

Handling inedible food production byproducts

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ONE of the often-stated ethical reasons people give for choosing vegetarianism/veganism is that by eliminating animal products, especially meat, from human diets, more plant-based foods would be made available globally because animals are inefficient at converting feed to products.

However, this ignores the fact that the production of human food generates a significant amount of byproducts that are not edible to people but can be fed to animals (Table 1).

Economically, many of these byproducts are valuable and, accordingly, are called "co-products" in agribusiness terms. The U.S. soy and ethanol industries wouldn't be viable if they couldn't sell soybean meal and dried distillers grains as part of their business models.

From a human nutrition point of view, the primary products from food processing are the human-edible portions — e.g., flour, vegetable oil, nuts, etc. — and the inedible remainders are byproducts.

How many byproducts are generated in human food production in the U.S.? A lot! Looking at individual crops (Figure 1), the edible portion varies from a low of 20% in the oil from soybeans to a high of 75% for flour from wheat.

In the case of soybeans, it could be argued that 20% is too low because it doesn't consider tofu and soy milk production. For this analysis, I am looking only at major food uses of crops in the U.S., not minor uses or what potential alternatives there are.

When citrus and other fruits and vegetables are eaten fresh, any inedible portion occurs at the retail/home level and isn't considered a contribution to the animal feed supply. Rather, the proportions for these items given in Figure 1 are when they're processed for juice, canned, frozen or dried.

The ethanol and biodiesel industries also generate significant amounts of byproducts that add to the animal feed supply. Over the 2009-13 crop years, 136.7 million tons of human food were produced from primary crops in the U.S. (Table 2). An almost equal amount of byproducts — 137.5 million tons — were generated in human food and biofuel production combined.

These byproducts are incorporated into feed for aquaculture species, livestock, poultry and pets. Ruminant livestock are especially good "sinks" for these byproducts since they are more able to digest and utilize the nutrients in high-fiber feeds than monogastric species are.

Not all of the 136.7 million tons of food and 137.5 million tons of feed are consumed in the U.S.; large amounts are exported. Also, primary crops (corn, wheat and soybeans) are exported and are not included in Table 2; nor do the byproducts include feeds from secondary processing, e.g., bakery waste, the rendering industries (animal protein meals, tallow, yellow grease, etc.) or crop residues (corn stover, straws, etc.).

Ruminants as recyclers

Byproduct feeds typically comprise 20-25% of common livestock and poultry diets in the U.S. (Figure 2). For swine and poultry, this portion is smaller than the grain portion in commercial rations, but the inedible proportion of those diets is still larger than the edible portion.

With cattle, there's a much wider range among byproducts, forages and grain, depending on the life stage. Of course, it is possible to feed a 90%-plus byproduct ration to cattle. These proportions consider the use of corn stover, wheat straw, etc., in cattle diets as forage and not as food byproducts, which is arguable.

Although it's possible to estimate how much of these crop residues are produced each year, it's very difficult to calculate the amounts used in livestock feeding versus other uses such as bedding or by the equine industry.

While U.S. feedlot rations contain high amounts of grain, the number of days a beef animal is on feed is a small portion of the whole cattle life cycle. Currently, beef from dairy cull cows and calf-fed Holstein steers comprises 22-25% of the beef produced in the U.S. When both cull beef and dairy cows are considered, only 65% of the beef animals slaughtered each year spend time in a feedlot (Knapp, 2014).

Combining these facts into a life-cycle assessment approach that accounts for animal-days per year, I estimated that U.S. cattle spend only 11-12% of animal-days per year in feedlots before slaughter (Knapp and Cady, 2014). Another way to think about it is that 35 million-plus fed cattle spend an average of 175 days in feedlots, while 50 million-plus brood cows, dairy cows, stockers and replacement heifers spend 365 days elsewhere.

The 11-12% of animal-days in a feedlot translates into grain comprising 16-17% of animal feed-days when diet composition is taken into account, with byproducts, forage and mineral/vitamin supplements comprising the other 83-84%. In other words, the U.S. produces more than 25 million lb. of beef and 200 million lb. of milk per year in a system that uses 16-17% grain to maximize the utilization of byproducts and forages.

The grain used in cattle feeding is like a fuel additive; adding it to the byproducts and forages allows for the achievement of 25-40% greater productivity than would be possible without it.

It would be nice to calculate the efficiency for byproduct and forage feeding, i.e., how many pounds of beef or milk are produced per pound of byproducts. Unfortunately, it's difficult to estimate, with any confidence, how many byproducts are fed to the different species and what amount is exported, given what data are publicly available.

Alternative disposal routes?

What if there were no animals on this planet to feed byproducts to? As an alternative to being used in animal feeding, byproducts can be disposed of by composting, combusting and fermenting to generate electricity, tilling back into the soil as an amendment and landfilling. All of these would be an expense to the food producer/processor.

Imagine how the U.S. soybean industry would dispose of 40 million tons of soybean meal and hulls or how the corn and ethanol industries would get rid of 62 million tons of gluten feed, gluten meal and distillers grains?

Composting and combusting can eliminate much of the solid mass, but this occurs with a substantial release of carbon dioxide into the atmosphere (Russomanno et al., 2013). It seems much better to capture this carbon in meat and milk.

Likewise, fermentation captures some of the carbon in methane as well as releasing carbon dioxide, but when it is burned to produce electricity, the methane ends up in carbon dioxide.

More carbon can be sequestered in soil amendment and landfilling. However, amending soils with byproducts would require the use of fossil fuels for tilling. There is simply not enough landfill space to contain all of the byproducts from food production and processing.

The flow of municipal solid waste into U.S. landfills over the 2008-12 period was 134 million tons annually (Environmental Protection Agency, 2015). Disposing of byproducts by landfilling would double that flow.

All evidence indicates that feeding byproducts to livestock and poultry is the most environmentally and economically sustainable way to dispose of byproducts.

Summary

Poultry and livestock, especially cattle, are excellent recyclers of the byproducts of human food production and processing.

Here are some talking points to help educate others about the importance of animal agriculture:

* For every 1 lb. per ton of human food produced and processed in the U.S., another 1 lb. per ton of byproducts is generated.

* The amount of byproducts generated from human food processing of primary crops is larger than the amount of municipal solid waste going to landfills — 137.5 million versus 134 million tons annually.

* The most economically and environmentally sustainable way to dispose of these byproducts is in animal feed. Composting, combusting or landfilling are less desirable disposal options.

* The use of byproducts reduces the need for grain feeding and results in more food available for people. This is a double benefit achieved by sparing grain for human consumption AND converting inedible feedstuffs into highly nutritious, edible animal-derived foods.

The production and disposal of inedible byproducts in the human food production system is not the only fact ignored by those who try to justify eliminating animal agriculture; there are more.

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1. Production and processing of edible foods, biofuels (ethanol and biodiesel) and associated non-edible byproduct animal feeds		
Crop	Human foods	Animal feeds
Corn	High-fructose corn syrup, corn starch, corn oil	Corn gluten feed, corn gluten meal, distillers grains, hominy
Wheat	Flour, wheat germ	Red dog, mill run, wheat middlings, wheat bran
Sorghum	—	Distillers grains
Barley	Beverage alcohol	Distillers grains
Rice	Brown and white rice	Rice bran
Soybeans	Soybean oil	Soybean meal, hulls
Canola	Canola oil	Canola meal
Cottonseed	Cottonseed oil	Whole cottonseed, cottonseed meal

Fruits & vegetables	Canned, frozen, dried	Peels, pits, seeds, pomace, etc.
Citrus fruit	Juice	Citrus pulp
Sugar beets	Beet sugar	Beet pulp
Almonds	Almonds	Almond hulls
Note: This list is not all-inclusive and captures only the major streams of food, fuel and feeds in the U.S.		

2. Million tons of human foods, biofuels or byproduct animal feeds produced annually from primary crops in the U.S., average of 2009-13 crop years

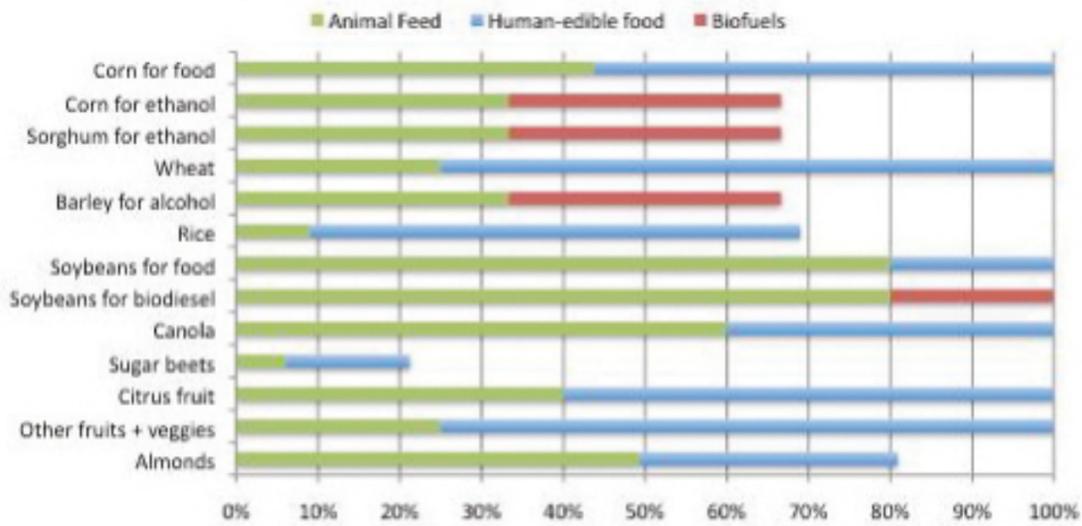
	Human foods	Biofuels	Byproduct animal feeds
Corn	21.6	45.1	61.8
Wheat	20.8	—	6.9
Sorghum	—	0.8	0.8
Barley	1.2	—	—
Rice	3.6	—	0.5
Soybeans	9.9	1.2	40.6
Canola*	0.6	—	0.8
Cottonseed	0.7	—	1.0
Fruits & vegetables	66.5	—	15.3
Citrus	6.3	—	4.2
Sugar beets	4.8	—	4.2
Almonds	0.9	—	1.4
Total	136.7	47.0	137.5

Note: All feeds, foods and fuels on an as-is basis. For most grains and oilseeds, this would be 85-90% dry matter. Fruits/vegetables, citrus and sugar beets would be less than 20% dry matter.

*Data include crops processed in the U.S. but do not imply that human food or animal feed is consumed only in the U.S. Significant quantities of food and feed are exported for consumption elsewhere in the world. Also, this does not include byproducts produced in other countries, e.g., canola meal, and imported into the U.S. for animal feeding.

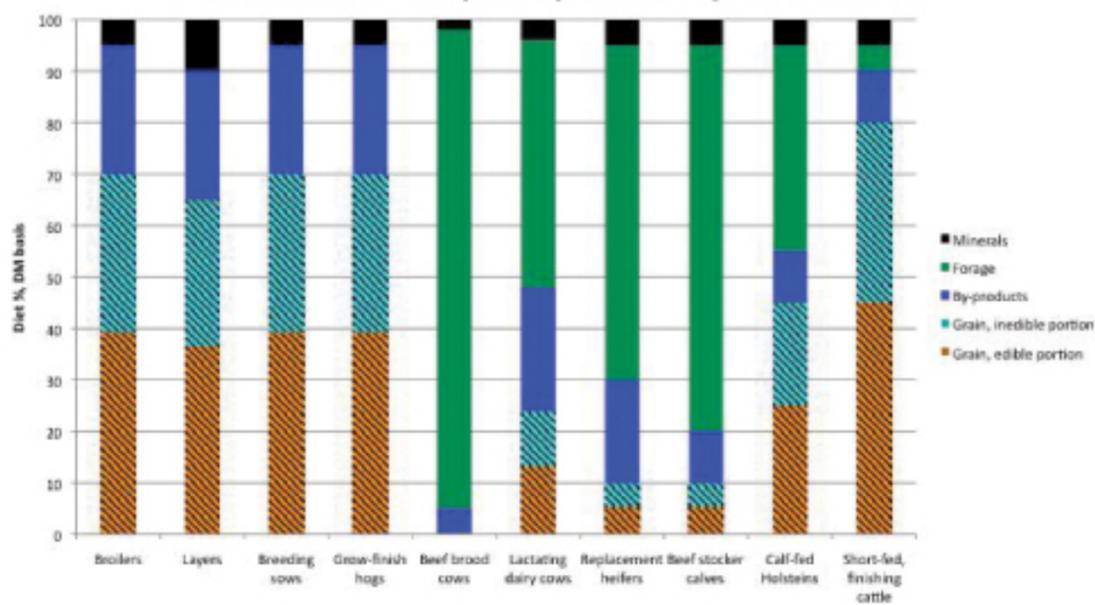
Sources: U.N. Food & Agriculture Organization (2013), Food Waste Reduction Alliance (2013), Renewable Fuels Assn. (2011), U.S. Department of Agriculture Economic Research Service.

1. Proportion of byproduct animal feeds generated when crops are processed for human food or biofuels*



*In certain cases, the products of crop processing do not add up to 100%. Fermentation to ethanol results in a 33% loss of grain mass as carbon dioxide. With rice, sugar beets and almonds, the discrepancy represents rice hulls, water loss and almond shells, respectively.

2. Proportions of grain, byproducts and forage in typical commercial U.S. livestock and poultry diets, dry matter basis



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