Co-Existence and Traceability: Implications for Contracting, Risks and Supply Chain Management

To the
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List of Studies/References

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Organization

Background

Costs and Risks Management Strategy Conforming EU Requirements

Contracting for EU Traceability

- Definition and Objectives
- Simulation and Equilibrium
- Base Case Results and Sensitivities

Conclusion and Implications

Background

GM Wheat: Status and Evolution of Traits

- Roundup Ready:
  - Monsanto
  - Approved in US but not submitted in Canada;
  - withdrawn from further consideration
  - Want greater acceptance; focus on other crops; value of traits greater for other crops
- Fusarium Resistance
  - Syngenta
  - Field trials complete
  - Not submitted for deregulation
  - Anticipated available (potentially) in 2013
  - In interim: Improved resistance from conventional breeding; and better chemical treatments (fungicides)
- Varying forms of other traits
  - Drought tolerance
    - Land grant efforts on trait developed at/by OSU
    - Also work in Australia (Victoria)
  - End-use improvement
  - All relatively modest efforts and no plan for commercialization

Australia GM in Small Grains

- Traditionally, non-GM
  - Canola
  - Wheat, barley
- 2 Factors which are Changing Approach to GM Development
  - Canola moratoriums being lifted
  - Drought 2 years
- Victoria Department of Primary Industries
  - Funding GM development (amongst others)
  - View: Drought and stress are critical to control; and without more efficient control, they will lose the industries
  - Traits: Drought tolerance: wheat and barley
  - Status:
    - Field trials at 2 sites in Victoria, 2007 based on approvals in 2006 for 15 lines containing 6 genes
    - Recently (Jan 23, 2008) approved for 2008-2010; up to 50 GM wheat lines containing 15 different genes designed to improve drought tolerance; some seed will be retained for seed increase
- Western Australia: new initiative announced Feb 2008

Recent Initiatives

- Joint North American Wheat Growers and North American Millers
  - Joint Biotech Committee
  - Issued joint statement supporting GM Wheat Development
    - W/Canada, and Australia Groups
- 10+years out before commercialization

European Requirements

- 2004: End of the moratorium (came in force in 1999).
  - EU allows grain from countries using GM seed under restrictive conditions:
    - Labeling of product containing more than 0.9% of approved GM material.
    - Maintaining high level of traceability
- 2005:
  - Traceability becomes obligatory for all food and ingredients.

Applications for Non-GM Grains

- Traceability:
  - One step back and one step forward: system to identify to whom and from whom products are made available.
  - Transmission of specified information concerning the identity of a product to the next agent: certification record, test records,…
  - 5 years period of recordkeeping.
- Labeling:
  - “this product contains genetically modified organisms” if upper the 0.9% threshold.

Recommendations

- On-Farm:
  - Certified seed
  - Isolation between GM and Non-GM fields,
  - Buffer strips,
  - Cleaning, Storage adapted,
  - Auditing, Certification, Testing, Traceability,…
- Others agents:
  - Maintain segregation (transport, storage), Testing, Traceability,…

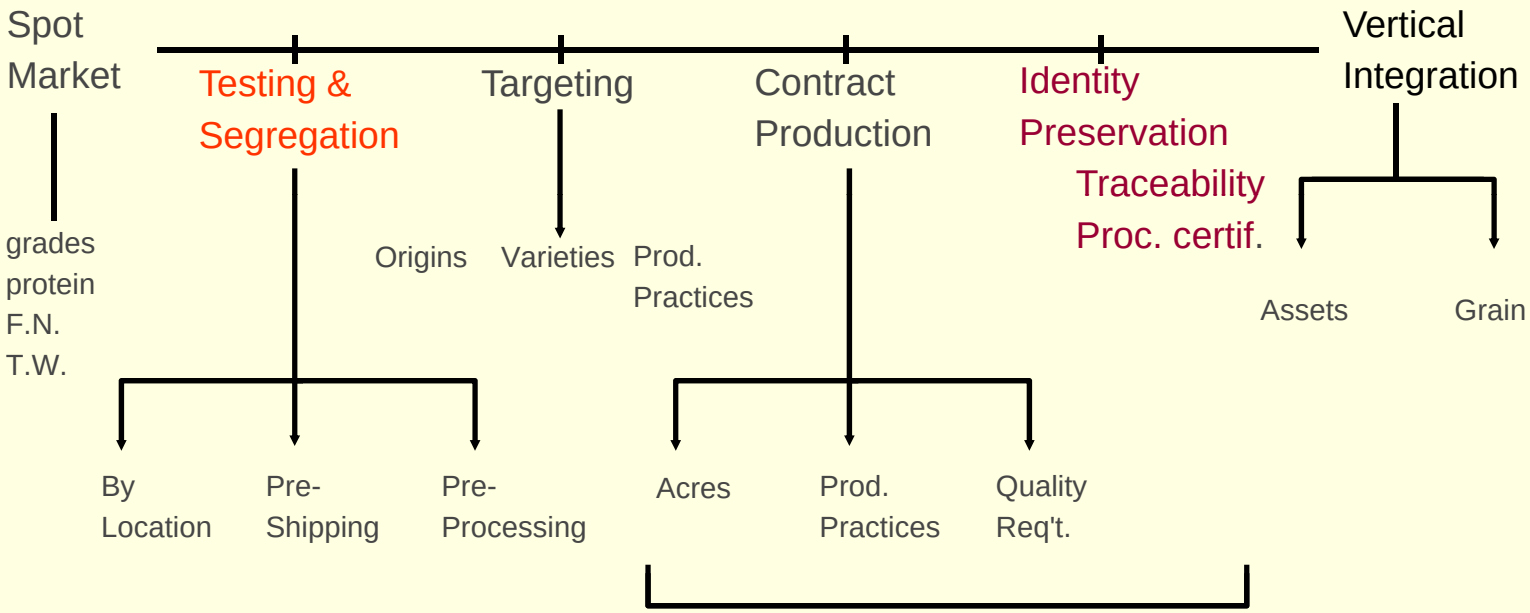
European regulation announces expected results but not means

Costs and Risks Management Strategy Conforming EU Requirements

Segregation in Practice

- Segregation arises due to heterogeneity in
  - Consumer/buyer demand
  - Crop characteristics
    - Random, or genetic
- Segregation is a process of de-commoditization
  - Desired by market participants
  - Emerges in response to buyer demands
- Segregation is used very extensively in practice
  - Buyers are finding ways to make purchases of non-GM even though GM may be the predominant crop
  - Numerous examples in US on corn and soybeans
  - Brazil routinely serves both market segments

Segregation, IP and Traceability Spectrum of Procurement Strategies: Buyers Choose!



IP/Segregation are not synonymous

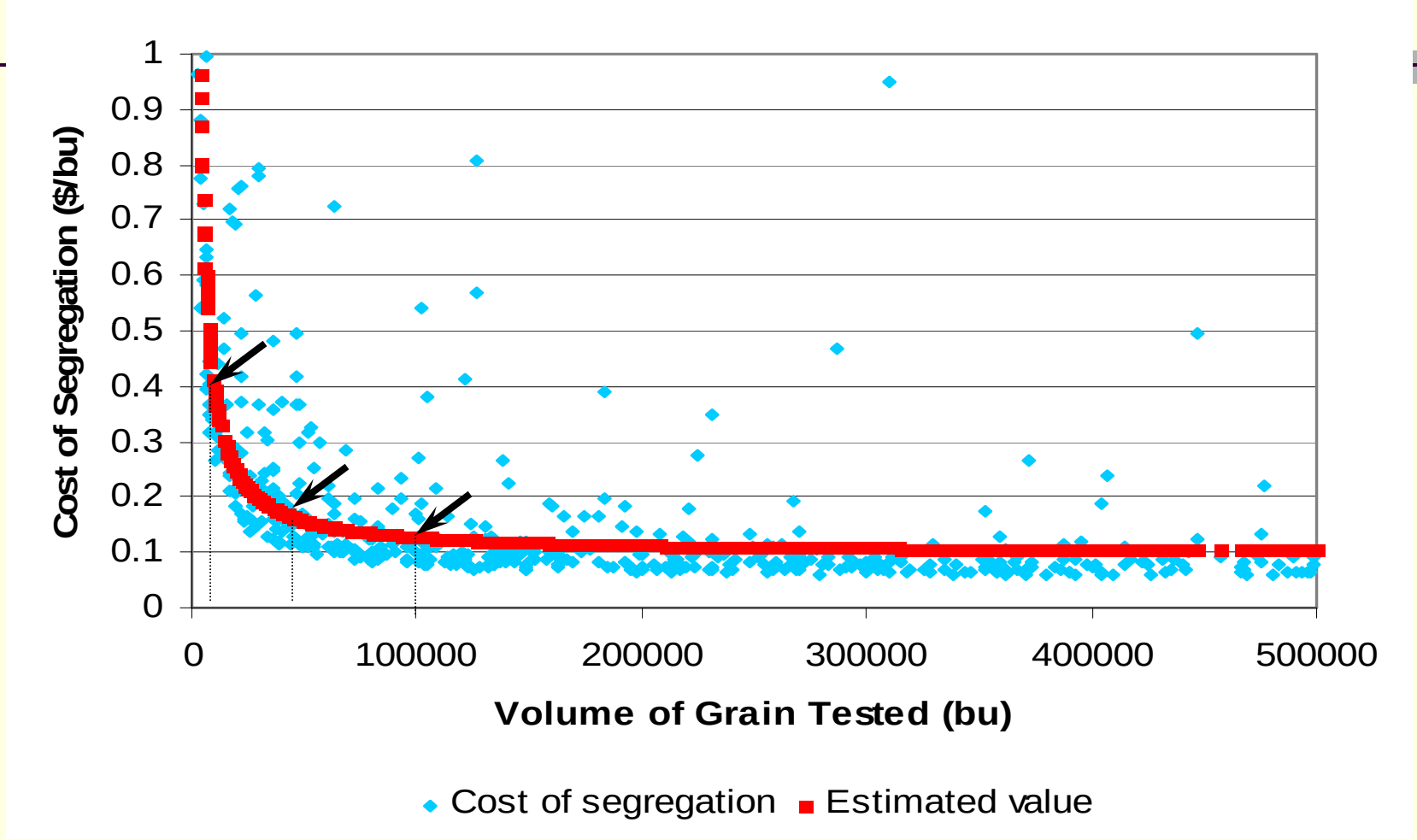
- IP
  - Audits conducted using varying mechanisms
  - Paper trail (sometimes)
  - Identity if preserved
  - Tests may/may not be component of system
  - Desired processes are declared
- Segregation
  - Grain is segregated based on varying forms of information:
    - tests
    - variety declaration
    - hunches!
  - Maintained throughout system in response to incentives
  - Tests assure integrity of segregations
- GM Averse buyers : want tests/segregations and traceability, not IP

Segregation costs and practices in US Midwest Elevators

	% Grain Segregated	Estimated Cost of Segregation ($/bu)	Cost of Modification ($)
Mean	**36%**	**0.07**	**195,713**
St Dev	35%	0.08	428,377
Min	0%	0.01	0
Max	100%	0.3	1.5M

- Estimated Cost of Segregation
  - Smaller for Large Elevators → 6 c/bu VS 12 c/bu
- Cost of Modification
  - Major Constraint to Effective Segregation
  - Smaller for Large Elevators

Cost of Segregation Versus Volume of Grain Tested



10,000 bu → < 40c/bu 50,000 bu → <16c/bu 100,000 bu → <13c/bu

Recent Survey of US Upper Midwest Elevators

- IP and GM Marketing
  - 89% handle GM grains
  - 18% handle IP
  - 57% use mechanisms of proof
  - 19% ask for variety declaration
- Certification
  - 22% HAACP and 19% ISO certified

Costs and Risks: Model and Data

- Stochastic optimization model to determine optimal intensity and location of testing to conform to EU traceability requirements
  - Model determines
    - Least cost subject to risks
    - Optimal testing strategy
    - Buyer and seller risk of non-conforming

Important Cost Elements

- On-farm
  - isolation, certified seed etc.
  - Which type of test (depends on cost/accuracy)
  - Lower yielding varieties vs. GM technology (11%)
  - Risk premiums: non-GM is more risky than GM
  - technology fee
  - Added costs of segregations and on-farm testing
- Off-farm
  - Testing (whether to test, and which type of test)
  - segregation, traceability certification

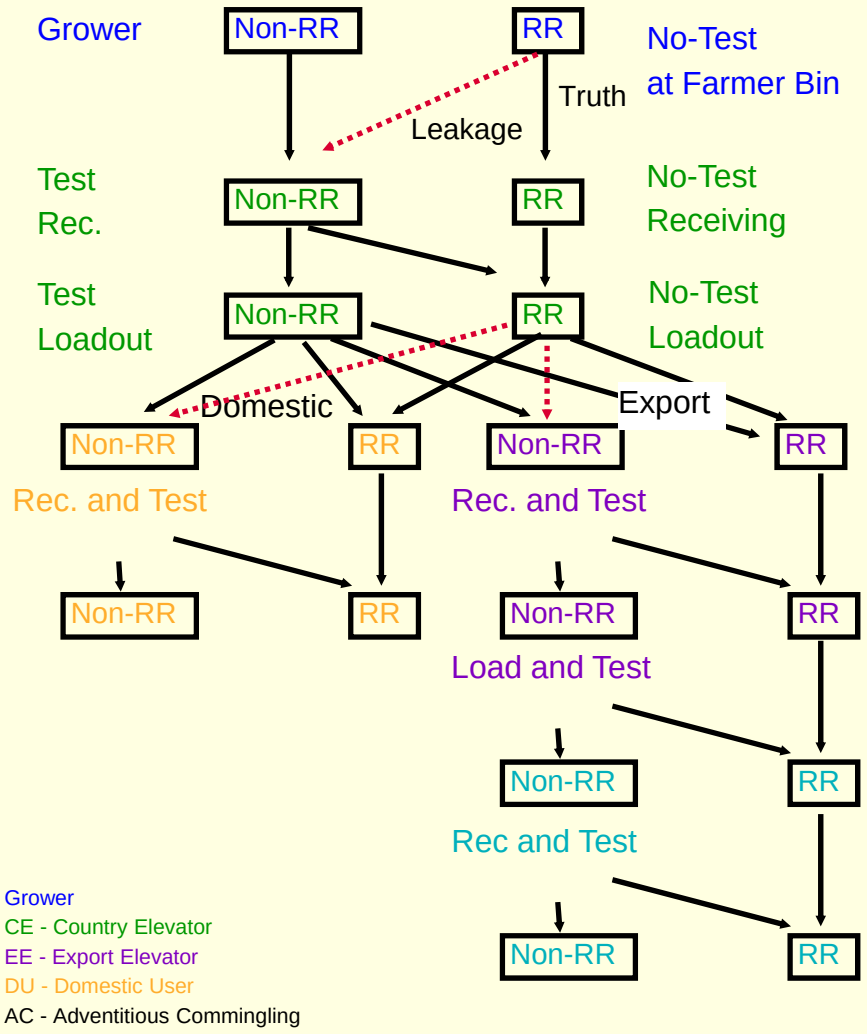
Data and Assumptions at the Farm Level

Item	Source	Estimated Range	Value Used	Distribution
Buffer Strips Prod	Assumption	18,018;484,746 bu		RiskUniform
Certified Production	NDSSD		$7.2/bu	
Auditing	Peterson, 2002.		3.6c/bu	
Testing Cost (Strip test)	Strategic Diagnostics Inc. 2003.		$3.5 , 99%	
Cleaning Cost	Bullock, Desquilbet, and Nitsi, 2000	0.708;2.320 c/bu		RiskUniform
Certification	Wright and Tilley, 2004		10 c/bu	
Traceability Cost	ESRI		4.6 c/bu	

Data and Assumptions at the CE, EE, Importer Levels and for the Market

Item	Source	Value Used
Country Elevator		
Testing Cost (Strip Test)	Strategic Diagnostic Inc., 2003.	$3.5 , 99%
Traceability	ESRI and USDA	0.06 c/bu.
Exporter Elevator		
Testing Cost (PCR)	Mid-West Seed Service, Inc., 2002.	$250 , 99%
Traceability	ESRI and USDA	0.03928 c/bu.
Importer Level		
Testing Cost (PCR)	Mid-West Seed Service, Inc., 2002.	$250 , 99%
Traceability	ESRI	0.03928 c/bu.
Market Characteristics		
Wheat price market	Swenson et al., 2003	$3.29/bu.
Non-GM Wheat Price	Assumed from Swenson (2003) and Maxwell (2003)	$3.4/bu

Testing and Tolerance Model



Overview of Market Mechanisms, Testing and Tolerances

- Growers: Declare/certify non-GM and related practices
- Elevators
  - Choose whether and how frequent to test and which type of test
  - Segregate based on declaration and/or test
  - Divert Non-GM to GM flow if found to have GM detection
  - Load-out and choose to test upon loading
- Export elevators
  - Receive and choose to test and which types of test
  - Segregate based on test and/or knowledge of GM content
  - Divert Non-GM to GM flow if found to have GM detection
  - Load out and choose to test
- Importer
  - Test
  - Accept/reject

Risks and Economic Tradeoffs

- Risks
  - AP on farm due to
    - pollination
    - Handling/segregation practices
  - Adventitious comingling
  - Testing accuracy
- Economic Tradeoffs
  - Type of test: some are more costly
  - Frequency of test: How often
    - More testing raises costs, and reduces risk of being out of contract
  - Grower declarations—how accurate or truthful are supply chain partners

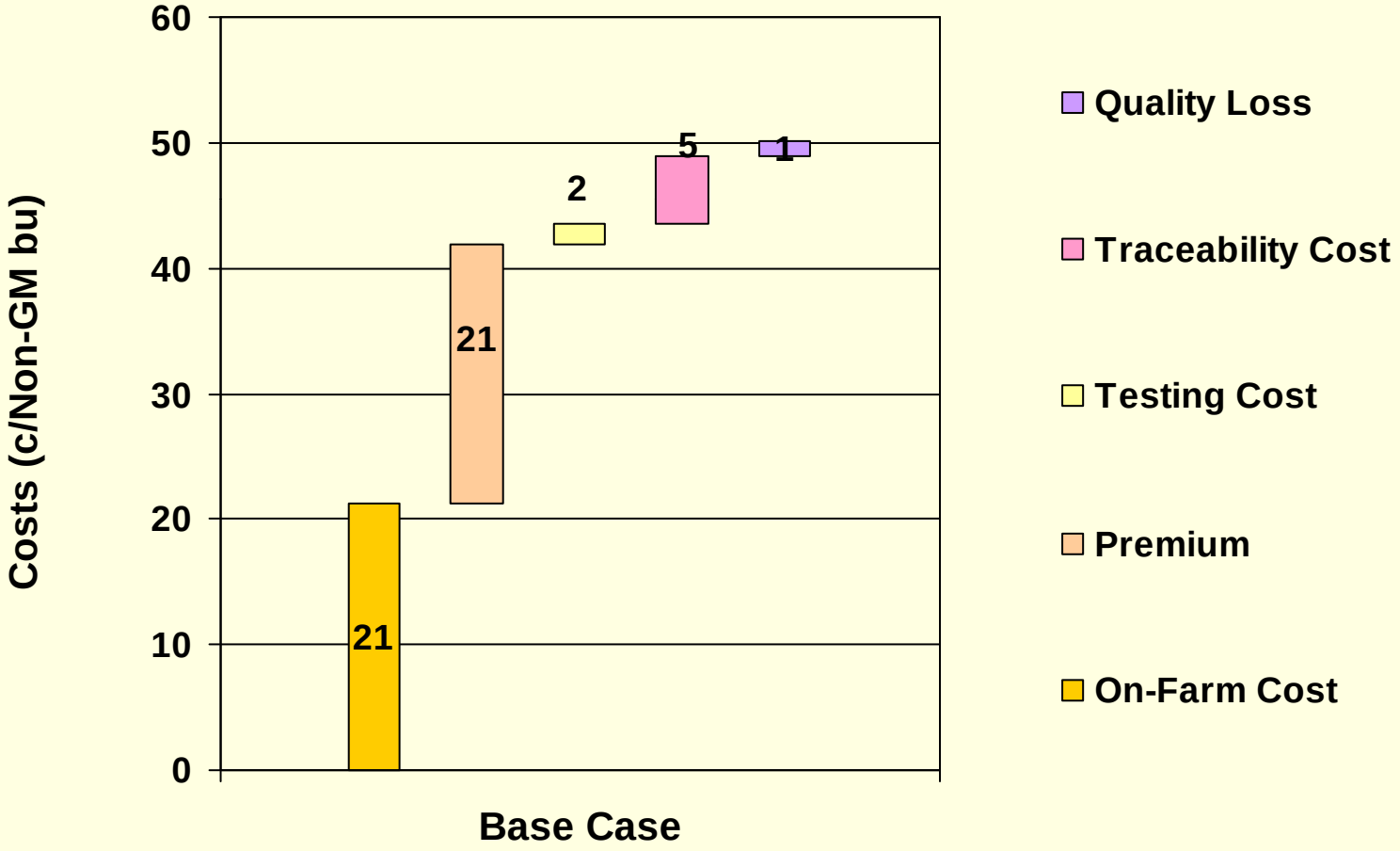
Base Case Results: Optimal Testing strategy

- Optimal testing strategy (tests per ___ samples):
  - On farm (e.g. 1 test per 5 loads) 1 out of 5 loads
  - Country Elevator receiving: 1 out of 5 loads
  - Country Elevator loading: 1 out of 5 loads
  - Export Elevator receiving: 0-NA (does not test, but relies on claim made by supplier and/or v. int purcase)
  - Export Elevator lading: Every sublot upon loadout

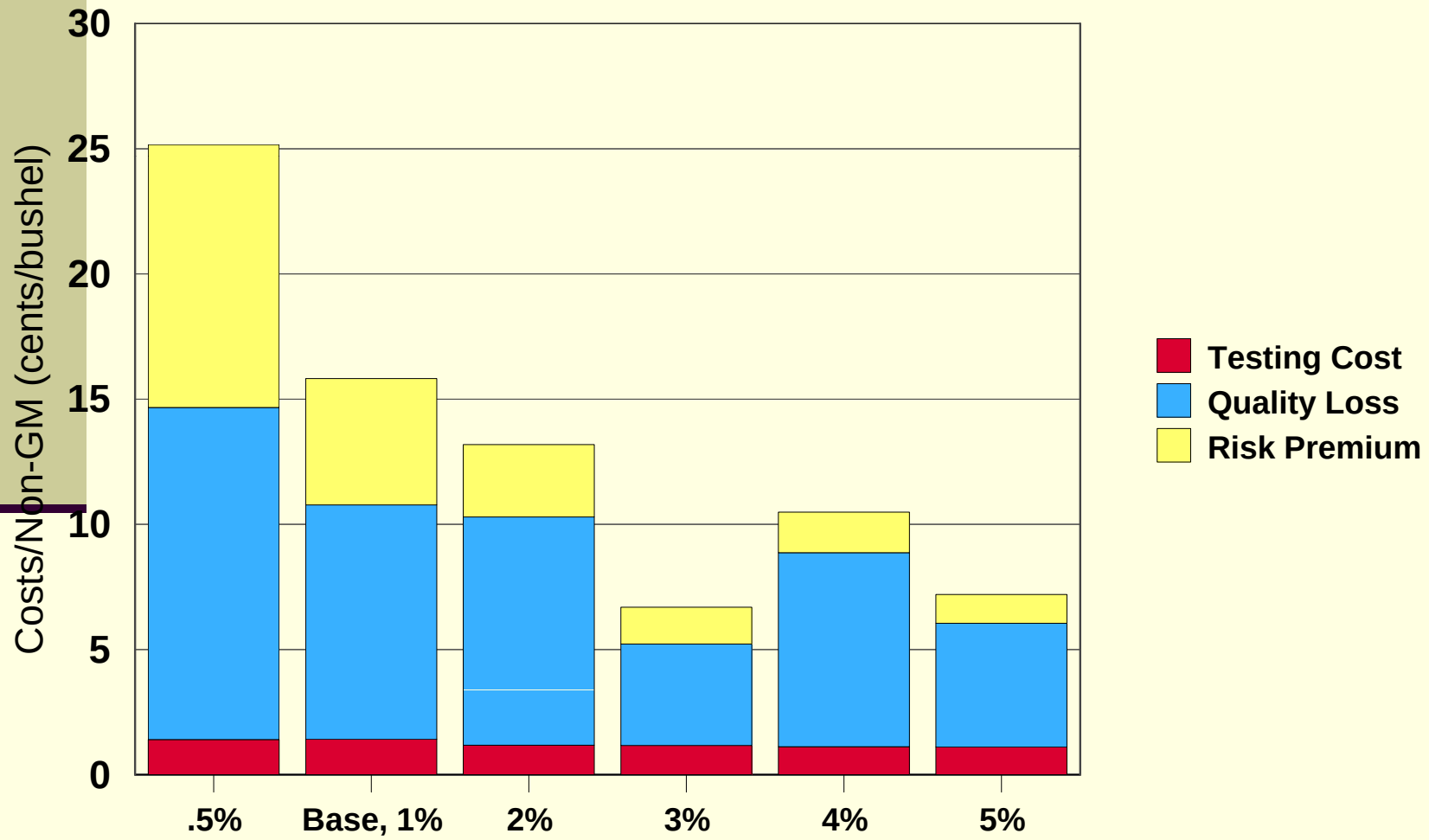
- Seller Risk Having product rejected that should be accepted.
  - For the seller 1.73% of shipments rejected by the importer
- Buyer risk: after 1.73% are rejected as exceeding tolerance.
  - Base case: .01%
    - less than 1/10 of 1% prob of being out of contract (receiving GM wheat in non-GM shipment)

- Risk premium to the grower for growing non-GM which is more risky
  - 20.56 c/bu $7.70/mt

Base Case Results
Elements of Cost



General Simulations: Effect of Importer Specifications on Costs



Contracting for EU Traceability

Objectives and Definition

- To determine ‘strategic/incentive premium’ to induce participation of US supply chain agent to EU traceability requirements.
- Problem posed as an extensive form game (P-A).
- 4 Players each seeking to maximize profits:
  - Buyer
  - Supplier
  - Farmer, and
  - Nature-- represents uncertainty.

Principal-Agent Problem

- Principal offers contract to the supplier;
  - Supplier accepts or rejects the contract;
    - If accepted: offers or not a contract to the farmer;
      - farmer accepts or rejects the contract.
- All players have outside options.
- Nature represents GM detection in the grain flow is modeled at the end of the tree.

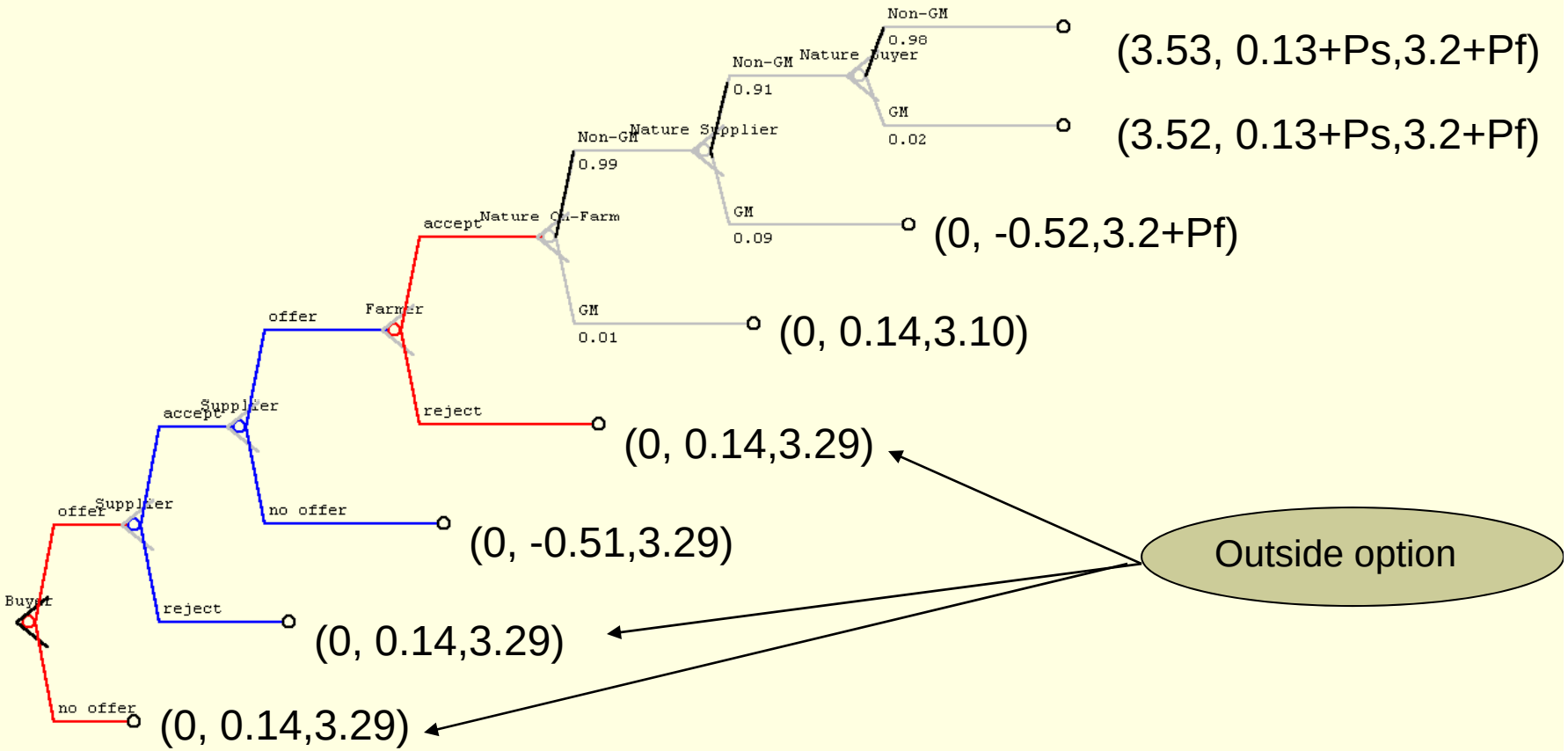
Base Case Data and Assumptions

	Items	Source	Value
Farmer	System Cost	Results of *Risk Optimizer* Base Case	19 c/Non-GM bu
	Testing Cost	Results of *Risk Optimizer* Base Case	0.01 c/Non-GM bu
	Market Price	Assumed from Swenson (2003) and Maxwell (2003)	340 c/Non-GM bu
	Outside Payoff	Swenson et al. 2003	329 c/bu
	Failure Cost	System cost and Testing cost	20 c/bu
	Nature	Results of *Risk Optimizer* Base Case	99.13%
Supplier	System Cost	Results of *Risk Optimizer* Base Case	0.11 c/Non-GM bu
	Testing Cost	Results of *Risk Optimizer* Base Case	0.74 c/Non-GM bu
	Net Margin	Wilson, Johnson and Dahl, 1995	14 c/bu
	Failure Cost	Wilson, Jabs and Dahl, 2002 (penalties)	65c/bu
	Nature	Results of *Risk Optimizer* Base Case	90.54%
Buyer	System Cost	Results of *Risk Optimizer* Base Case	0.1 c/Non-GM bu
	Testing Cost	Results of *Risk Optimizer* Base Case	0.62 c/Non-GM bu
	Market Price	Summation of supplier and farmer market prices	354 c/bu
	Outside Payoff	Summation of supplier and farmer outside payoffs	0 c/bu
	Failure cost	Results of *Risk Optimizer* Base Case (Quality loss)	0.92 c/bu
	Nature	Results of *Risk Optimizer* Base Case	98.19%

Simulation and Equilibrium

- Sequential Equilibrium
- Premium adjustment until contracting strategy achieved
- Costs and nature probabilities are specified and conformed to stochastic optimization:
  - Direct costs included in the model,
  - Nature probabilities are defined from the Non-GM flow of the stochastic simulation.
    - Derived from stochastic simulation

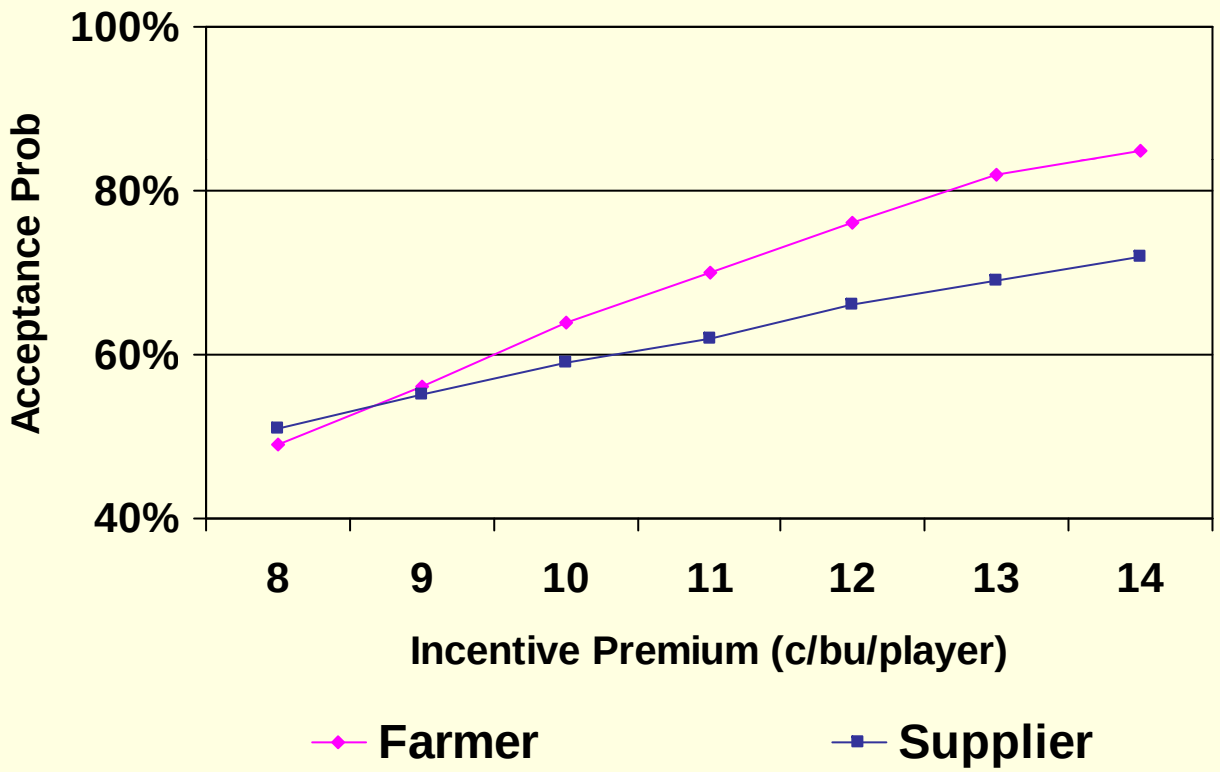
Base Case Tree and Theoretical Payoffs



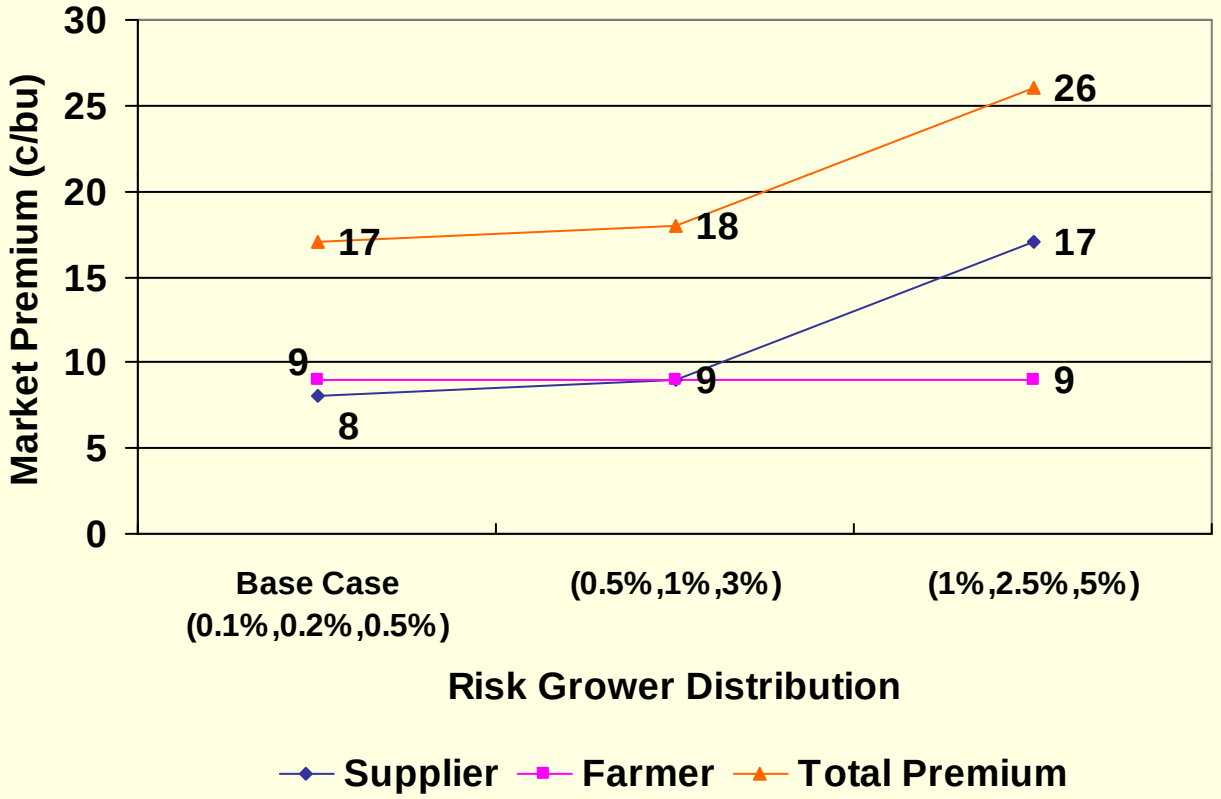
Base Case Results

- Without premium
  - Equilibrium: No contract
- Premiums necessary to induce acceptance (participation)
  - 2.93 $/mt/Non-GM for the supplier:
    - the supplier requires an incentive premium equal to $2.93/mt to participate
  - 3.93$ /Non-GM mt for the farmer:
    - the farmer requires an incentive premium equal 3.93/mt to participate
  - Total premium equal to $6.24/mt/Non-GM
- Mixed strategy equilibrium results:
  - 51% acceptance for the supplier:
    - the supplier accepts contract with prob=51%
  - 56% acceptance for the farmer:
    - the farmer accepts contract with prob=56%
  - Principal and supplier offer 100% of the time

Impacts of Incentive Premium on Prob of Acceptance



Adventitious Commingling (on-farm AP risks) on Premiums



Conclusion and Implications

- Segregation and traceability
  - Are costly practices
  - Costs are not homogeneous between supply chain agents
  - Part of cost is the differential in productivity between GM and non-GM production
- Contracting
  - Necessary to induce traceability and segregation to conform to EU requirements
  - Not-traditional

Strategic Simulation Conclusion

- Contracts can be developed to induce participation by growers and handlers
  - P-A model of contracting
  - Inclusion of risk and mixed game sequential equilibrium
- Strategic premiums:
  - $2.93/mt (farmer) and $3.30/mt (supplier) to induce participation.
- Farmer incentive premium is sensitive to: Premiums
- Supplier incentive premium is sensitive to:
    - Adoption rate (more GM, more risk, greater premium),
    - Penalties for non-conformance
    - On-farm Risks
- Such contracts are more easily implementable in private grain trading industries
  - More difficulty, though not impossible, in STE's due in part to tradition of pooling

Likely Evolution: Contracting and Segregation

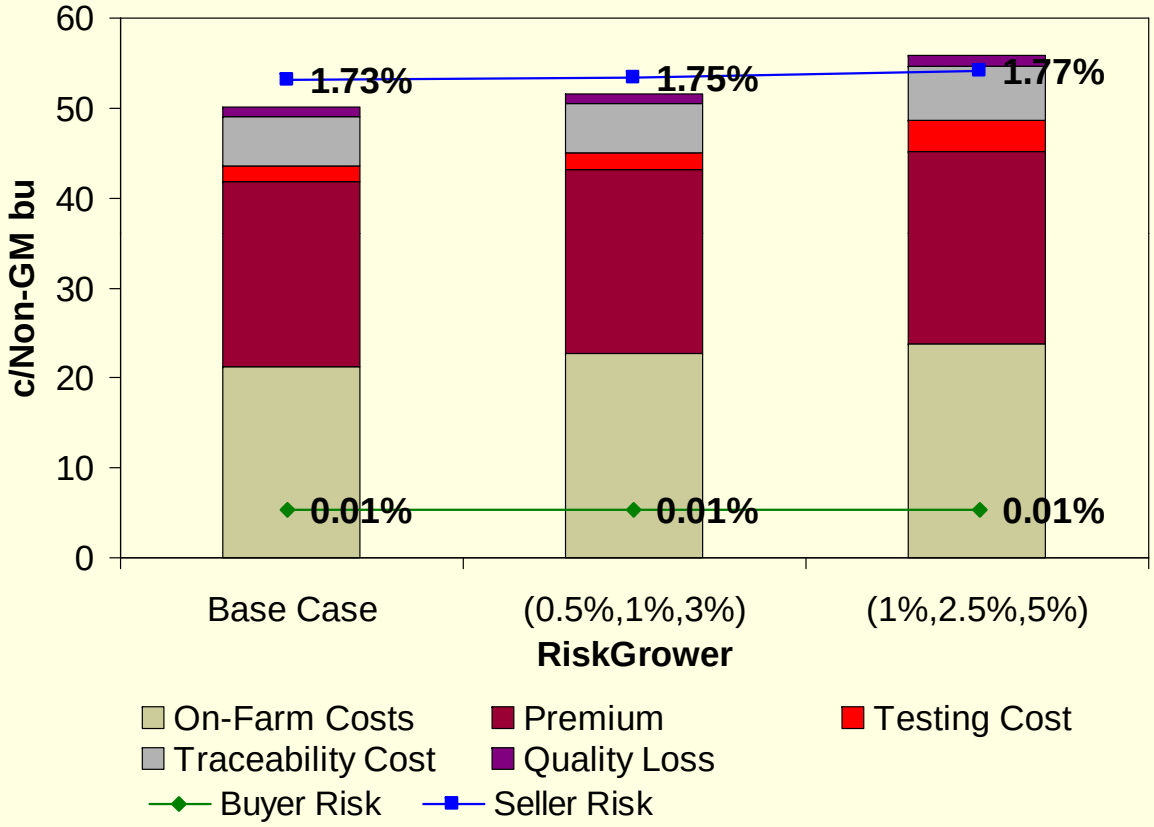
- Costs/risks can be reduced/mitigated further by
  - Grower contracts/purchase protocols with variety declaration
  - Targeting regions with known non-GM production
  - Specialization by facility to serve non-GM markets
  - Specialization by port facility to serve non-GM markets

Summary: Segregation Mechanisms and Costs

- ***Buyers: How buyers can assure non-GM!***
  - Segregation requires contracts which are Initiated by buyer!
  - Pre-planting contracts including definitions of varieties, use of certified seed (likely) delivery point and other agronomic protocols—most difficult particularly for non-US buyers!
  - Variety (or, non-GM) declaration at point of delivery
  - Random testing to assure integrity
  - Must be initiated by buyer: not farmers, or associations, or necessarily handlers
- ***Specialization*** in non-GM production {(and likely handling and processing (mills)}
    - Regions (e.g., Montana); elevators and farmers

Questions and Discussions

Adventitious Commingling Sensitivities



Int. Contamination:

- Less Non-GM grain
- Costs ↑

High Contamination:

- Costs ↑
- Different Testing Strategy
- Testing cost ↑
- Seller risk ↑

Premium increase