Feasibility and Acceptability of Guar Substitutes in the USA

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Why Guar? Why Now?

- No different than in the past—just larger potential demand due to oilfield fracking
- Guar gum is highly valuable and sought after as an ingredient from small quantities in numerous food products to large scale uses in oil field services (e.g., a component of frac fluids, about 70% of total demand, especially due to shale-gas drilling)
- After all these years guar gum and guar derivatives are hard to beat for overall quality and effectiveness

The (Undeserved) Perception of Guar:

"Low-Input/Stepchild Crop" (USA)

"Poor Man's Crop" (India)

Current Status of USA Guar Production

- Current USA farm guar production: ~35,000 acres (~15,000 hectares)
  - Range of 7,000 to 50,000 acres (3,000 to 20,000 ha) since 2000
- Farm 2013 seed price was higher, $0.45/lb. ($0.99/kg) due to market expectations held over from 2012
  - $0.30/lb. ($0.66/k) in 2011, past lows of ~$0.15/lb. ($0.35/kg) in 2008
- Farm yields for well-managed guar average about 500-1,000 lbs./A (600-1,100 kg/ha) depending on rain
  - Limited irrigation (~3% of acres), ~1,400 lbs./A (~1,500 kg/ha), but 2,000 lbs./A (2,200 kg/ha) possible with moderate irrigation

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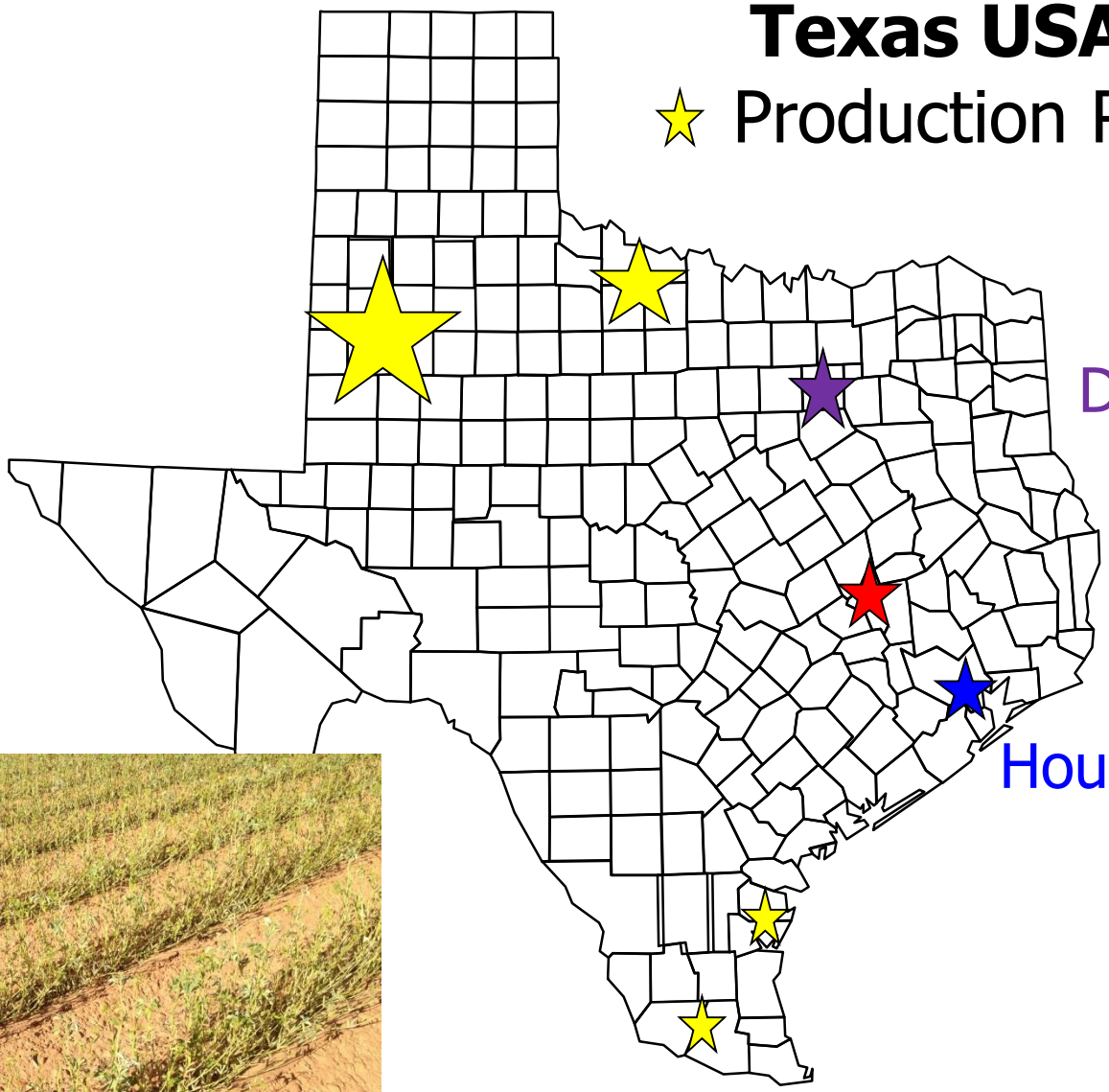
Texas USA Guar

★ Production Regions



Limitations of USA Guar Production I

- "Stepchild crop" in a different form: Though drought and heat tolerant, guar is a low-input/low-cost crop with too-low profit potential or gross income potential to satisfy many growers
  - Much of this is only perception; guar is inexpensive to grow (so consider the net economic return)
  - Currently many USA farmers only consider guar after losing their primary crop to storms, drought, etc.
- Old guar varieties (1970s) vs. profitable corn, cotton, soya
- Guar is of interest—and best adapted relative to other crops—only in semi-arid farming areas (rain <20"/year; <500 mm/year)

Limitations of USA Guar Production I

- Many USA farmers take large risks financially to grow most crops due to land costs, input costs (though low for guar), and borrowed money for operations
- Farmers prefer some financial protection in the form of crop insurance to protect against storm damage, drought, insect & disease pests
- Agricultural lenders often require crop insurance if they loan the money
- USA Guar currently has no meaningful crop insurance, however, viable private insurance options appear to be at hand
  - Fortunately the money required to grow guar is low compared to other crops

Guar Production Potential in USA

- Currently only one crop production contractor for farmers (mostly in Texas) and only one splitter currently operating
  - Additional facilities anticipated by 2015 (new investment)
  - Several USA facilities process guar splits
- **Working question**: "What would it take for USA guar to reach 250,000 acres (100,000 hectares)? Would this be a meaningful increase in supply of domestic guar?"
- It will require:
  - Additional guar contracting in another semi-arid growing region
  - Meaningful crop insurance
  - Better varieties with higher yield, better disease resistance
  - An increase in irrigation use to balance the effect of drought on rainfed production

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Markets and Guar Supply in the USA

- USA concerns about the stability of price and supply
  - Guar: India's largest ag. export to USA in 2011: $915 million
- No business likes uncertainty in pricing of raw materials for manufacture or service
  - Can increased USA supply smooth price and supply fluctuations?
  - USA 250,000 acres (100,000 ha) would be meaningful for partial supply for some users
- 2011 to mid-2012: guar gum prices rose from about $2/lb. ($4/kg) to as high as $12/lb. ($~27/kg), May, 2012, then dropping to ~$3.50/lb. ($7-8/kg) in Sept., 2012; now back down to $2/lb. (~$4/kg), Dec., 2013
- The large change in price leads companies to seek alternatives

Common Question

- "Does lack of stability in guar supply and/or pricing contribute to the desire to use alternatives to guar gum?"
- Yes! Of course!
  - But are there suitable alternatives?
  - Have they been tested?
  - Do they work almost as well? (these don't have to be as good)
  - Can they be produced reliably and economically?
  - Or would an alternative product be subject to the same potential price and supply volatility?
- Because overall guar gum works well, USA users would prefer to NOT have to use alternatives.

Guar Materials

Samples courtesy West Texas Guar

Alternatives to Guar Gum in USA Oilfield, Food, and Industrial Markets

- A lot of smart people in universities and companies have tried for 40 years to come up with a good alternative to guar gum
- In general they haven't succeeded

- Suitable alternatives themselves are subject to ease of production at economical cost and availability
  - Suitable alternatives do not have to work quite as well as guar gum
  - Could be blended to reduce guar demand
  - Hard to scientifically test in a drill hole 5,000-8,000 feet (1,500-2,500 m) deep

Alternatives to Guar Gum (Fracking)

- "No guar substitute has yet been developed that is as effective for high-viscosity hydraulic fracturing, although Halliburton, Baker Hughes, Schlumberger, FTS International, or their affiliates (combined 54% of USA fracking activity, 2011) as well as the chemical company Dupont, are working on developing synthetic polymers whose properties might rival those of guar gum."

(Journal of Petroleum Technology, Dec., 2012)

Alternatives to Guar Gum (Fracking)

- "Guar is a perfect material for hydraulic fracturing."

  (Mr. Mickey Callanan, PfP Technology, Houston, Texas USA, quoted in Journal of Petroleum Technology, Dec., 2012)

- Guar gum is not perfect, but all things considered, is currently the best choice in many applications, thus "If guar gum and guar derivatives work the best, why would you want to use anything else?"
- Guar is:
  - Available in large amounts
  - Affordable, low cost
  - Superior thickening agent
  - Excellent friction reducer
  - Crosslink-able, breakable, biodegradable

Potential Guar Alternatives I

- Companies may not reveal research/testing of alternatives
- Synthetic polymers (examples: acrylamide and acrylamido-methyl compounds)
  - May be most likely replacement in shale gas fracking due to superior thermal properties: easy to hydrate, crosslink well, but may damage the fractures in the formation (residues remain reducing flow); guar must have significant costs to justify use of synthetics
- Locust bean gum, xanthan gum
  - Not easily produced on large scale, not heat stable

Potential Guar Alternatives II

- Cellulose-based materials like carboxymethylcellulose (one current test product is derived from cotton fiber) and carboxymethyl-hydroxyethyl cellulose
  - Useful though cost may be a little higher than guar gum
  - Thermal stability not as good as guar gum and not likely to be improved
  - Price could be competitive with large scale manufacture
- Starch
  - Many potential sources at low cost per kg
  - But many kg required to achieve significant viscosity
  - Fracking success (breaking rock) is limited

Relative Properties, Guar & Alternatives

Dr. Lewis Norman, consultant (formerly Halliburton USA)

Property	Guar Gum	Cellulosic	Xanthan	Locust Bean	Starch	Synthetic Polymers
Hydration	4	4	2	3	1	5
Viscosity	5	3	4	3	2	3
Cross-linking	5	4	1	3	2	3
Thermal Stability	4	3	3	3	2	5
Fracture Damage	3	5	2	3	1	1
Cost ($)	5	4	3	2	2	1
"Score"	26	23	15	17	10	18

Scale: 1-Bad, 2-Poor, 3-Good, 4-Very good, 5-Excellent

Guar Alternatives—"The Bottom Line"

- "Guar is still the King!"
- But insufficient supply or excess pricing or *speculation* fosters interest in maintaining alternatives to guar gum/guar derivatives **and switching** if needed
- In general, India, Pakistan, and some increased production in newer areas can likely meet the general guar gum need and sporadic production can be minimized if there is at least some supply from different world farming regions

- Reliable…stable…supply
- Reasonable…cost…without…excessive…swings…in…price

Guar Gum and the Future

- 200 million lbs. (90 million kg) of guar gum use per year in North America? That's about 750,000 acres (300,000 ha) of USA production at 900 lbs./A (1,000 kg/ha).
- Though guar is preferred for oilfield fracking, companies will continue to develop/test alternatives—and switch—in case guar price is too high or supply is not reliable.
- When guar gum prices are high in 2011 and 2012: "Everybody wants to grow guar!" Many phone calls, e-mails (but little to no understanding)
- Today, it is quiet—*until the next time* price or supply becomes an issue

Thank You!

- Thank you to NCDEX and Tefla's!
  - Public trading and pricing will stabilize guar supply and marketing
  - Daily pricing and futures via NCDEX, http://www.ncdex.com/
    - For guar gum: http://www.ncdex.com/GlobalSearch/Search.aspx?SearchText=GUARGUM&SearchTitle=GUAR%20GUM
    - Daily e-mail update,

      contact vineet.sharma@ncdex.com

- Additional info. prepared for this conference, including an expanded PowerPoint—

http://lubbock.tamu.edu/programs/crops/other-field-crops/guar/

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