North Carolina

1,659,050 food insecure

204 kg per person

Harvest and distribution systems need improvement

What is <u>THE VALUE OF</u> what is left in the field?

Can growers profit from utilizing the entire crop?

We can calculate the value based on a set of assumptions, *critical assumption is that a market exists*

- Pounds marketable and edible
- Harvest and field pack
- Harvest and shed pack
- Packaging
- Transport
- Price

Harvest/Sale Scenarios

(1)

Shed pack in bins for 50% of wholesale (Alternative mkt)

(2)

Field pack in bins for $0.07/lb (Food bank)

(3)

Shed pack, marketable in cartons, edible for 50% wholesale in bins (regular +alternative)

(4)

Shed pack, marketable in cartons, edible for $0.07 in bins (regular + food bank)

How could these quantities impact grower profit?

Harvest Scenarios	Returns ($/acre)					
	Bell Pepper	Cabbage	Cucumber	Summer Squash	Sweet Corn	Sweet Potato
Scenario 1: Packed in bins at 50% of wholesale price	466	(557)	823	(137)	(178)	88
Scenario 2: Field packed, sold in bins at $0.07/lb	(97)	(338)	38	(277)	(155)	106
Scenario 3: Packed in cartons for marketable and bins for edible; wholesale price for marketable and 50% of this for edible	1,059	(538)	1,135	(116)	5	515
Scenario 4: Packed in cartons for marketable and bins for edible; wholesale price for marketable and $0.07/lb for edible	580	(580)	211	(289)	(111)	364

Opportunities to improve marketing and demand

Why put time, money, and effort into measurement?

- Really don't have very strong data yet
- Can't set effective targets without a baseline
- Starting with accurate estimates prompts development of solutions at scale
- Analysis reveals opportunity for societal benefit
- Analysis reveals economic opportunity for growers

How to Determine the Potential to Increase Vegetable Yield through Estimating and Reducing Field Losses

NC STATE EXTENSION

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Estimating
case study

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Gleaning

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Field measurement in vegetable crops indicates need for reevaluation of on-farm food loss estimates in North America

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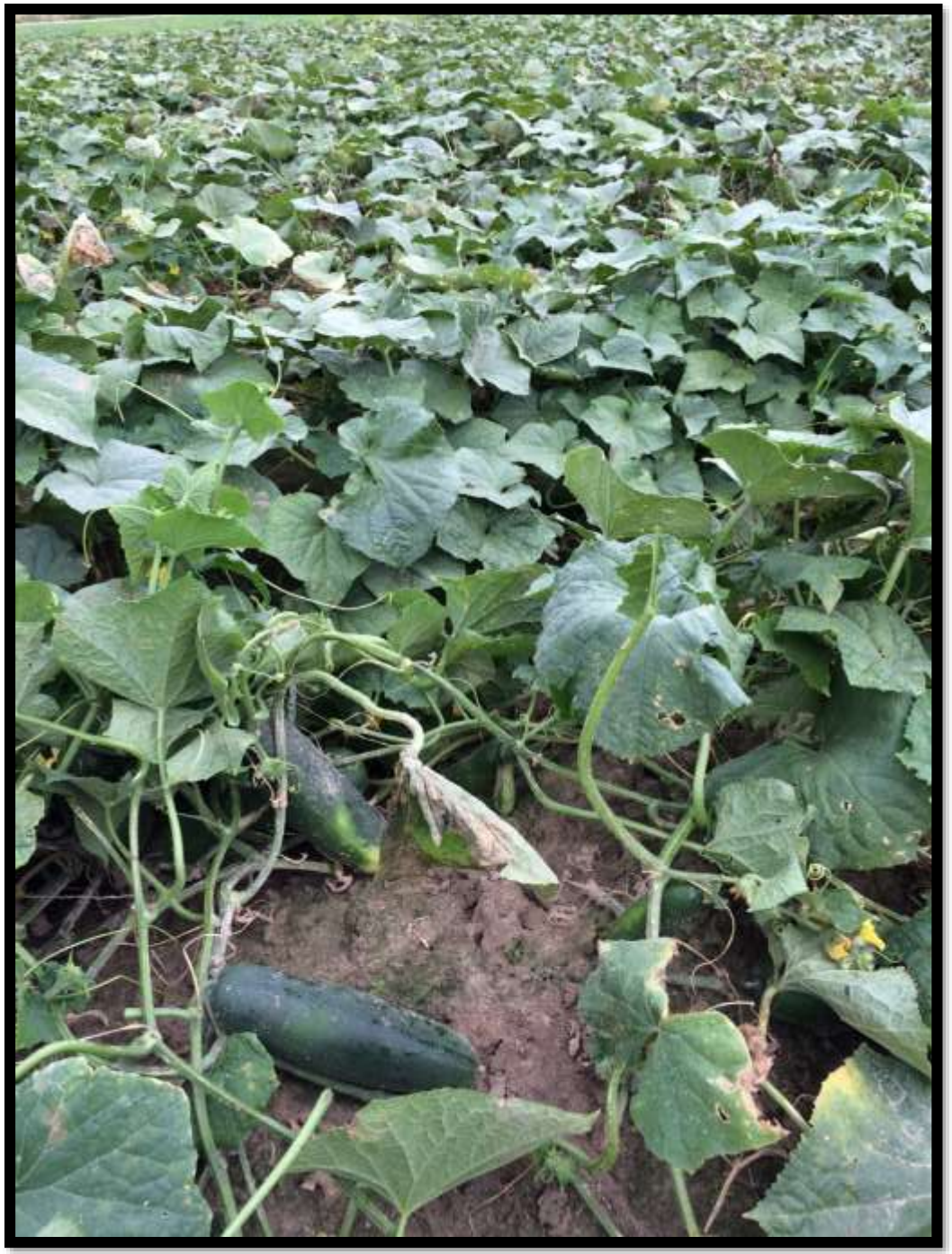
ABSTRACT

Food loss and waste in the US has been estimated at 40%, a figure that does not include losses at the agricultural level. Consumer food waste is expensive and environmentally damaging as it travels the length of the supply chain and largely ends up in the landfill. Most research and campaigns emphasize the consumer level, which has resulted in the omission of data collection and development of solutions for producers of fruit and vegetable

that hold potentially positive impacts for farm viability and resource-use efficiency. This paper describes a straightforward methodology for field-level measurement and demonstrates its utility on six vegetable crops harvested in 13 fields of a 121-hectare North Carolina vegetable farm.



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