Comparison of World Staple Crops

by Ronald L. Conte Jr.

Introduction

This article is essentially one long complex chart, analyzing 50 of the top staple crops in the world, along with explanatory notes and references for the data in the chart. The purpose of this chart is to understand which crops contribute most to the macronutrients (protein, fat, and carbohydrates) consumed by the world population. This article provides useful data for my book: *Hunger Math: world hunger by the numbers.*

The chart orders the crops by total calories (kcal/year) available worldwide from that one type of food crop. Most of the data on production quantity, area harvested, and yield is from the United Nation's Food and Agricultural Organization (the FAO), specifically from their online database of agricultural information from nations all over the world called: FAOSTAT
http://faostat.fao.org/site/567/default.aspx#ancor
Data is from calendar year 2009, the latest year with finalized data during the time that this chart was researched and prepared. Please note that FAO data for recent years continues to be updated, (despite being termed final data,) and so numbers in this chart may vary slightly from whatever the current numbers are for 2009.

Most of the nutritional data used to determine the protein, fat, and carbohydrates and total caloric content available from the crop is taken from the USDA National Nutrient database for Standard Reference (SR23 and SR24). When other data was used, see the endnotes, organized by crop name, for the source of the data.

Please remember that all of the information usually found in footnotes is in the endnotes, ordered by crop name, without endnote numbers. This approach was necessary because the chart has so many data cells with numbers that adding a reference number to each cell would make the chart unreadable. Finding the reference material is much easier by crop name than by a number.

See the Chart in PDF format here:
http://www.gardeningplaces.com/articles/World-Staple-Crops-2009.pdf
or in PNG (image) format here:
http://www.gardeningplaces.com/articles/World-Staple-Crops-2009.png

Explanation of the Chart

The first row of the chart has the labels for each of the columns of data. The second row gives the units for that data.

The first column is the name of each staple crop; this is repeated in the next to last column for ease in reading the chart. The crop names sometimes include or exclude foods that usually fall under the term given. For example, "maize" (corn) excludes "maize green", listed further down the 'crop name' column. This distinction is made by the FAO in their data. Maize green is considered to be corn harvested for fresh use, such as corn on the cob, or corn kernels (frozen or canned) as a side dish. The main listing for maize includes all other uses of corn, such as cornmeal, high fructose corn syrup, corn oil, corn as cattle feed, and corn to make fuel ethanol. Wherever FAO data is used for a

crop, the crop definition is that determined by the FAO. The FAO crop definitions are available online at: FAO Metadata, classifications, ProdSTAT commodities, under each crop name: http://faostat.fao.org/site/384/default.aspx

The units used in the chart are tonnes (t), which always indicates metric tonnes (1 tonne = 1000 kg), and kilocalories (kcal), which is called 'calories' in common parlance. A hectare (ha) is 2.471 acres of land. The FAOSTAT data reports yield in hectograms (hg) per hectare (which is the same as grams per 100 square meters), but this value has been converted to kg/ha for this chart. Yields from other sources, when given in lbs/acre were converted to kg/ha by multiplying by a factor of 1.12085.

The total kcal per crop per year is calculated from the tonnes of each macronutrient times a conversion factor of 3.87 calories per gram (kcal/g) for protein and for carbs, and 8.84 kcal/g for fat. The explanation for these approximate values is in my book: *Hunger Math: world hunger by the numbers*.

Some of the crops on the top 50 staple crops list are used in large part to feed livestock, and thereby to provide sustenance, indirectly, to the human population. About half of the barley crop in the U.S. is used for cattle feed. About 40% of the maize crop in the U.S. (35% in 2010; 40% in 2011) was used to make ethanol fuel; another 40% was used to feed livestock (in 2011). Soybeans are another food that is largely grown for livestock feed (including cows, poultry, and farmed fish).

Why include data for a crop that is used for livestock feed or to make fuel ethanol? The reason is that the food used for feed or fuel is edible by human persons; it is a food resource. These crop resources are human food, diverted for non-food uses, or for indirect food uses: feeding livestock to produce animal food products.

The crop "rice paddy" is typically lowland rice, i.e. rice grown with ample amounts of water (often in flooded fields). However, upland rice, which is a rain-fed crop, is included in the data. The reported production quantity is "Rice grain after threshing and winnowing. Also known as rice in the husk and rough rice" (FAO Metadata).

Palm fruit oil refers to the oil from the fruit of the palm tree, not including the oil from the kernel of the same fruit. Rapeseed oil includes canola oil. Groundnuts is commonly known in the U.S. as peanuts. Groundnuts does not include the Bambara bean (sometimes called groundnut). The production quantity of groundnuts (peanuts) includes the shell (70% nut; 30% shell).

"Beans dry" includes a variety of different species of beans under the Phaseolus genus. Beans are not all the same species, nor even all the same genus, so there are various different classifications of beans in FAO data. Note that "beans dry" does not include cow peas (a type of bean), or broad beans (Vicia faba), or any fresh beans (called green or snap). Pigeon peas is another separate bean category, which is for the genus and species Cajanus cajan.

* Some crop names have an asterisk next to the name. This indicates that the yield data could not be calculated from FAO data on production quantity and area harvested because a substantial portion of the crop is used for other purposes. Some of the harvested coconut meat is pressed for oil, and some is used for fresh coconut and various processed food products. Some olives are used as a whole food, canned or fresh, and some olives are pressed for oil. Linseed oil is also called flaxseed oil, but some flaxseed is used as whole seed and some is pressed for oil. Yield data was therefore obtained from other sources; see the endnotes.

Sweet potatoes are distinct from yams. The latter category is various species of Dioscorea, whereas the former is specifically and only Ipomoea batatas. In the U.S., sweet potatoes are sometimes called 'yams', but not in FAO or other agricultural data.

The choice of crops on the list of the top 50 is -- for the top 10 or 20 crops -- almost inarguable. Who could deny that maize, rice, wheat, soy, and barley are the main staple crops of the world? You might argue that crops used as food for people should be distinguished from crops used for livestock feed. But these types of crops are dual use: cattle feed and human food. Their use as cattle feed diverts food resources from the human population; only a portion those nutrients end up in food products from animal sources.

As for the other crops on the list, these become more and more arguable, and even somewhat arbitrary, as we move toward the bottom of the list. There are many other crops at the level of 10^{12} kcal/year. These crops are several orders of magnitude below the top four crops, in terms of kcal/year. That is why a longer list, with more crops at the 10^{12} or even 10^{11} kcal/year level, would not change the overall analysis significantly. In the world agricultural system, a small number of crops are grown in vast quantities; all other crops are grown in far less quantities.

A few crops were included on this list, not only because the kcal/year of the crops is at or above the 10^{12} level, but also because these crops are under consideration, in a separate article, as possible future staple crops. See the article 'Comparison of Potential Staple Crops' at gardeningplaces.com. For example, crops such as cabbage, cauliflower, and even tomatoes can be processed for the protein and/or carbs in the plant, while removing most of the cellulose (fiber) and water. The amounts of carbs and protein produced by these and other crops per unit area of land, per unit of growing time, is competitive with, or may even exceed, the current top staple crops. In another example, a crop such as pumpkin could possibly be grown for the sugar in the flesh, and processed much like sugar cane or sugar beet. In theory, pumpkin would need only a modest amount of development to increase its sugar content, in order to be competitive with other sugar crops: cane sugar, beet sugar, and high-fructose corn syrup. Then the protein and fat in the pumpkin seeds could also be harvested, so that one crop provides all three macronutrients.

Fonio is on the list of top staple crops, at the very bottom, not only because it offers 10^{12} kcal/year, but also because it is an important survival crop. Subsistence farmers plant fonio when there is a problem with a main staple crop, such as rice. Fonio has a short 6 to 8 week growing season. So if the rice crop fails, they can plant fonio and have a crop to harvest at about the same time that the rice crop would have matured. Also, as a subsistence farming crop, the production quantity of fonio is probably underestimated.

The second column is the Production quantity for each crop. The data is from the FAOSTAT database, for total world production of each crop (in 2009), unless otherwise noted in the endnotes, organized by crop name.

The third column (labeled 'times') is an adjustment factor to account for the hulling, drying, or other processing of the crop, which then reduces the weight of the production quantity. The nutritional data is from the USDA Nutrient Database (SR24), which is for the table-ready food. The FAO data is typically the field weight, or the weight after minimal processing. When the value is 1.00, the production quantity was not reduced. For example, "beans dry" is data reported for the beans already hulled from the pods and dried, so no reduction is needed. By comparison, "rice paddy" is

reduced to 65% of the production quantity due to losses when the rice is milled (to make white rice from 'rough rice'). Data for various types of oil is typically not reduced since the quantity reported is for the oil, not the oilseed. Peanuts, almonds and other nuts/seeds are reduced significantly, due to the removal of the shell.

The source of the adjustment factor varies. In many cases, the USDA Nutrient Database (SR24) has a food description that includes "Refuse", which is the inedible or not typically eaten portion of the food, such as stems, peelings, parings, shells, etc. For example, the SR24 data for "Beans, snap, green, raw" adds this note: "Refuse: 12% (Ends, strings, trimmings)". Therefore, the production quantity was reduced by 12% (i.e. multiplied times 0.88). For the source of the adjustment factor, see the endnotes, organized by crop name.

The fourth column ('Adjusted') is the result of multiplying the Production quantity by the adjustment factor. This result is then used in the data to the right in each row, to calculate the total macronutrients and calories provided by the adjusted production quantity for each food crop.

The 'Area Harvested' is in hectares and is typically taken from FAOSTAT world data (2009).

The 'Yield' is given in metric tonnes per hectare (t/ha), and is typically calculated from the 'Adjusted' production quantity and the 'Area Harvested'. In a few cases, yield was obtained from other sources; see the endnotes. Yields for most crops are from world data; these yields are lower than typical yields from developed nations (due to extensive use of irrigation, fertilizer, pesticides, herbicides, and mechanized production).

Metric tonnes is typically abbreviated as "t" or "MT". The spelling "tonnes" indicates metric tonnes, and the spelling "tons" indicates the imperial system, most typically the short ton (2000 lbs). Conversion of lbs/acre to kg/ha determined by the following formula:
2.4710538147 (number of acres in hectare)
divided by
2.2046226218 (number of pounds in kilogram)
= 1.12085
Multiply lbs/acre by 1.12085 to convert to kg/ha (just over 12% higher), or divide kg/ha by 1.12085 to convert to lbs/acre.

Protein, Fat, and Carbs (carbohydrates) as a percent are taken from USDA Nutrient Database (SR24) for that food, unless otherwise noted. Protein, Fat, and Carbs, as a weight is given in metric tonnes, is calculated from Adjusted production quantity and the USDA Nutrient Database listing (SR24) for that food, unless otherwise noted.

'Calories' is the total kilocalories provided by that one crop, worldwide, as calculated from adjusted production quantity and USDA nutrition data. The spreadsheet formula is as follows:

=((Protein*1000)*3870)+((Fat*10000)*8840)+((Carbs*1000)*3870)

The formula takes the data, for each crop, for protein, fat, and carbs in metric tonnes, times 1000 to convert to kilograms, times the kcal in one kilogram (1000 g) of protein, of fat, and of carbs, added together, to equal total kcal for that crop. The exact conversion factor (grams to kcal) for protein, fat, and carbohydrates varies depending on the food source of that macronutrient. The numbers used here for protein and carbs are an approximate average. (This point is explained in detail in my book:

Hunger Math: world hunger by the numbers.) The number for fat is the exact conversion factor for most vegetable oils; animal fat has a higher conversion factor, whereas dairy fat a lower value.

Percent A

The first percent column, labeled 'Percent A', is calculated as the total kcal provided by a crop worldwide divided by the total kcal for all crops on the list. This number indicates what percent of the total caloric production of the world agricultural system is provided by that one crop. For example, maize (corn) provides over 28% of the calories of all crops combined. But 'maize green' (corn eaten fresh) provides only 0.085%. The last crop on the list, fonio, provides only 0.012% of the total kcal of all 50 crops.

How can we determine this percentage when the list only has 50 crops out of the thousands of crops grown worldwide? The answer can be found by reading down the list of total kcal provided by each crop. A few crops provide about 10^{15} kcal, then there are several that provide 10^{14} kcal. A larger but still limited number of crops provides about 10^{13} kcal. The last crop on the list provides only 3E+12 kcal (that's scientific notation for: 3 times 10 to the 12th power). The first crop on the list provides 3E+15 kcal, 1000 times more kcal than the 50th crop on the list. Even if there were many other crops at the 10^{12} kcal level, it would have little effect on the total kcal of all the crops. And there are many more crops that provide 10^{11} kcal, which is 1/10,000th the kcal provided by any one of the top crops. Therefore, we can characterize the world agricultural system, in terms of the total kcal it provides, by analyzing only 50 or so crops.

Percent B

The second percent column, labeled 'Percent B', is calculated as a running total of the percentages from Percent A. The top crop provides 28.921% of the total kcal of all 50 crops. The first and second crops together provide 48.555% of the total kcal. The top 5 crops together provide 76.617% of the total kcal. Only 5 crops provide over 75% of the total calories in the world agricultural system. Only 11 crops provide 90% of the total kcal grown in the world. Only 20 crops provide 95% of the kcal. The current system of world staple crops is very top heavy.

The last column in the chart is simply the numbered order of the crops according to total kcal provided by that crop. This value is the total amount of food energy available from that crop for human nutrition. However, it is not uncommon for large amounts of protein, fat, and carbohydrates to be used instead as animal feed, or even to produce fuel, such as biodiesel or ethanol. So not all of these kilocalories actual feed the world population.

Purpose

The purpose of this chart and brief explanation is to provide data for further analysis of the world agricultural system. I use this data in my book: *Hunger Math: world hunger by the numbers*. Other authors and researchers are free to use this data in their work as well. Please give proper attribution, at a minimum: "Conte, Comparison of World Staple Crops, 2012."

ENDNOTES:

Almonds, with shell
USDA Nutrient data (SR24) used for "Nuts, almonds" Refuse: 60% (Shells)

Production quantity reduced by 60% (to 40%) to account for shells.

Barley
BarleyFoods.com, "Industry Facts", Source: National Barley Growers Association:
"Approximately 51 percent of the barley crop consumed in the US is used for animal feed."
http://www.barleyfoods.org/facts.html
USDA Nutrient data (SR24) data used for "Barley, hulled"
Production quantity reduced by 15% (to 85%) to account for hulls.
"the hull makes up 12 percent to 15 percent of the weight of traditional barley"
Wade E. Thomason, et al., Virginia Cooperative Extension; Growing Hulless Barley in the Mid-Atlantic, (1 May 2009);
http://pubs.ext.vt.edu/424/424-022/424-022.html

Beans broad
USDA Nutrient data (SR24) used for "Broadbeans (fava beans), mature seeds, raw"
FAO also calls these 'horse beans'.
Production quantity not reduced; see note under 'Beans dry'.

Beans dry
Production quantity not reduced because yields are commonly stated after cleaning and drying of beans, and there are no shells or hulls.
USDA Nutrient data (SR24) data used for "Beans, pinto, mature seeds, raw"
USDA ERS, "Dry Beans":
"The United States produces many kinds of dry edible beans, but the leading varieties for 2006-08 were: Pinto, 42 percent; Navy (pea), 17 percent; Black, 11 percent; Great Northern, 5 percent; Garbanzo, (large chickpeas) 5 percent."
http://www.ers.usda.gov/Briefing/DryBeans/background.htm

Beans green
USDA Nutrient data (SR24) data used for "Beans, snap, green, raw"
"Refuse: 12% (Ends, strings, trimmings)"
Production quantity reduced by 12% (to 88%).

Buckwheat
USDA Nutrient data (SR24) used for "Buckwheat"
Production quantity reduced by 25% to account for hulls, per:
Myers and Meinke, Department of Agronomy, University of Missouri Extension, "Buckwheat: A Multi-Purpose, Short-Season Alternative";
http://extension.missouri.edu/publications/DisplayPub.aspx?P=G4306

Cabbage
Cabbages and other brassicas, including kale, but not cauliflower or broccoli.
USDA Nutrient data (SR24) used for "Cabbage, raw"
"Refuse: 20% (Outer leaves and core)"
Production quantity reduced by 20% (to 80%).

Carrots
FAO Metadata: "Daucus carota. Trade data may include turnips (Brassica rapa var. rapifera)."
USDA Nutrient data (SR24) used for "Carrots, raw"

"Refuse: 11% (Crown, tops and scrapings)"
Production quantity reduced by 11% (to 89%).

Cashew nuts
USDA Nutrient data (SR24) used for "Nuts, cashew nuts, raw"
Production quantity reduced by 75% (to 25%), per:
Gayathri Industries, "Cashew Nut Processing An Overview":
"A pair of skilled worker normally de-shells about 80 kg of cashew nuts in 8 hrs, which yields approximately 20 kg of Cashew kernel."
http://www.cashewmachines.com/Documents/CASHEWNUT PROCESSING AN OVERVIEW.pdf

Cassava
USDA Nutrient data (SR24) used for "Cassava, raw"
Production quantity reduced by 10% to account for peelings, per:
Adegbola and Asaolu, "Preparation of cassava peels for use in small ruminant production in western Nigeria", Department of Animal Science, University of Ife, Ile-Ife, Nigeria;
http://www.fao.org/wairdocs/ilri/x5487e/x5487e0g.htm

Cauliflower
Cauliflowers and broccoli
FAO Metadata: "Brassica oleracea var. botrytis, subvariety cauliflora and cymosa. Includes headed broccoli."
USDA Nutrient data (SR24) used for "Cauliflower, raw"
"Refuse: 61% Refuse Description: Leaf stalks, cores and trimmings"
Production quantity reduced by 39% (to 61%).

Chick peas
USDA Nutrient data (SR24) used for "Chickpeas (garbanzo beans, bengal gram), mature seeds, raw"
Production quantity not reduced; see note under 'Beans dry'

Coconut oil
also called coprah oil
USDA Nutrient data (SR24) used for "Oil, coconut"
Production quantity not reduced because quantity refers to the oil, not the raw coconut source of the oil.
Yield estimated as follows:
FAO yield for coconuts 61,708,358 tonnes, times 48% (USDA refuse for 'Nuts, coconut meat, raw') times 33.49% (USDA percent oil in meat) times 87% efficiency of pressing per Piteba oil press website:
http://www.piteba.com/eng/performance.htm
divided by area harvested (11,864,344 ha) equals 0.727 t/ha.

Cottonseed oil
Oil yield (400 kg/ha) estimated based on:
Sawana, et al., "Cottonseed: protein, oil yields, and oil properties as influenced by potassium fertilization and foliar application of zinc and phosphorus", Cotton Research Institute, Egypt, 2007;
http://grasasyaceites.revistas.csic.es/index.php/grasasyaceites/article/download/7/7

Cow peas dry
USDA Nutrient data (SR24) used for "Cowpeas, common (blackeyes, crowder, southern), mature seeds, raw"
Production quantity not reduced; see note under 'Beans dry'.

Fonio
Production quantity and area harvested from FAOSTAT 2009 world data.
Production quantity reduced by 20% to account for drying and dehusking of the grain.
The husks on the fonio grain are relatively thin, per:
Karen De Leschery, "More Fonio, Less Hard Work", Saudi Aramco World, Volume 48, Number 1, January/February 1997:
Also, "husked fonio is three to four times the price of rice." So it is a useful commercial crop for small farms.
http://www.saudiaramcoworld.com/issue/199701/more.fonio.less.hard.work.htm

Groundnuts with shell
commonly called Peanuts (does not includes Bambara beans, which are also termed groundnuts)
USDA Nutrient data (SR24) used for "Peanuts, all types, raw"
FAO Metadata classification states: "For trade data, groundnuts in shell are converted at 70% and reported on a shelled basis."
http://faostat.fao.org/site/384/default.aspx
Since FAOSTAT data is for "groundnuts, with shell", production quantity reduced by 30% to account for shells.

Hazelnuts
USDA Nutrient data (SR24) used for "Nuts, hazelnuts or filberts"
"Refuse: 59% (Shells)"
Production quantity reduced by 59% (to 61%).

Lentils
Production quantity not reduced because yield data is apparently for threshed seeds (without pods).
USDA Nutrient data (SR24) used for "Lentils, raw"

Linseed oil (flaxseed oil)
USDA Nutrient data (SR24) used for "Oil, flaxseed, cold pressed"
* Yield not calculated from chart data because a large percentage of flaxseed is not used for oil. Yield estimated as 1.457 tonnes per hectare, per:
"Flax: A Crop from America's Past With Renewed Potential", Thomas Jefferson Agricultural Institute:
"Yields of better flax varieties have been 1200 to 1400 pounds per acre in replicated yield trials...."
http://www.jeffersoninstitute.org/pubs/flax.shtml
Calculation: 1300 lbs/ac times a conversion factor of 1.12085 gives us 1457 kg/ha of flaxseed.
Flaxseed is 42.16% oil (USDA SR24). But flax oil used for food is generally cold-pressed, with a yield of about 37%, not 42%, per: Omega Nutrition;
http://www.omeganutrition.com/static.asp?htmltemplate=faqs-nutrition-flaxseedoil.html
So 1457 kg flax/ha x 37% oil = 539 kg of flax oil per hectare.

Maize (corn)

This is the type of corn used for cattle feed, for high fructose corn syrup, for ethanol, and for corn flour and corn meal.
USDA Nutrient data (SR24) used for "Corn, yellow"
Production quantity not reduced because yield data is apparently for shelled corn.

Maize for livestock
USDA Economic Research Service, "Topics, Crops, Corn, Background", U.S. Domestic Corn use 1980 to 2012;
http://www.ers.usda.gov/topics/crops/corn/background.aspx

Maize for ethanol
U.S. Corn Production and Use for Fuel Ethanol;
http://www.afdc.energy.gov/afdc/data/docs/corn_production_ethanol.xls
citing: "Data Sources, Corn Production: USDA National Agricultural Statistics Service - Quick Stats U.S. & All States Data - Crops query; corn grain, 1986-2011, United States";
http://www.nass.usda.gov/QuickStats/Create_Federal_All.jsp
Corn Used for Ethanol: USDA Economic Research Service - Feed Grains Database custom query; supply and use, utilization for alcohol in fuel, corn, United States, market year, 1986-2011;
http://www.ers.usda.gov/data/feedgrains/FeedGrainsQueriable.aspx
In 2011, 5 billion bushels (127,272,727 MT) of maize was used to make fuel ethanol.

Maize green
This is the type of corn eaten on the cob, or eaten off the cob, fresh, as a side dish, commonly called sweet corn.
USDA Nutrient data (SR24) used for "Corn, sweet, yellow, raw"
Production quantity not reduced because yield data is apparently for shelled corn.

Melonseed
Includes the seeds of pumpkins and other Cucurbits.
USDA Nutrient data (SR24) used for "Seeds, pumpkin and squash seed kernels, dried"
"Refuse: 26% Refuse Description: Hulls"
Production quantity reduced by 26%.

Millet
Includes teff and all forms of millet: Japanese, proso, finger, foxtail, pearl, ditch, etc.
USDA Nutrient data (SR24) used for "Millet, raw"
Production quantity reduced by 25%, as an estimate of percentage of hulls (see oats and barley).

Oats
USDA Nutrient data (SR24) used for "Oats"
Production quantity reduced by 27%.
LaDon Johnson, et al., 'OATS as a Feed for Beef Cattle', October 1991, North Dakota State University:
"The hull commonly accounts for 24 to 30 percent of the weight of the oat kernel";
http://www.ag.ndsu.edu/pubs/ansci/beef/as1020w.htm

Olive oil
FOA data lists as "Olive oil, virgin"
USDA Nutrient data (SR24) used for "Oil, olive, salad or cooking"

* Yield not calculated from chart data because a large percentage of olive production is not used for oil, but as whole olives.
Fruit yields and oil as a percentage of fruit vary greatly. Typical oil content ranges from about 15 to 20%; average is 17.5%, per:
Barrio and Carman, "Olive Oil: A 'Rediscovered' California Crop", Giannini Foundation of Agricultural Economics, Vol. 8 No. 5 May/June 2005;
http://giannini.ucop.edu/media/are-update/files/articles/v8n5_1.pdf
Typical fruit yields can range from 1 to 6 tons per acre, with 2 to 4 tons being more typical; average 3 tons per acre. This translates into 6.73 metric tonnes per hectare, per:
Paul Vossen, "First Press Newsletter of Olive Oil Production and Evaluation", Fall 2006, Table 1. Orchard Yield Projections for Oil Olives;
http://cesonoma.ucdavis.edu/files/27239.pdf
Calculating the oil from the fruit: 17.5% of 6.73 tonnes/ha is 1.17775 tonnes of oil/ha. These numbers are very approximate, but they are in the same range as numbers given in other sources.

Palm fruit oil
FAO metadata definition of Palm oil:
"Obtained from the mesocarp of the fruit of the oil palm by pressure, and also by solvent from the residues of the pressure extraction";
http://faostat.fao.org/site/384/default.aspx
USDA Nutrient data (SR24) used for "Oil, palm"

Palm kernel oil
FAO metadata definition of Palm kernel oil:
"Obtained from the kernel of the nut of the fruits of the oil palm by pressure in two or three stages at different temperatures. Including oil of babassu kernels."
USDA Nutrient data (SR24) used for "Vegetable oil, palm kernel"

Peas dry
Yield (2292 kg/ha) from FAOSTAT 2009 USA.
USDA Nutrient data (SR24) used for: "Peas, split, mature seeds, raw" (11.27% water)
complete protein; lysine 1.42, meth+cys 1.02, tryptophan 1.60

Peas green
Yield (11414 kg/ha) from FAOSTAT 2009 USA.
USDA Nutrient data (SR24) used for: "Peas, green, raw" (78.86% water)
near complete protein; lysine 1.15, meth+cys 0.84, tryptophan 0.98

Pigeon peas
FAO classification: "Pigeon pea, cajan pea, Congo bean (Cajanus cajan)."
USDA Nutrient data (SR24) used for "Pigeon peas (red gram), mature seeds, raw"

Plantains
USDA Nutrient data (SR24) used for "Plantains, raw" Refuse: 35% (Skin and stems).
Production quantity reduced by 35%.

Potatoes
USDA Nutrient data (SR24) used for "Potato, flesh and skin, raw" (refuse 25%)
Production quantity reduced by 25%.

Pumpkin flesh
USDA Nutrient data (SR24) used for: "Pumpkin, raw"
"Refuse: 30% Refuse Description: Seeds, rind and stem"
Yield reduced by 30% (to 70%).

Rapeseed oil
includes canola oil
USDA Nutrient data (SR24) used for "Oil, canola"
B. D. Shukia et al., Oil Seeds Processing Technology, 1992;
http://idl-bnc.idrc.ca/dspace/bitstream/10625/11596/1/95811.pdf

Rice paddy
USDA Nutrient data (SR24) used for "Rice, white, medium-grain, raw, unenriched"
as a compromise between long-grain (higher protein content) and short-grain (lower protein content). Most rice is eaten as milled (white) rice, even though substantial nutrition is lost when milling brown rice into white rice. Production quantity reduced by 35% (for a recovery percentage of 65%) as a compromise between the recovery percentages for brown rice, white rice, and small-scale village rice mills.
Rice Knowledge Bank, 'Rice Milling', International Rice Research Institute;
"The maximum milling recovery is 69-70% depending on rice variety, but because of grain imperfections and the presence of unfilled grains, commercial millers are happy when they achieve 65% milling recovery. Some village type rice mills have 55% or lower milling recovery."
http://www.knowledgebank.irri.org/rkb/index.php/rice-milling

Rye
USDA Nutrient data (SR24) used for "Rye"
Production quantity reduced by 25% (using estimate of hull percent taken from barley).

Sesame seeds
USDA Nutrient data (SR24) used for "Seeds, sesame seeds, whole, dried"
Production quantity reduced by 15% to account for hulls.
M. T. Farran et al., Performance of broilers and Layers Fed Graded Levels of Sesame Hull, p. 1 (cites 12%);
http://japr.fass.org/cgi/reprint/9/4/453.pdf
B. D. Shukia et al., Oil Seeds Processing Technology, 1992 (cites 14-18%);
http://idl-bnc.idrc.ca/dspace/bitstream/10625/11596/1/95811.pdf

Sorghum
USDA Nutrient data (SR24) used for "Sorghum"
Production quantity reduced by 20% to account for milling losses.
FAO Food and Nutrition Series, Sorghums and Millets in Human Nutrition, 'Processing untreated grains', (1995);
http://www.fao.org/docrep/T0818E/T0818E00.htm

Soybeans
USDA Nutrient data (SR24) used for "Soybeans, mature seeds, raw"
Production quantity not reduced because field weight excludes pods.

Soybean Harvesting, University of Arkansas, Division of Agriculture, Cooperative Extension Service;
http://www.aragriculture.org/crops/soybeans/harvesting.htm

Sugar beet
USDA Nutrient data (SR24) used for "Sugars, granulated"
Production quantity reduced by 82% (to 18%) of FAO production quantity because raw sugar beets are 18% sugar.

Sugar cane
USDA Nutrient data (SR24) used for "Sugars, granulated"
Production quantity reduced by 90% (to 10%) of FAO production quantity because raw sugar cane is 10% sugar.

Sunflower seeds
USDA Nutrient data (SR24) used for "Seeds, sunflower seed kernels, dried"
"Refuse: 46% (Hulls)"
Production quantity reduced by 46% (to 54%) to account for hulls.
http://www.jeffersoninstitute.org/pubs/sunflower.shtml

Sweet potato
USDA Nutrient data (SR24) used for "Sweet potato, raw, unprepared"
"Refuse: 28% (Parings and trimmings)"
Production quantity reduced by 28% (to 72%).

Taro (old cocoyam)
FAO metadata: "Dasheen, eddoe, taro, old cocoyam (Colocasia esculenta)."
USDA Nutrient data (SR24) used for "Taro, raw"
"Refuse: 14% (Ends and skin)"
Production quantity reduced by 14% (to 86%).

Tomatoes
USDA Nutrient data (SR24) used for "Tomatoes, red, ripe, raw, year round average"
"Refuse: 9% Refuse Description: Core and stem ends"
Production quantity reduced by 9%.

Triticale
A minor cereal that is a cross between wheat and rye, combining the quality and yield of wheat with the hardiness of rye.
USDA Nutrient data (SR24) used for "Triticale flour, whole-grain".
Production quantity reduced by 25% (to 75%) using estimate of hull percent taken from barley.

Walnuts
USDA Nutrient data (SR24) used for "Nuts, walnuts, english" Refuse: 55% (Shells)
Production quantity reduced by 55% (to 45%).

Wheat
USDA Nutrient data (SR24) used for "Wheat flour, whole-grain"
Production quantity reduced by 15% (to 85%).

Yams
Dioscorea spp.. The principal edible yams are widely grown throughout the tropics. A starchy staple foodstuff, normally eaten as a vegetable, boiled, baked or fried. In West Africa they are consumed mainly as "fufu", a stiff glutinous dough. Trade data cover both fresh and dried yams.
USDA Nutrient data (SR24) used for "Yam, raw" Refuse: 14% (Skin)
Production quantity reduced by 14% (to 86%).