Revenue Risk, Crop Insurance and Forward Contracting

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Background

- Marketing experts say the prudent thing to do in the spring is to use forward contracts in case prices go down

- Crop insurance salespeople say you need crop insurance in case yields go down
  - Then you can hedge up to your guaranteed bushels

- Producers must understand the underlying price-yield relationship
  - how forward contracting interacts with crop insurance
  - Implications of buying back over-contracted yield
  - Paying crop insurance premiums

Producer Motivation

- Agricultural production is risky
  - Revenue is ***<u>unknown</u>*** when making the investment decision
  - Tools exist to reduce the chance of revenue < cost
    - For commodity price - futures market (i.e., forward contracting)
    - For yield - crop insurance
      - Revenue policy interacts with futures market
- Higher costs (same acreage)
  - In 2006 it took $330,000 to produce a crop and
    - 2013 it takes over a million dollars

- **Farm is concerned with two things**
  - **Positive expected income and farm survival (surviving a 1 in 100 year event)**

Producer Motivation

- How does forward contracting and crop insurance interact to reduce revenue risk
  - Answer depends upon farm specific characteristics
    - Farm yields
    - Farm-price relationship

- Misunderstanding of these interactions could lead to an inefficient combination of revenue risk and income

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Modeling 2013 Revenue Uncertainty

- Focus: income (costs depend upon yield)
- Crop: Corn

- Revenue = yield*price
  - Empirical yield distribution = Producer yield data
    - De-trended field level over 33 years of experience
    - Multiple tracts are combined into one enterprise
    - Trend yield is expected

  - Price probability distribution
    - December 2013 futures market options prices
      - Contains all market info
- Cost
  - Current producer corn production costs for 2013
    - Cost is a function of yield = $0.58 per bushel

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Objective Function

- Hedging = futures hedging using personal margin account

- Crop Income = yield*Price
  + Crop Insurance(APH Yield, coverage level (65-85%), unit type (enterprise), insurance type [(RP, RP-HPE) (base price, harvest price)], trend adjustment, premium)
  + hedged yield*hedged price
  + hedging cost (buying back over contracted bushels, interest on margin calls)

  – APH vs. expected yields
    - APH are path dependent.
      – 2012 APH = 138.7 and after the low yield in 2012
      – 2013 APH = 132.7

The Model

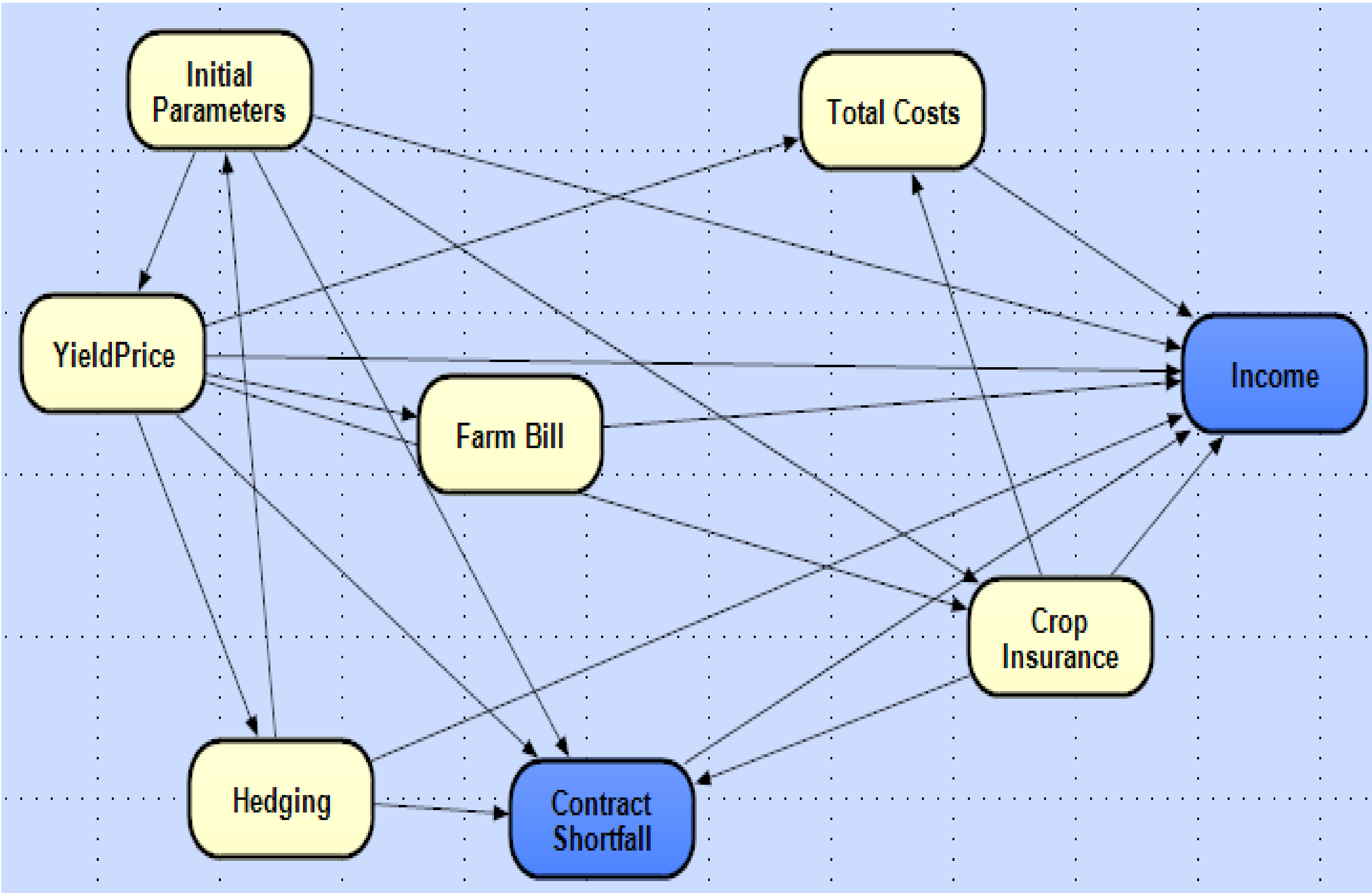
- Software: ANALYTICA
  - Monte Carol simulation through influence diagrams view of models

- 30,000 runs

- Income is derived from randomly selecting farm level yield and price

- Dates of Analysis
  - March 1st – Insurance base price set
  - November 29th – Dec futures enter delivery

The Model



Initial Parameters
Total Costs
YieldPrice
Income
Farm Bill
Crop Insurance
Hedging
Contract Shortfall

Yield-Price Relationship

- Model joint dependence between yields and prices
  - Realizing a low yield increases the chances of a higher price are much better than if yield was average
  - Strength of inverse relationship depends upon producer location relative to primary crop growing area
- Spearman correlation is approximately -.187
- Relationship depends on location within distribution
  - Use a copula to combine multiple joint densities into one
    - » We are interested in identifying a copula displaying tail dependence
      - Clayton copula, from the Archimedean copula family allows for yield price dependence to strengthen in one of the tails of the distribution

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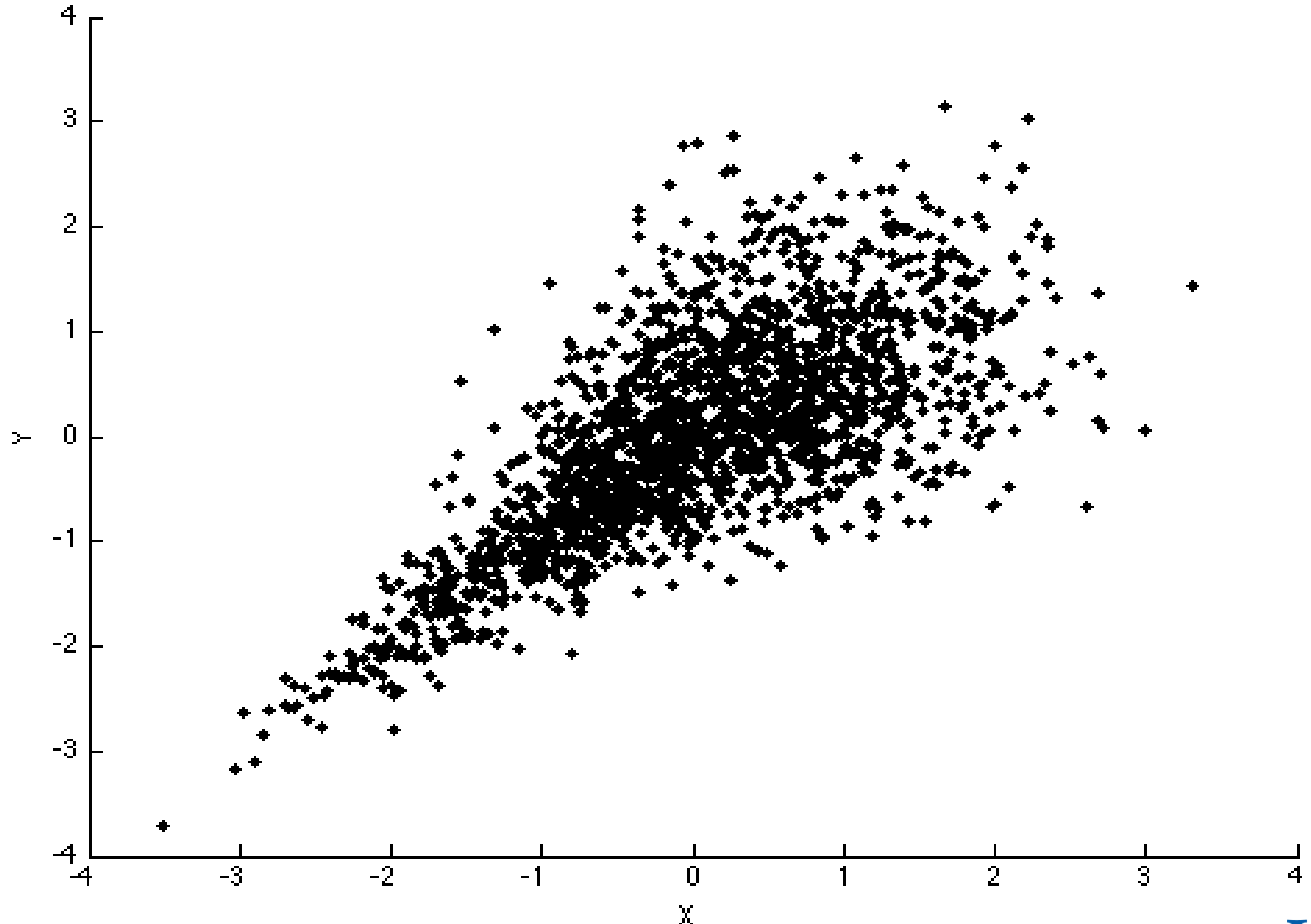
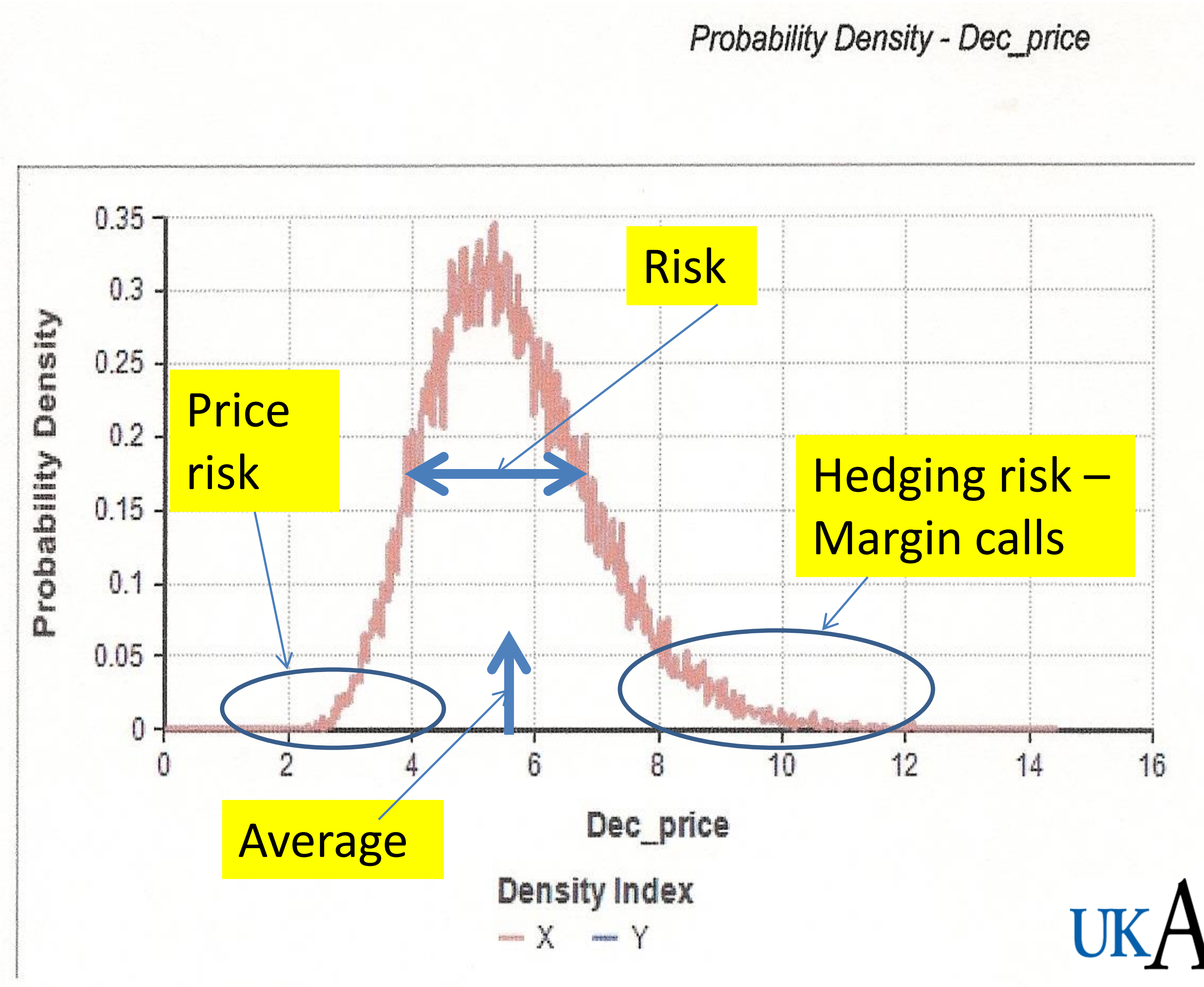
Clayton Copula



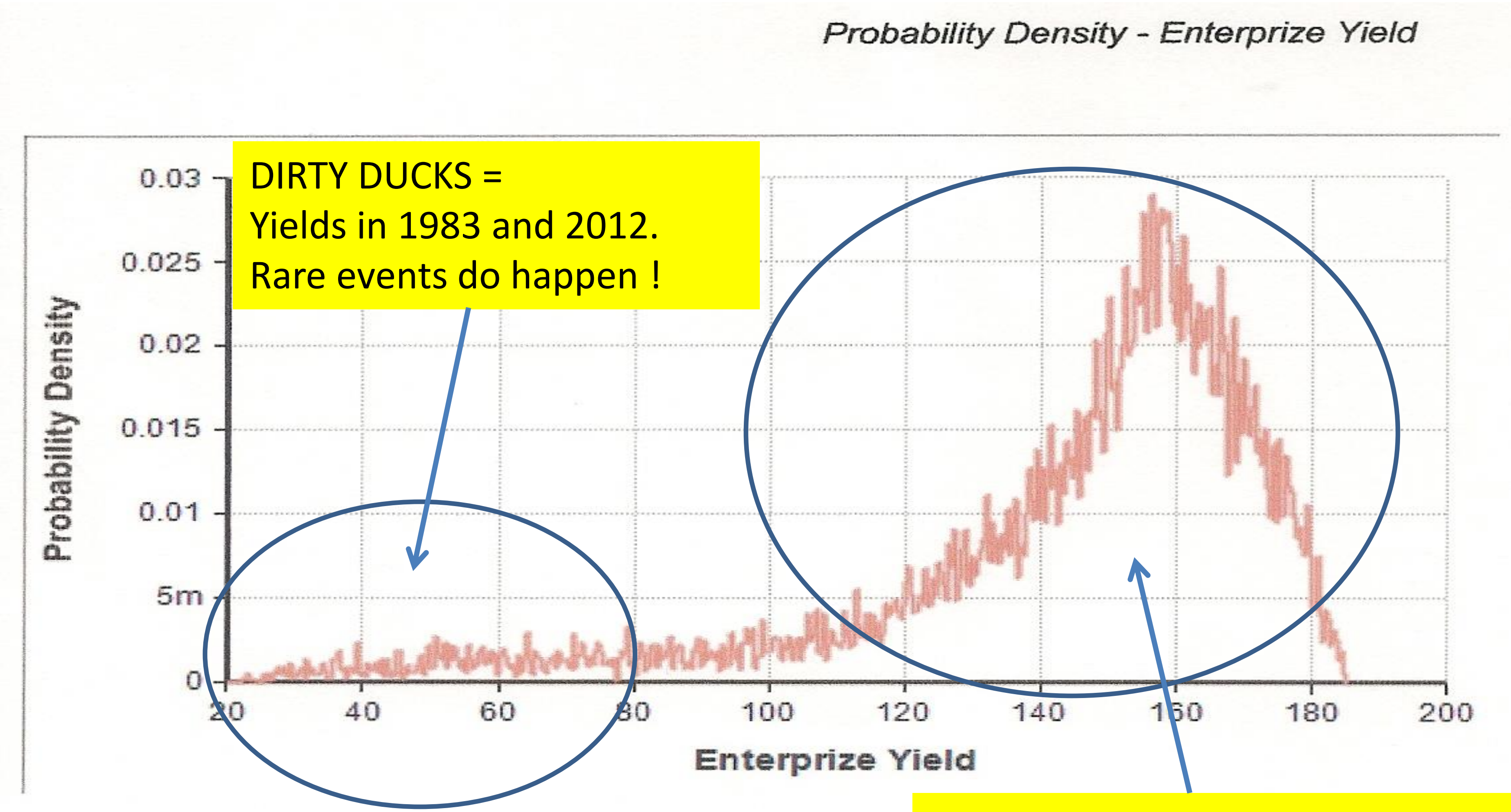
December 2013 Corn Futures Prices



December 2013 Corn Futures Prices

- Median = around $5.60
- 10% chance price is less than $4.00
- 10% change price is greater than $7.60

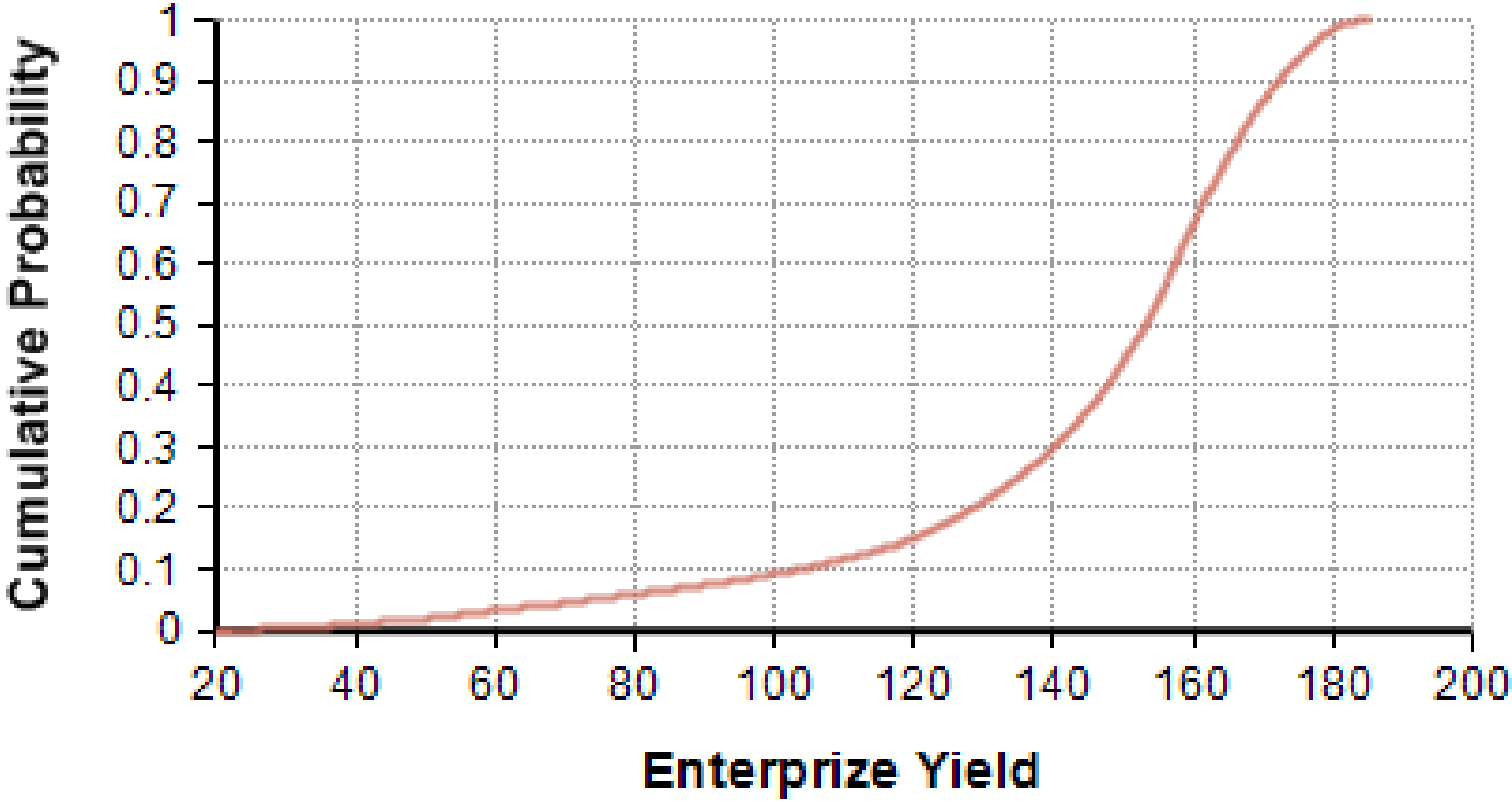
Farm Corn Yield



Farm average = 144.4 bu/acre

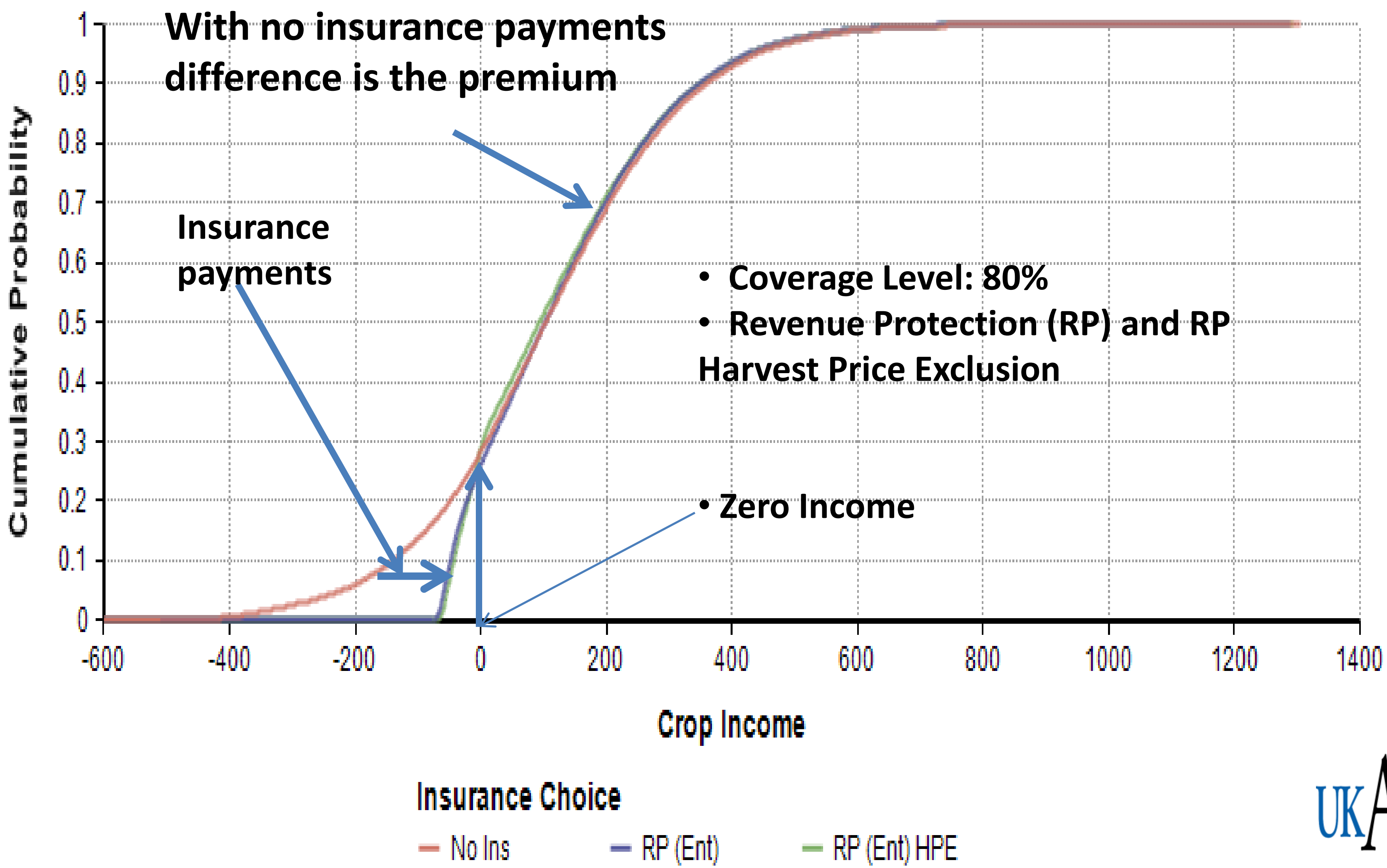
Most years expect yields between 110 and 170 bu/acre

Farm Corn Yield



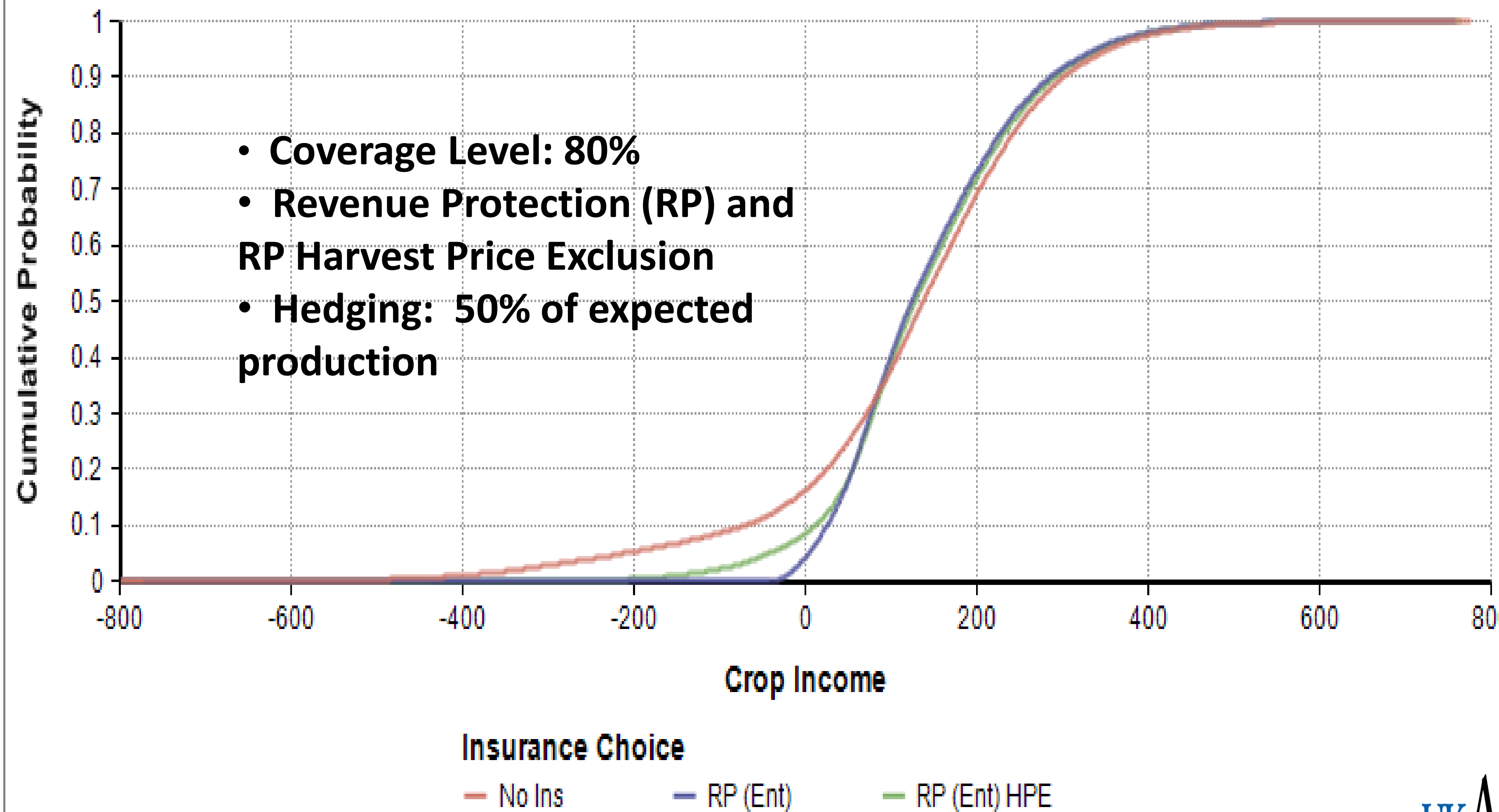
- Median = around 155 bushels per acre
  - 10% chance yield is less than 101 b/ac
  - 10% change yield is greater than 170 b/ac

Crop Income and Insurance



- 80% coverage, enterprise units does not guarantee positive income
- No hedging at this point

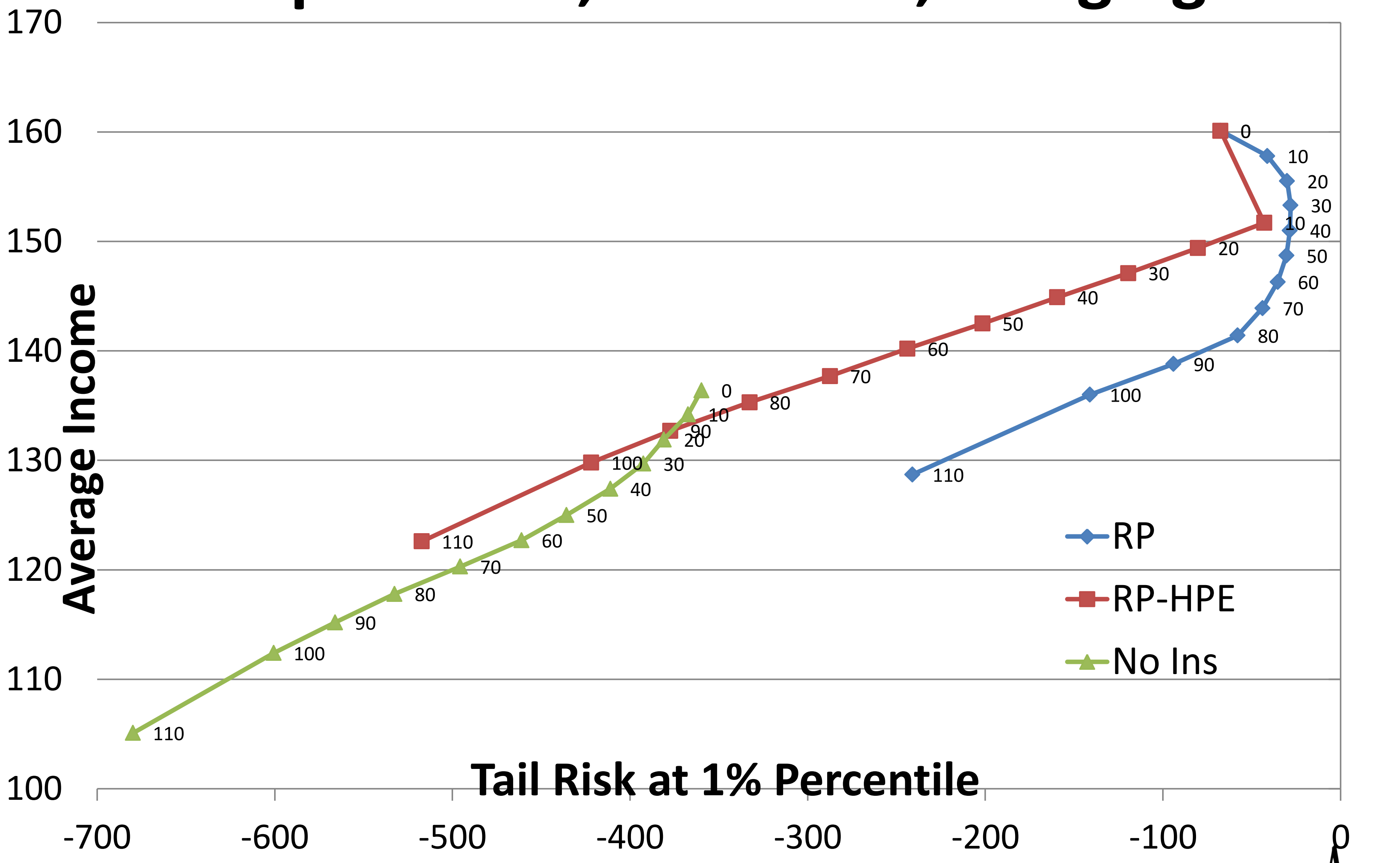
Crop Income, Insurance and Hedging

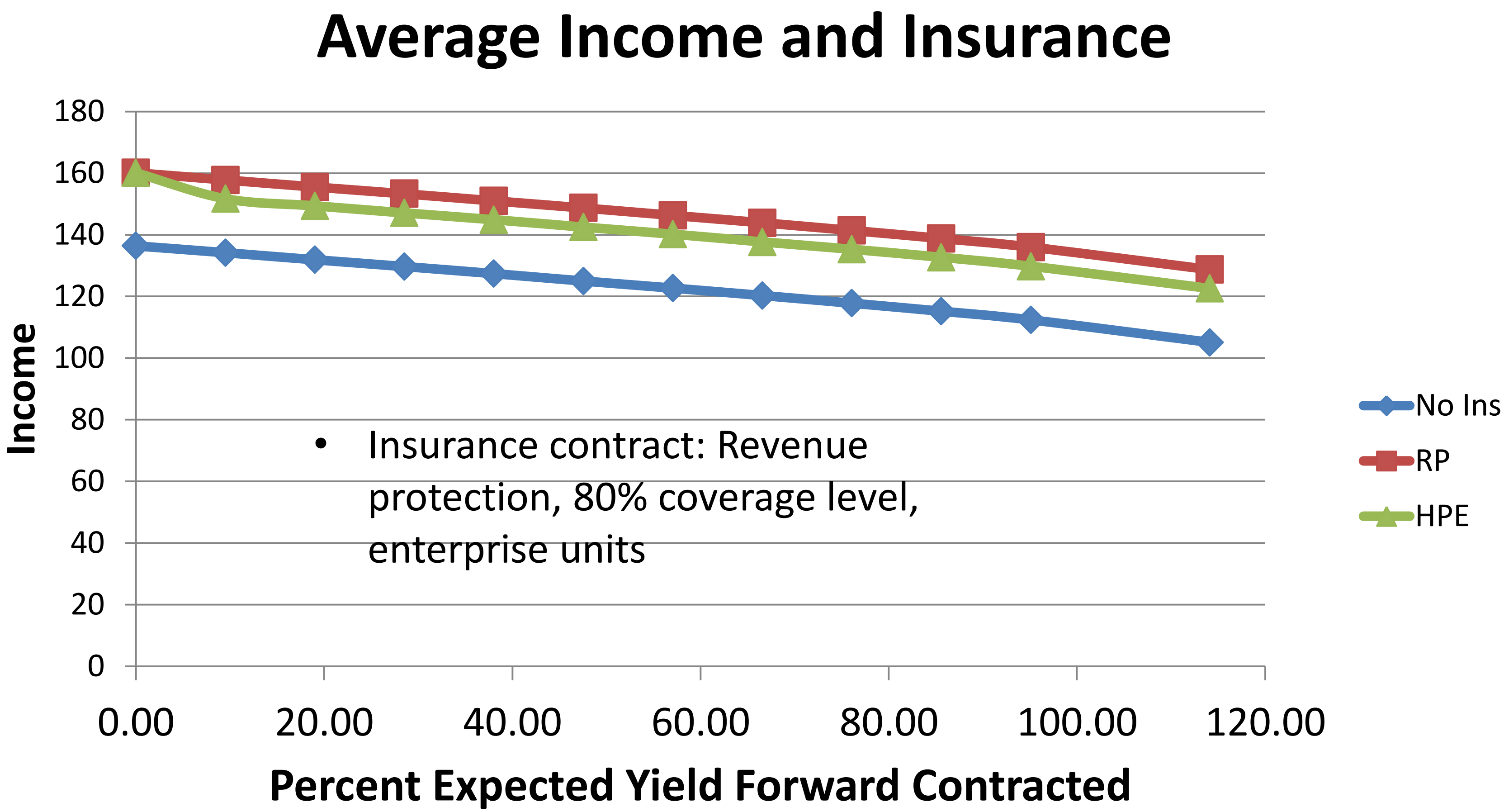


- Coverage Level: 80%
- Revenue Protection (RP) and RP Harvest Price Exclusion
- Hedging: 50% of expected production

- **HEDGING PLUS INSURANCE (RP, 80% Coverage Level, Enterprise units), 50% hedged reduces chance of less than zero income by about 13%**

Crop Income, Insurance, Hedging





- At the average income RP provides the highest income because it receives the most subsidy dollars. Insurance beats no insurance because of the subsidy – If you farm forever you will get paid more than you paid in.

Summary

- Everyone faces the same futures prices
- Results are specific to risk faced by this farm
  - Location, planting dates, soil types, etc…
  - APH relationship to actual
    - 2012, APH = 138.7, expected = 143.5 (-4.8)
    - 2013, APH = 132.7, expected = 145.0 (-12.3)
- Hedging without crop insurance increases risk of farm failure even though it reduces income uncertainty
  - Validity (?) in – 'he gambled on the futures market' or 'don't sell a crop you don't have'
- RP dominates all other insurance contract types when hedging is involved. RP= RP-HPE with zero hedging.

Summary

- Results indicate that crop revenue risk (the ‘dirty duck’ rare event of 1 in 100 years) are reduced when using crop insurance (RP, enterprise units, 80% CL)
  - \- $292/acre
- Income risk is further reduced by futures hedging
  - \- $39/acre (30% hedged)

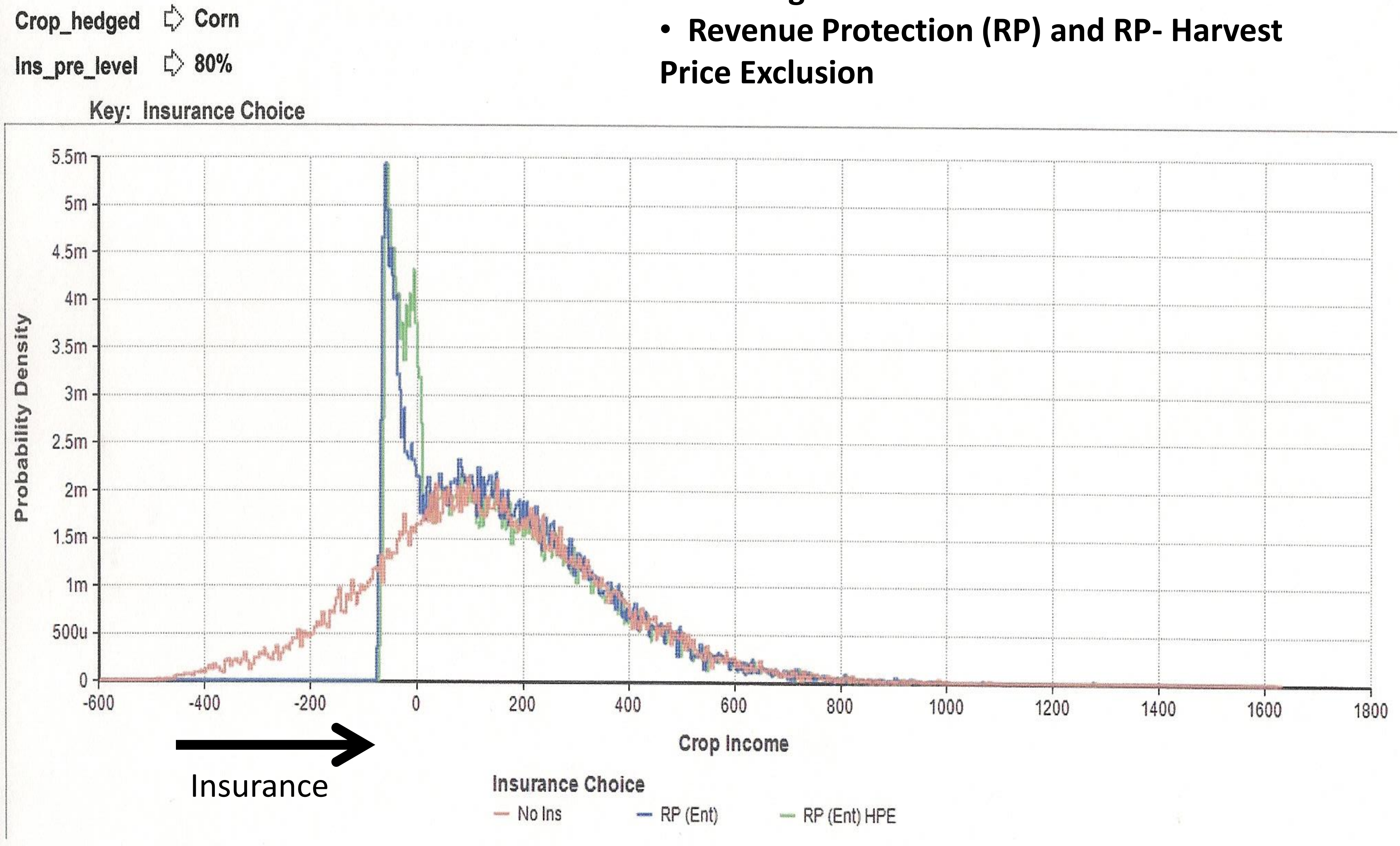
- Consequently, this producer does not need to hold as much capital in reserves for a bad event
  - Can invest this money

Caution

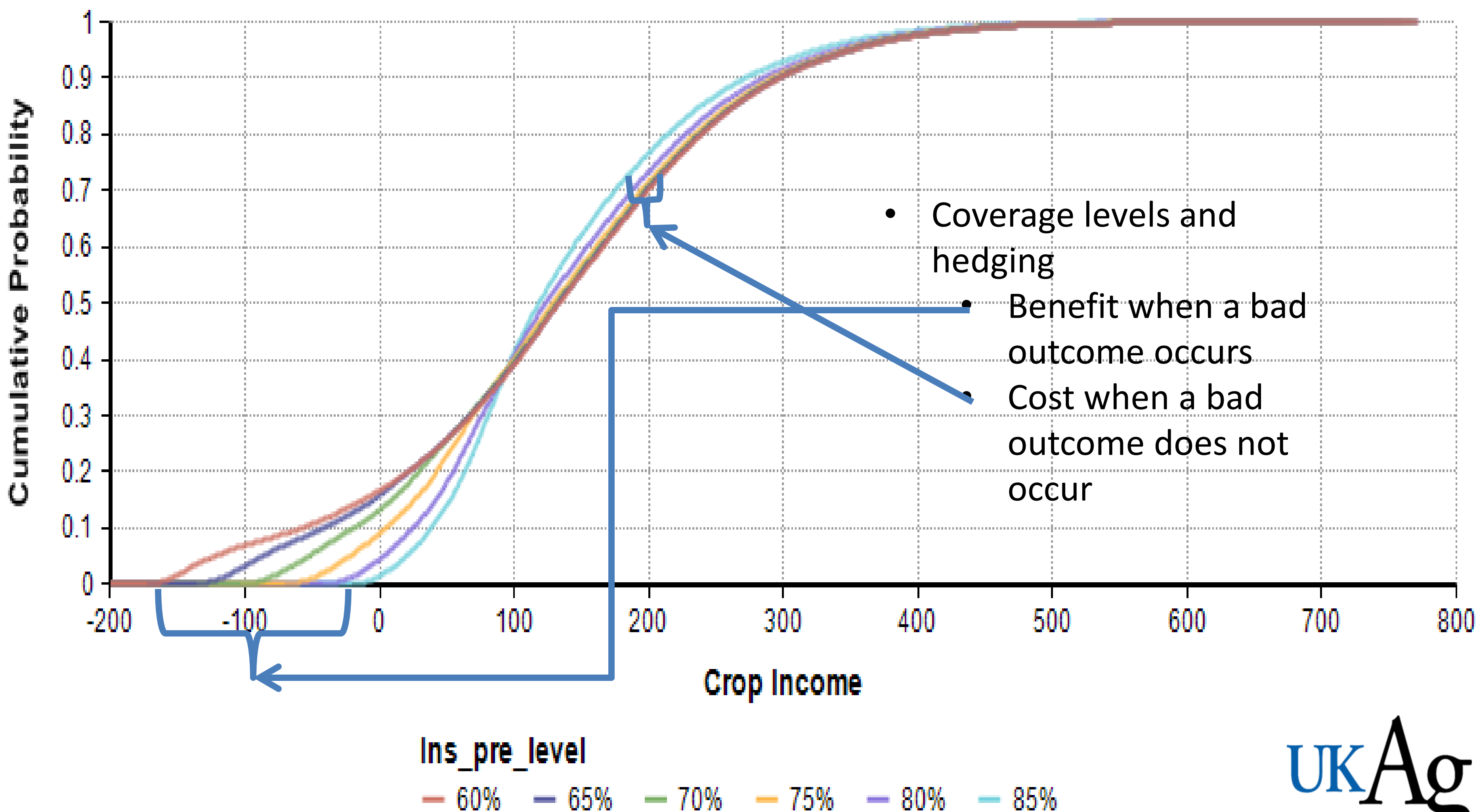
- Portfolio evaluation
    - March 1st (Base price just set) to last trading day in November (December futures enter delivery)
- No storage consideration
- No carry or basis consideration
- No continuous hedging decision making
- No option contracts

Crop Income With and Without Insurance

- **Coverage level: 80%**
- **Revenue Protection (RP) and RP- Harvest Price Exclusion**

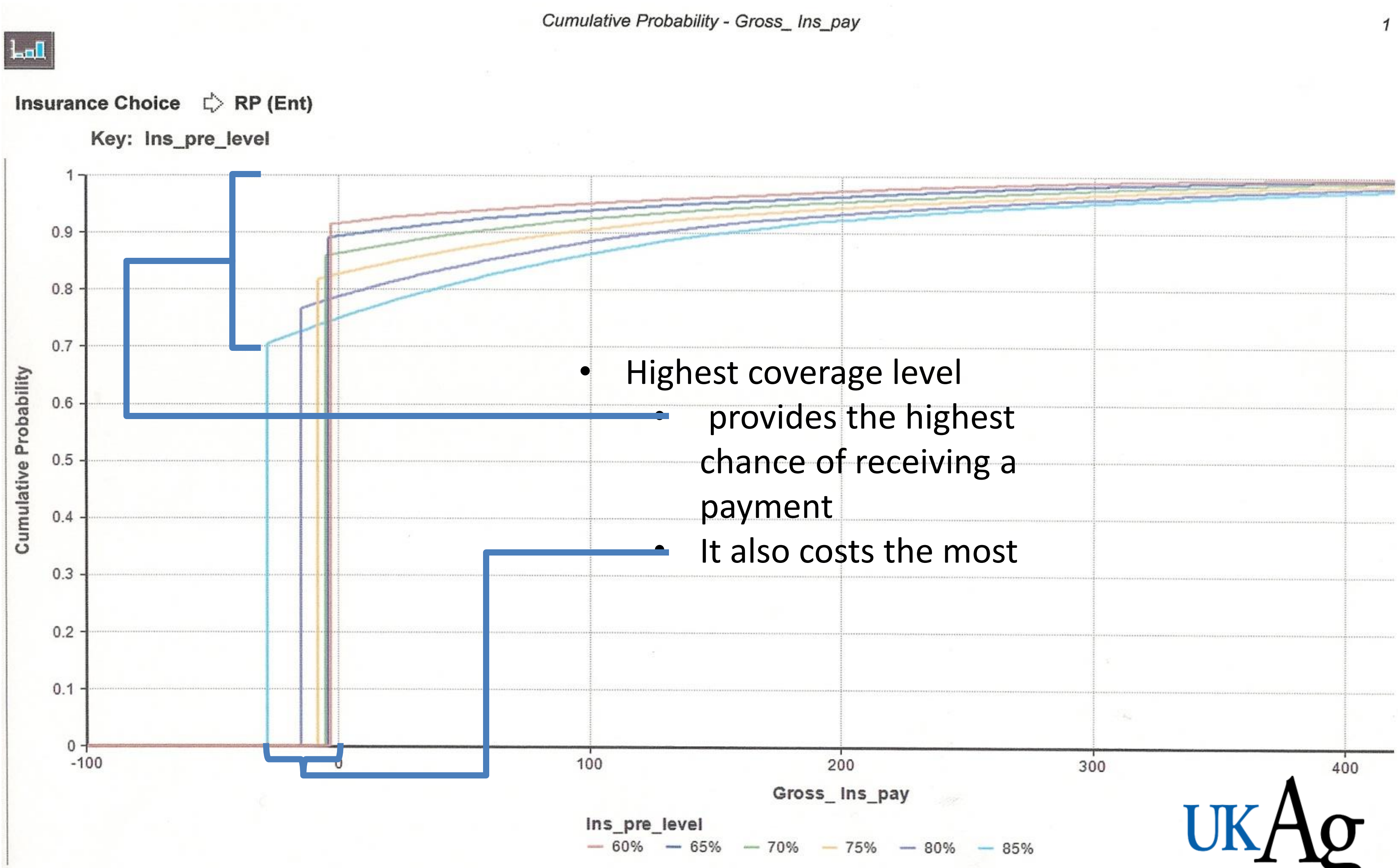


Income Across Coverage Levels with 50% hedged



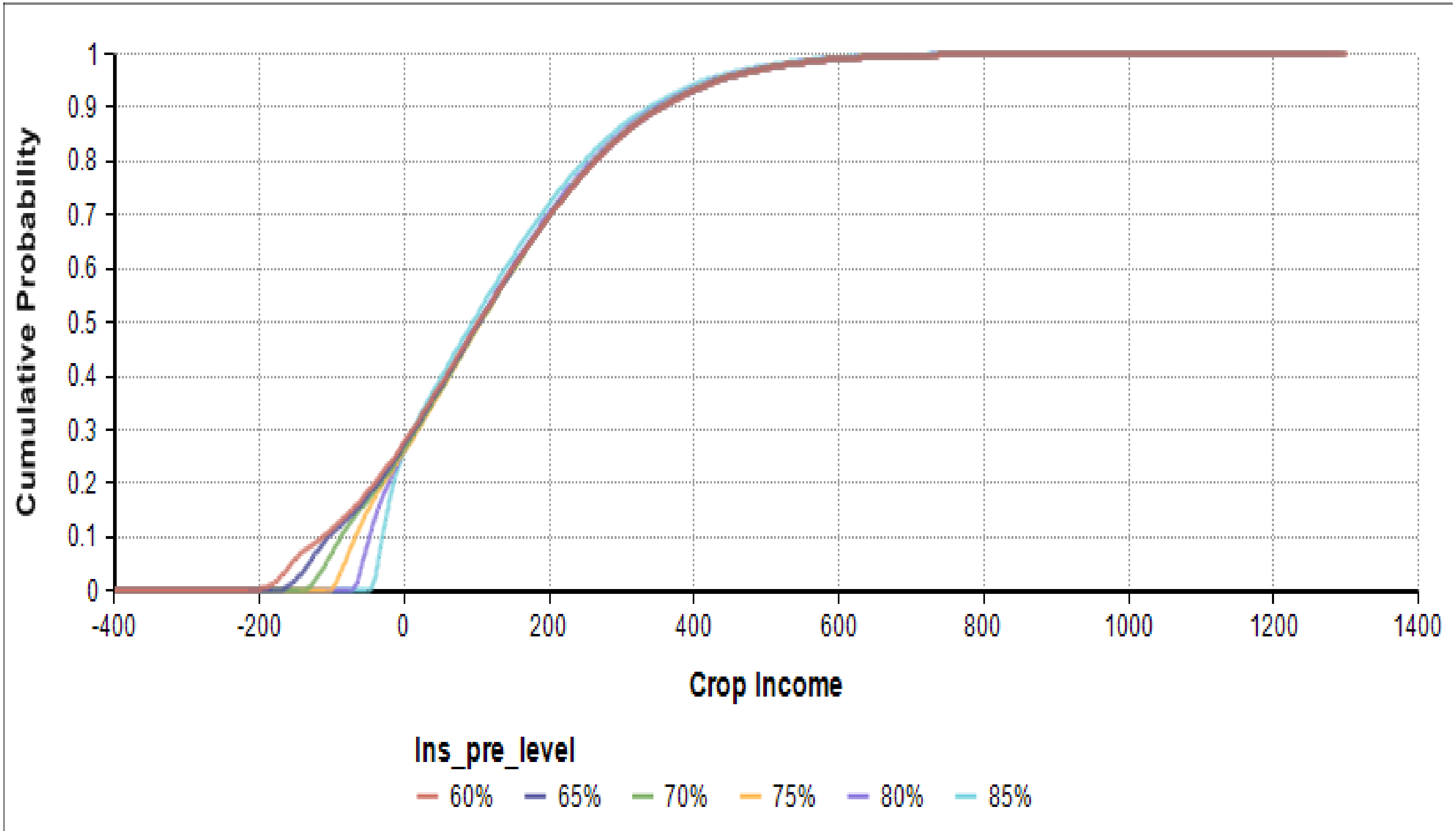
- Coverage levels and hedging
  - Benefit when a bad outcome occurs
  - Cost when a bad outcome does not occur

Insurance Coverage Level Payouts



- Highest coverage level
  - provides the highest chance of receiving a payment
  - It also costs the most

Revenue Protection, Enterprise Units, No Hedging



2013 Premium Subsidies, in Percent

Coverage Level	Non-Enterprise	Enterprise
50%	0.67	0.8
55%	0.64	0.8
60%	0.64	0.8
65%	0.59	0.8
70%	0.59	0.8
75%	0.55	0.77
80%	0.48	0.68
85%	0.38	0.53

Crop Income With and Without Insurance