Plant Protein Feedstuffs

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Aquaculture Research, 2007, **38**, 551–579 doi: 10.1111/j.1365-2109.2007.01704.x

Expanding the utilization of sustainable plant products in aquafeeds: a review

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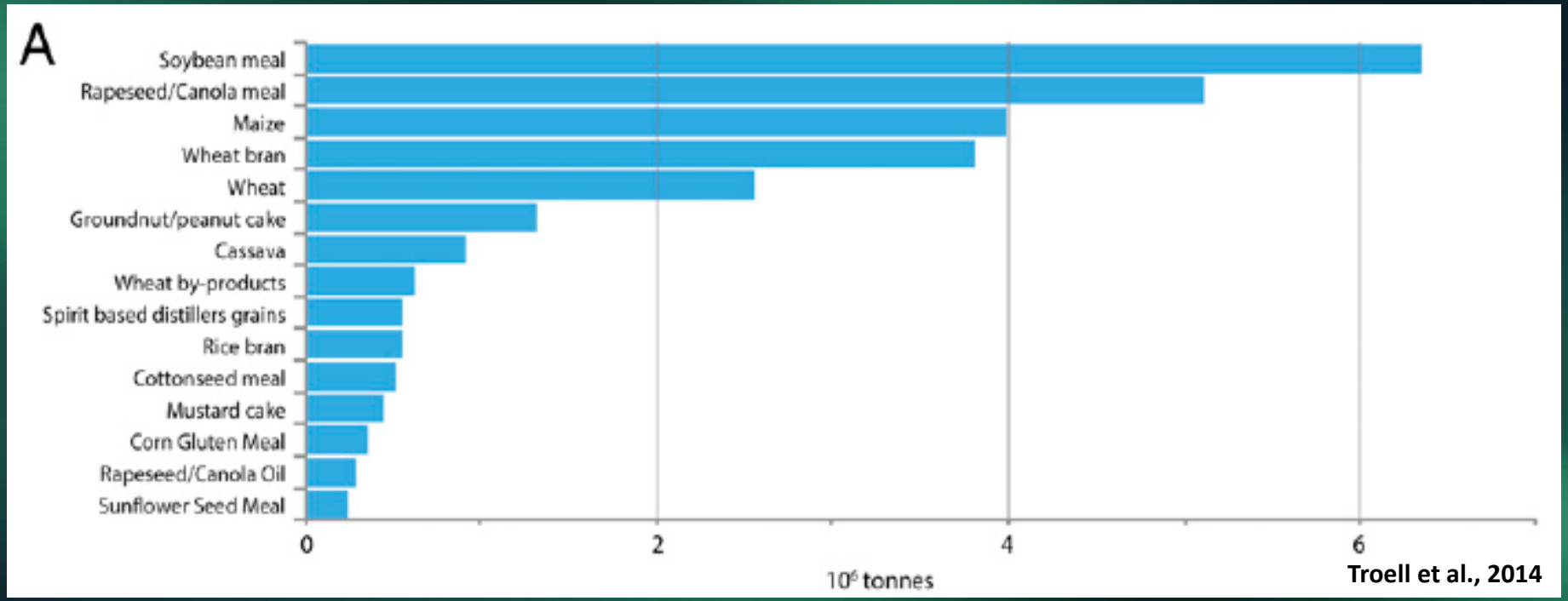
Gatlin and Barrows are Chair and Vice-chair, respectively, of the Plant Products in Aquafeeds Working Group, and coordinated the development of this document; all other authors are listed in alphabetical order.

Terrestrial Plant Meals

Several by-products of oil seed or grain processing for human consumption are available as protein feedstuffs

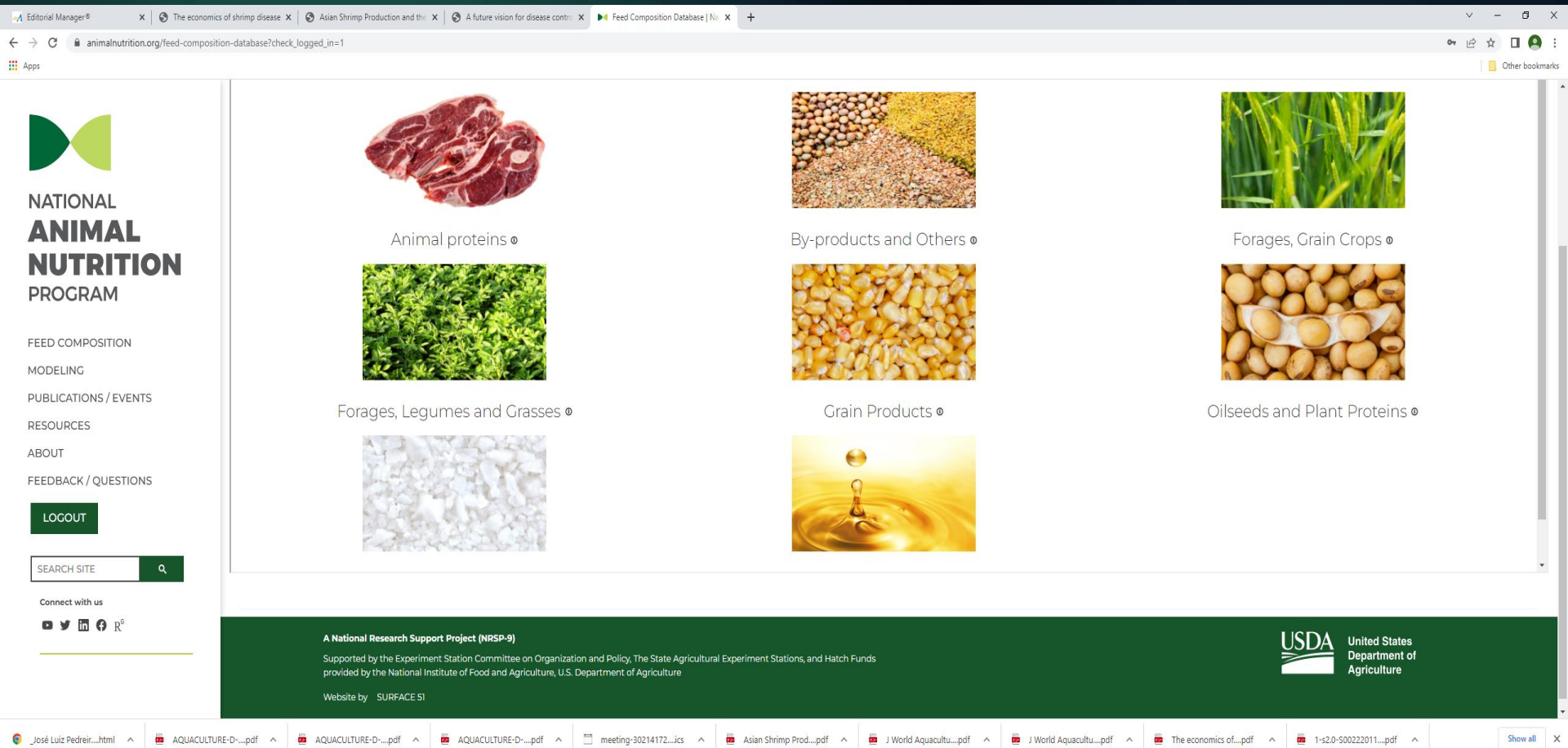
- **Their costs can be relatively low to other protein feedstuffs given the quantities processed**
- **Crude protein (CP) varies considerably**
- **Most have limiting amounts of one or more amino acids**
- **Anti-nutritional factors also may be present**
- **Phosphorus is primarily as phytate**

Major Plant Feedstuffs Used In Aquafeeds



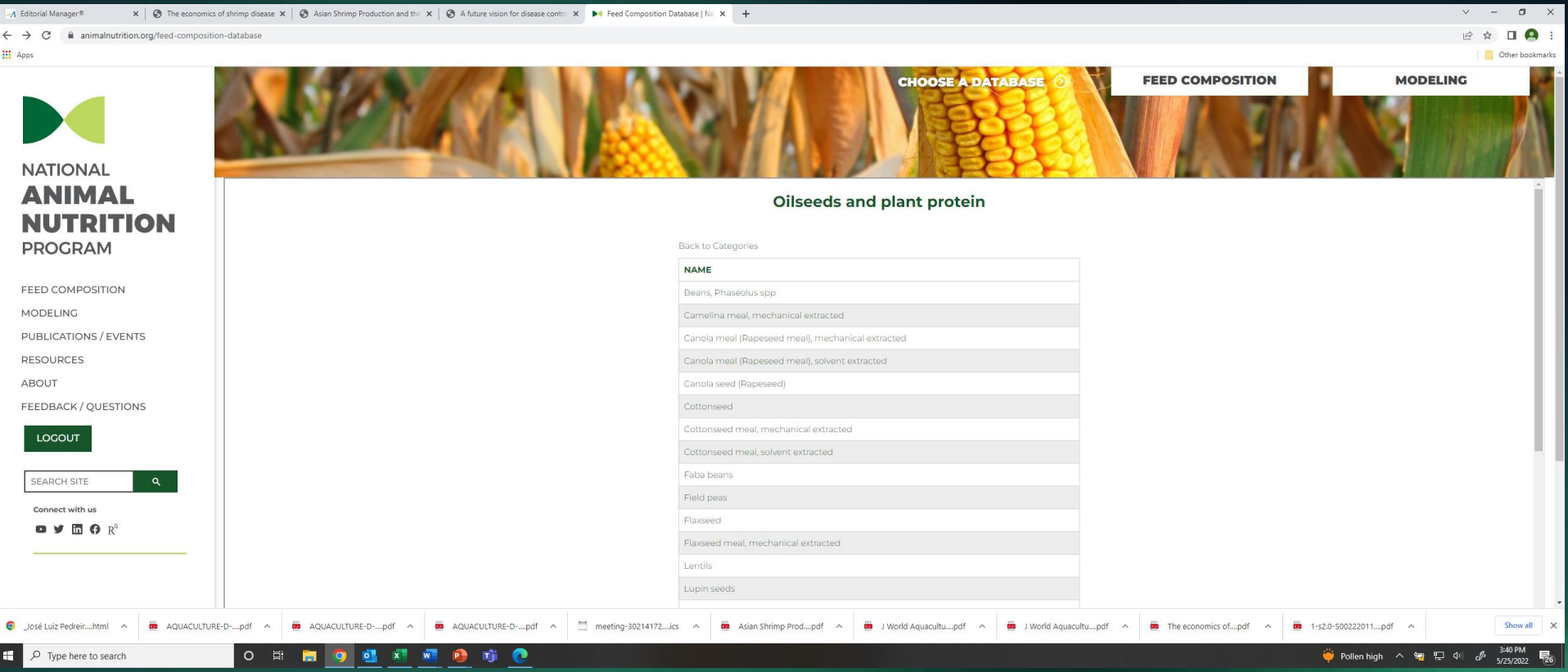
Troell et al., 2014

Ingredient Database



https://animalnutrition.org/

Oilseeds and Plant Proteins



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Soybean Meal

Most widely available plant protein feedstuff

- **Solvent-extracted, dehulled meals most readily used in aquafeeds (~48% CP)**
- **Methionine most limiting amino acid**
- **Protease inhibitors, oligosaccharides and lectins are primary antinutrients**
- **Variable degrees of sensitivity to enteritis among omnivorous and carnivorous fish**
- **Ethanol extraction to produce soy protein concentrate (~65% CP) greatly reduces negative effects – but increases costs considerably**
- **Fermentation can reduce oligosaccharides**

Canola Meal

Solvent extract meal contains ~40% CP

- **Early rapeseed cultivars had lower CP and relatively high levels of erucic acid (22:1n-9) and glucosinolates**
- **Canola varieties have more desirable nutritional characteristics**
  - **Transgenic variety (Nuseed Omega-3 Canola) now available which produces high levels of DHA**

Corn Protein Products

Various by-products from ethanol production consisting of mixtures of corn protein and yeast have been developed including:

- Distiller's dried grains with solubles (DDGS) - ~31% CP
- High-protein DDGS (54% CP)
- Corn gluten meal (63.2% CP)
- Corn protein concentrate (76.2% CP)
  - Lysine deficiency a concern
  - Elevated pigment levels of concern for some white-flesh fish

Cottonseed Products

Regular cottonseed meal historically was limited in fish diets due to relatively low protein (41% CP) and lysine as well as high gossypol (~7,000 to 11,000 ppm) levels

Several different products have been developed from different cotton varieties

- Glandless meal (~200 ppm gossypol)
- Glanded meal with 97% reduction in seed gossypol through gene silencing
- Refined processing has resulted in products with relatively high protein (54%) and low gossypol

Other Plant Protein Feedstuffs

Safflower Meal

- Solvent extracted product contains 38.4% CP
- Very high in fiber (22.3%)

Peas/Lupins

- Lower levels of CP (25 and 39%, respectively, for peas and lupins)
- Very high protein digestibility

Wheat Products

Wheat gluten is high in protein (82.9%) but also quite expensive

- **Other wheat products derived from flour production may be used for animal feeds but generally much lower in protein such as wheat middlings (17.7% CP)**

S.W.O.T. of Plant Meals

- Strengths
  - Production methods well established
  - Most are by-products of human foods
- Weaknesses
  - LCA for some crops are not good
  - Nutritional characteristics (protein, fiber or anti-nutrients) may limit their inclusion in aquafeeds
- Opportunities
  - Processing methods such as fermentation and air classification have improved nutritional value of some products
  - Genetic technology has allowed several crops to improve their nutritional value
- Threats
  - Climate change
  - Demands from a growing world population

Thanks for your attention