Context on Corn

A 1st Generation Bridging Crop

It's not food or bioplastics...it's food AND bioplastics

Today, at our first Ingeo facility in the US, we transform atmospheric carbon into Ingeo by utilizing the starch by-product of purpose grown industrial corn. Since many often think first of corn as a food source, this can understandably raise concerns around a perceived conflict between food versus materials uses of our agricultural land.

The question is not about choosing only food or only biopolymers from corn. Rather, the opportunity is for food and biopolymers. Typically, in the utilization of purpose grown industrial crops, all sugar, starch, oil proteins, and fibers are used in a wide range of applications. Biorefineries convert all parts of a harvested crop into food, feed, materials and fuel, maximizing the crop's total value.

For example, we currently make Ingeo from the starch in #2 yellow dent field corn which is purposely grown to supply both feed and industrial end-uses simultaneously. We use only the starch from corn for Ingeo while the plant-based proteins are directed to the animal feed industry.

The figure below shows how one bushel of corn serves a multitude of end-uses for both food and industrial applications.

What can you get from one bushel of corn?[1]

Even at capacity, our Ingeo manufacturing facility in Blair, Nebraska would use the starch from less than 0.03% of the annual global corn crop.[2] And, the corn oil, gluten feed, and gluten meal markets for that 0.03% would remain unaffected.

all of these

1.5
lbs of corn oil
cooking oil, margarine, mayonnaise, salad dressing, shortening, soups, printing ink, soap, leather tanning

AND

2.6
lbs of gluten meal
amino acids, fur cleaner, poultry feed

AND

13.5
lbs of gluten feed
livestock & poultry feed, pet food

and

one of these

31.5
lbs of starch
adhesives, batteries, cardboard, crayons, degradable plastics, dyes, plywood, paper, antibiotics, chewing gum

OR

33
lbs of sweetener
shoe polish, soft drinks & juices, jams & jellies, canned fruit, cereal, licorice, peanut butter, ketchup, marshmallows

OR

2.8
gallons of fuel ethanol
motor fuel additive, alcoholic beverages, industrial alcohol

OR

22.4
lbs of Ingeo biopolymer
nonwovens, food packaging, serviceware, durables, apparel, films, home textiles, cards

1. National Corn Growers Association, World of Corn Report 2017
2. Global crop: USDA, FAS Grain: World Markets and Trade, 2017

> *"At present, the world is mainly short of protein and not of carbohydrates such as sugar and starch. This means that there is no real competition with food uses, since the valuable parts of the food crops still flow into food and feed uses."*
>
> *- nova-Institute[3]*

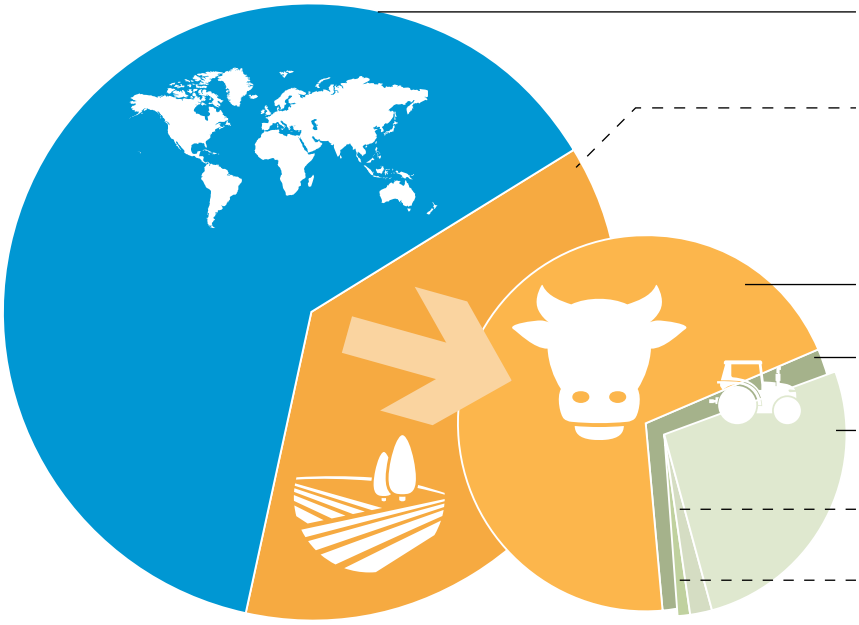
Using available land efficiently

More important than food vs. bioplastics, is the issue of land use and availability. Only 2% of global agricultural area is actually used to grow feedstock for material production and only ~0.01% is used in the production of bioplastics, compared to 98% used for food, feed, and as pastures.

In a recent publication the nova-Institute[3] noted that:

> ... the cultivation of non-food crops on arable land would reduce the potential availability of food just as much or even more [than using food crops for industrial purposes].
>
> The real question is: "What is the most resource-efficient and sustainable use of land and biomass in your region?". It is not a question of whether the crop can be used for food or feed; it is a question of resource and land efficiency and sustainability.

German based **nova-Institute** was founded as a private and independent institute in 1994. For two decades, the nova-Institute has been globally active in feedstock supply, techno-economic evaluation, market research, project management and policy for a sustainable bio-based economy. www.nova-institut.de



Global land area
13.4 billion ha = 100%

Global agricultural area
5 billion ha = 37%

GLOBAL AGRICULTURAL AREA

Pasture
3.5 billion ha = 70%*

Arable land**
1.4 billion ha = 30%*

Food & Feed
1.24 billion ha = 26%*

Material use
106 million ha = 2%*

Bioplastics***
2014: 0.6 million ha = 0.01%*
2019: 1.4 million ha = 0.02%*

Biofuels
53 million ha = 1%*

Source: European Bioplastics | Institute for Bioplastics and Biocomposites | nova-Institute | 2015

* In relation to global agricultural area

** Also includes approx. 1% fallow land

*** Land-use for bioplastics is part of the 2% material use

A study recently published by the World Bank[4], found that an increase in food prices is largely influenced by the oil price. Biofuels and, by extension, bioplastics are a negligible influence. The study looked at food commodities such as corn, wheat, rice, soybeans and palm oil and compared commodity prices to energy prices, exchange rates, interest rates, inflation, income and a stocks-to-use ratio to determine which of these drivers had the most impact on food prices.

3. Carus, Michael and Dammer, Lara, nova paper #2 on bio-based economy: "Food or non-food: Which agricultural feedstocks are best for industrial uses?", nova-Institute, July 2013, www.nova-institut.de
4. Long-Term Drivers of Food Prices, The World Bank Development Prospects Group & Poverty Reduction and Economic Management Network Trade Department, May 2013

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