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PRESENTS

Who Will Feed Us?

The Peasant Food Web vs. The Industrial Food Chain

3rd Edition, 2017

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The Peasant Food Web

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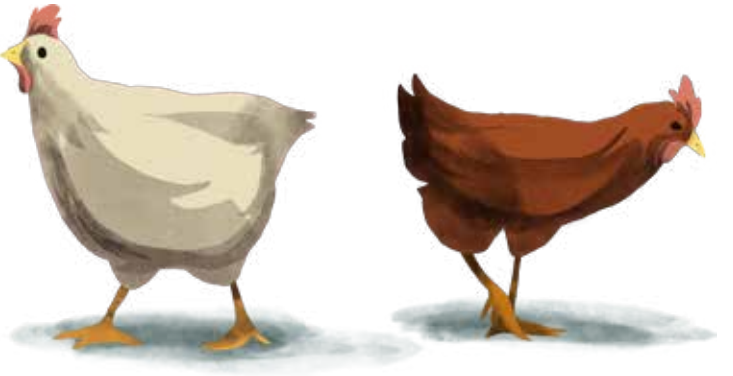
24 questions about our food system...

Symbols & Abbreviations Key

Web	Peasant Food Web
Chain	Industrial Food Web
R&D	Research & Development
GM	Genetically-modified
p/a	Per annum (per year)
kg/g	Kilogram/gram
kcal/cal	Kilocalories/calories
ha	Hectare (=2.47 acres)
Million	1,000,000
Billion	1,000,000,000
Trillion	1,000,000,000,000
$	US Dollar
GHG	Greenhouse gas
ppm	Parts per million



Key Messages

1. Peasants are the main or sole food providers to more than 70% of the world's people,[1] and peasants produce this food with less (often much less) than 25% of the resources – including land, water, fossil fuels – used to get all of the world's food to the table.
2. The Industrial Food Chain uses at least 75% of the world's agricultural resources and is a major source of GHG emissions, but provides food to less than 30% of the world's people.[2]
3. For every $1 consumers pay to Chain retailers, society pays another $2 for the Chain's health and environmental damages.[3] The total bill for the Chain's direct and indirect cost is 5 times governments' annual military expenditure.[4]
4. The Chain lacks the agility to respond to climate change. Its R&D is not only distorted but also declining as it concentrates the global food market.[5]
5. The Peasant Food Web nurtures 9-100 times the biodiversity used by the Chain, across plants, livestock, fish and forests. Peasants have the knowledge, innovative energy and networks needed to respond to climate change; they have the operational scope and scale; and they are closest to the hungry and malnourished.[6]
6. There is still much about our food systems that we don't know we don't know. Sometimes, the Chain knows but isn't telling. Other times, policymakers aren't looking. Most often, we fail to consider the diverse knowledge systems in the Peasant Food Web.
7. The bottom line: at least 3.9 billion people are either hungry or malnourished because the Industrial Food Chain is too distorted, vastly too expensive, and – after 70 years of trying – just can't scale up to feed the world.

What do we mean by...?

Food: Includes food crops, livestock, fish (meaning any edible marine or freshwater species), foods hunted or gathered, and foods grown in urban and peri-urban environments (primarily crop and livestock). Food is often measured by weight, by calories (energy) or by nutritional or commercial value. However, food should also be measured by time and place – e.g. in the weeks prior to harvest, or during the "hurricane" season, a kilo of less popular plants (so-called "famine foods") is more vital to survival than several kilos of high-calorie foods in times of abundance. When economists describe the contribution of different foods to food security it is often unclear whether they are describing the amount of food that was produced or the portion that was consumed, and whether food produced might have been sidelined into biofuels, livestock feed or fishmeal en route to people. It would, of course, be best if we could measure food by its contribution to health.

Technical Terms: We try to avoid technical language, but it is sometimes unavoidable. Explanations and much more technical detail are available in the "Sources & Comments" section.

Resources: Food requires genetic (breeding) stock, land, soil, water, and pollinators that must be protected. The very basic resources needed for agricultural production – adequate sunlight, clean air and a stable climate – are also resources under threat from industrial systems and climate change. In addition, the Chain also needs non-renewable resources such as synthetic fertilizers, fossil fuels, agrochemicals and industrial machinery.

Hunger & Malnutrition: The official UN estimate is that 795 million people are "hungry" – meaning they don't get enough calories, or adequate nutrition from those calories. While this means that 10% of the world's population is hungry, this is, by far, the lowest percentage

ever recorded. However, it is also estimated that at least 3.9 billion of us (52%) suffer from malnutrition. Beyond those who are hungry in the traditional sense, this number includes the many more who have sufficient calories but are suffering, often severely, from nutritional deficits and damage (lack of micronutrients, vitamins or protein) or from the ill health caused by overconsumption. It is a tragic irony that many peasants and agricultural workers struggle with hunger and malnutrition even as they provide their services and labor to their neighbours or even to the Chain. In a world full of food, more than half of us continue to be unable to get the food we need. The ultimate tragedy is that both in hard numbers and as a percentage, the ranks of the malnourished are continuing to grow.

Hunger has structural and historic causes. The world's most famous famines, from Ireland in the 1840s, to Bengal in the 1940s, to the Soviet Union in the 1930s, to China in the 1950s, to Yemen and South Sudan today, have been either political, profitable, or both. Chronic hunger is the pandemic of resource-rich countries, from the rare earths of the Congo to the oil-rich lands of Angola and Nigeria. Landgrabs have destabilized farming and pastoralism, while the export of everything from groundnuts in West Africa to flowers in East Africa has surrendered some of the continent's best soils to foreigners.[7]

Peasant Food Web: We have adopted this language to describe the small-scale producers, usually family- or women-led, that include farmers, livestock-keepers, pastoralists, hunters, gatherers, fishers and urban and peri-urban producers. Our definition includes not only those who control their own production resources, but also those who work for others to produce and supply food, and who have often been dispossessed of their land. Depending on season and opportunity, peasant farmers may also be fishers, as well as hunters and gatherers, and urban peasants may have fish ponds and small livestock as well as outside employment. Peasants may move back and forth between food production and urban jobs for environmental and socio-economic reasons. It is important to remember that peasants are by no means always self-sufficient and sometimes purchase food from the Chain, and that the reverse is also true. They may or may not grow all of

their own food, trade with neighbours and sell the surplus in local markets. While growing all they can under difficult conditions, peasants are often malnourished, but could still have food to trade. "Peasant" sometimes implies "indigenous," but we recognize that Indigenous Peoples have their own identity and define their own livelihoods and food systems. No single word adequately describes the range of peoples and livelihoods encompassed by the Peasant Food Web.

The Web is not a pseudonym for agroecology, organic farming, permaculture, or any other production system. Were organic farming employed throughout food production, we would be closer to food security but not necessarily closer to Food Sovereignty. Peasants make their decisions about synthetic fertilizers or pesticides for ethical, economic, environmental, or access reasons. Some use chemicals for commercial produce but avoid them for their own consumption. Regardless, much (or most) of what peasants produce is de facto "organic."

Industrial Food Chain: The Industrial Food Chain is a linear sequence of links running from production inputs to consumption outcomes. The first links in the Chain are crop and livestock genomics, followed by pesticides, veterinary medicines, fertilizers, and farm machinery. From there, the Chain moves on to transportation and storage, and then milling processing, and packaging. The final links in the Chain are wholesaling, retailing and ultimately delivery to homes or restaurants. In this text we use 'industrial' or 'corporate' to describe the Chain, and 'commercial foods' should undoubtedly be associated with the Chain. Just as peasants can't be comprehended outside of their cultural and ecological context, the links in the Chain – from agro-inputs to food retailers – must be understood within the market economy. All the links in the Chain are connected within the financial and political system, including bankers, speculators, regulators and policymakers. The Chain controls the policy environment of the world's most important resource – our food.

Questioning the Industrial Food Chain & the Peasant Food Web

1. Where do most people get their food?

ETC Group estimates about 70% of the population – **4.5–5.5 billion**[8] **of the world's 7.5 billion people**[9] – depend on the Peasant Food Web for most or all of their food.

This includes the following (often overlapping) groups:

- Almost all of the **3.5 billion rural people** (including the 2.7 billion who depend on biomass – primarily fuelwood for cooking).[10] This also includes millions of peasants in the North and their allies in community-shared agriculture or fisheries cooperatives.[11]
- An estimated **1 billion urban food producers** (gardens, fish and livestock).[12]
- Most of the **800 million people** worldwide who depend on fishing or small-scale fisheries for their food and livelihood.[13]
- **Hundreds of millions more** who regularly turn to the Web in times of scarcity.[14]

This estimate seriously undervalues the Web's vital contribution to health and livelihoods. The Web's protection of agricultural biodiversity means that rural people who regularly look to "famine foods" in the seasons of scarcity prior to harvests will survive, and that mothers and children will have some nourishment to get through the weeks or months of scarcity in areas where the Chain is unreachable or unaffordable.[15] **The importance of the Web to the most vulnerable people in their most vulnerable times far outweighs any calculation of the Web's caloric contribution.**

70% of people depend on the Peasant Food Web. (4.5-5.5 billion)

30% of people depend on the Industrial Food Chain. (1.8-2.8 billion)

including

3.5 billion rural people

Millions Northern peasants

1 billion urban growers

800 million small-scale fishers

Rural peoples who look to "famine foods" in the seasons of scarcity prior to harvests will survive thanks to the Web's protection of agricultural biological diversity.

2. Who produces the most food?

Not only does the Web feed 70% of humanity, it also produces about 70% of the world's available food, in calories and weight:

- **Peasant farmers in the Global South harvest 53% of the world's crop calories** consumed by humans (e.g. 80% of rice and 75% of groundnuts).[16]
- Globally, urban agriculture provides 15% of food consumed in urban areas, including 34% of total meat production and 70% of egg production.[17] Urban agriculture will double over the next 20 years.[18] **2.5 billion people (almost all from the Global South) get some or all of their food from street vendors** who customarily source their food from peasants.[19]
- Artisanal fishers harvest 25% of the global catch.[20]
- At least **77% of food crops and livestock production is still consumed within the country in which it is harvested**[21] and most of this food (other than in OECD countries) is sourced within the Web.

In previous editions of *Who Will Feed Us*, we estimated that the Web produces 70% of food, and this remains a fair and conservative estimate.[22] However, a precise calculation isn't possible because comprehensive data doesn't exist.[23] ETC's 70% estimate was controversial in 2009 when we first made it but now is widely accepted by UN officials, academia and even industry. A summary of who accepts the 70% figure is included at the end of this booklet.

3. What happens to all the food produced by the Chain?

The Chain produces vast quantities of food that can't just disappear. How is it that it feeds less than 30% of the population? The figures below are of the total calories harvested by the Chain each year...

- **44%** of the Chain's crop calories are 'wasted' in meat production: more than 50% of the Chain's crop calories are used as livestock feed, but only about 12% of *those* calories (or 6% of total calories) are then converted into food for people.[24]
- Another **9%** of the Chain's crop calories go to biofuels or other non-food products.[25]
- At least **15%** of the Chain's calories are lost in transportation, storage and processing.[26]
- About **8%** of the Chain's calories are wasted in households.[27]

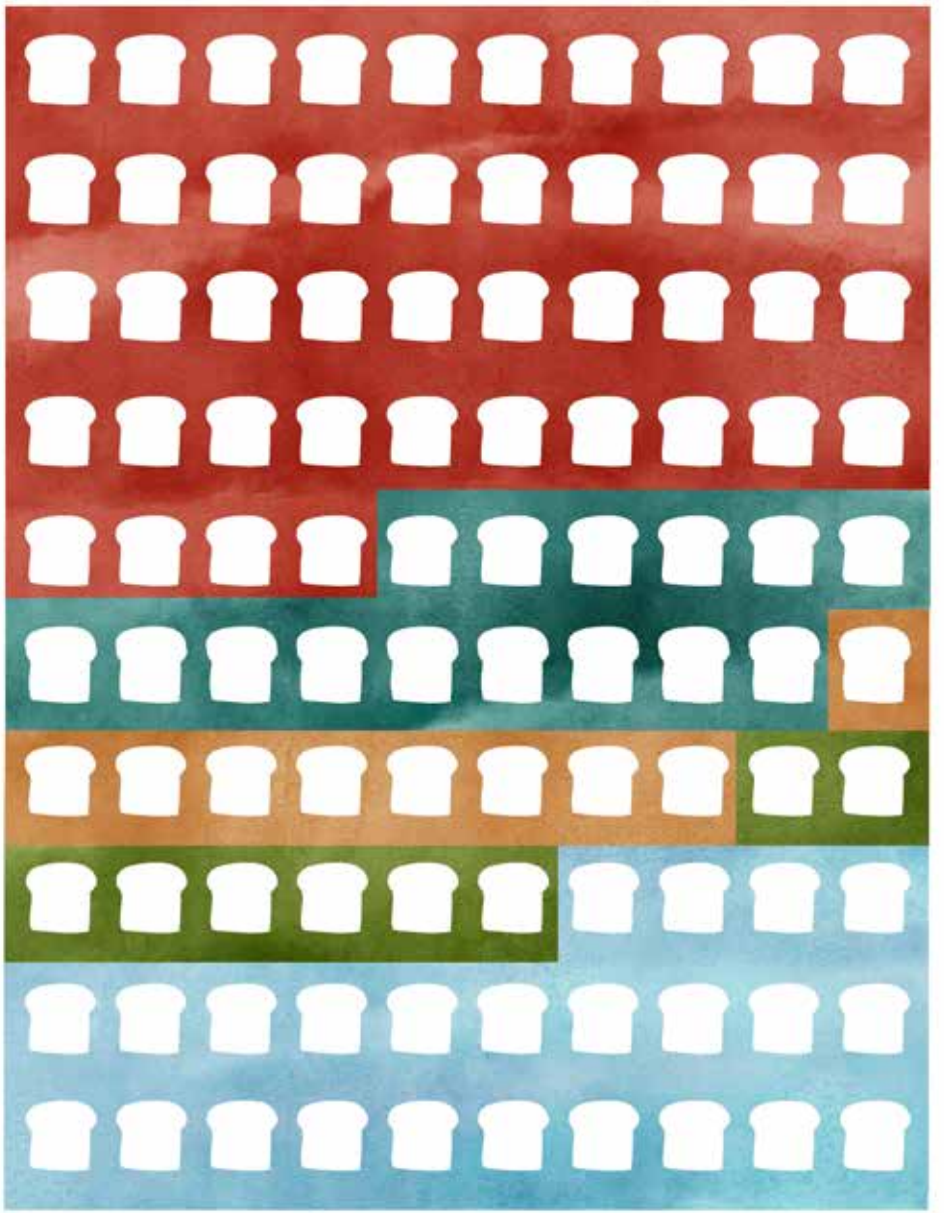
This means 76% of the Chain's total calories are wasted before making it to the plate, and only 24% are eaten by people.

In addition, much of the Chain's calories eaten don't contribute to health and well-being. By some estimates, 1/4 of food that people eat (by weight - not calories) is overconsumed, making people sick.[28] If we (conservatively) estimate that at least 2% of the Chain's calories are harmful to health,[29] it means at least 78% of the Chain's production is wasted or overconsumed, and only 22% nourishes people.

Calculations of the Chain's food "disappearances" depend on cultural understandings of food waste and on whether considering an omnivorous or herbivorous diet.[30] An underlying reason that the Chain only feeds 30% is that, to the Chain's retailers, almost half the world (the rural poor) are too remote and too poor to offer much profit.

Where does the Chain's food go?

If the Chain's crop calories were depicted in 100 sandwiches...



44 wasted in meat production

15 lost in transport and storage

9 create biofuels and other products

8 wasted in households

only 24 feed people directly

4. Who is using up our agricultural resources?

The Web uses less than 25% of agricultural lands[31] to grow the food that nourishes more than 70% of people (providing primary support for the 2 billion people most at risk[32]). ETC estimates that the Web uses approximately 10% of agriculture's fossil energy and no more than 20% of agriculture's total water demand,[33] with far less damage to soils and forests than the Chain.

The Chain uses more than 75% of the world's agricultural land[34] and in the process annually destroys 75 billion tonnes of topsoil[35] and controls the market environment that cuts down 7.5 million hectares of forest.[36] Further, the Chain accounts for at least 90% of agriculture's fossil fuel use (and GHG emissions)[37] and at least 80% of freshwater use, **and leaves us with a bill of $12.37 trillion** (for food and damages).[38] It also leaves 3.9 billion people underfed or malnourished.[39]

BOX 1: AGROECOLOGY VS AGRIBUSINESS

Peasant agriculture is reliable and resilient. In a normal or abnormal year, on good or poor soils, women and men working with diverse crops, fish ponds and livestock will produce more food per hectare than industrial farms.[40] **Using agroecological strategies,**[41] **the Web will consistently produce more, at less risk to people and the planet.**

In a normal year, with sufficient money, machines and labour, on good soils, using high-yielding varieties or breeds of commercial crops, livestock species or fish monocultures, the Chain *may* be able to produce more commercial mass per hectare than peasant-bred varieties of the same species.[42] **However, in recent decades, yields have stagnated for 4 of the Chain's major crops (maize, rice, wheat, and soybeans, which together account for 57% of the Chain's crop calories).**[43]

The Chain's crop genetic uniformity caused the devastating Corn Leaf Blight in the USA in 1970;[44] a new wheat rust is threatening the crop in Africa and around the world;[45] black sigatoga is destroying genetically-uniform banana plantations;[46] Tungro and leafhopper infestations devastated Southeast Asian rice;[47] and crops from coffee to oranges and rubber remain impressively vulnerable today because of their uniformity. Before the Chain, genetic uniformity caused the 1840s Irish Potato Famine that killed one million people and forced another million to migrate.[48]

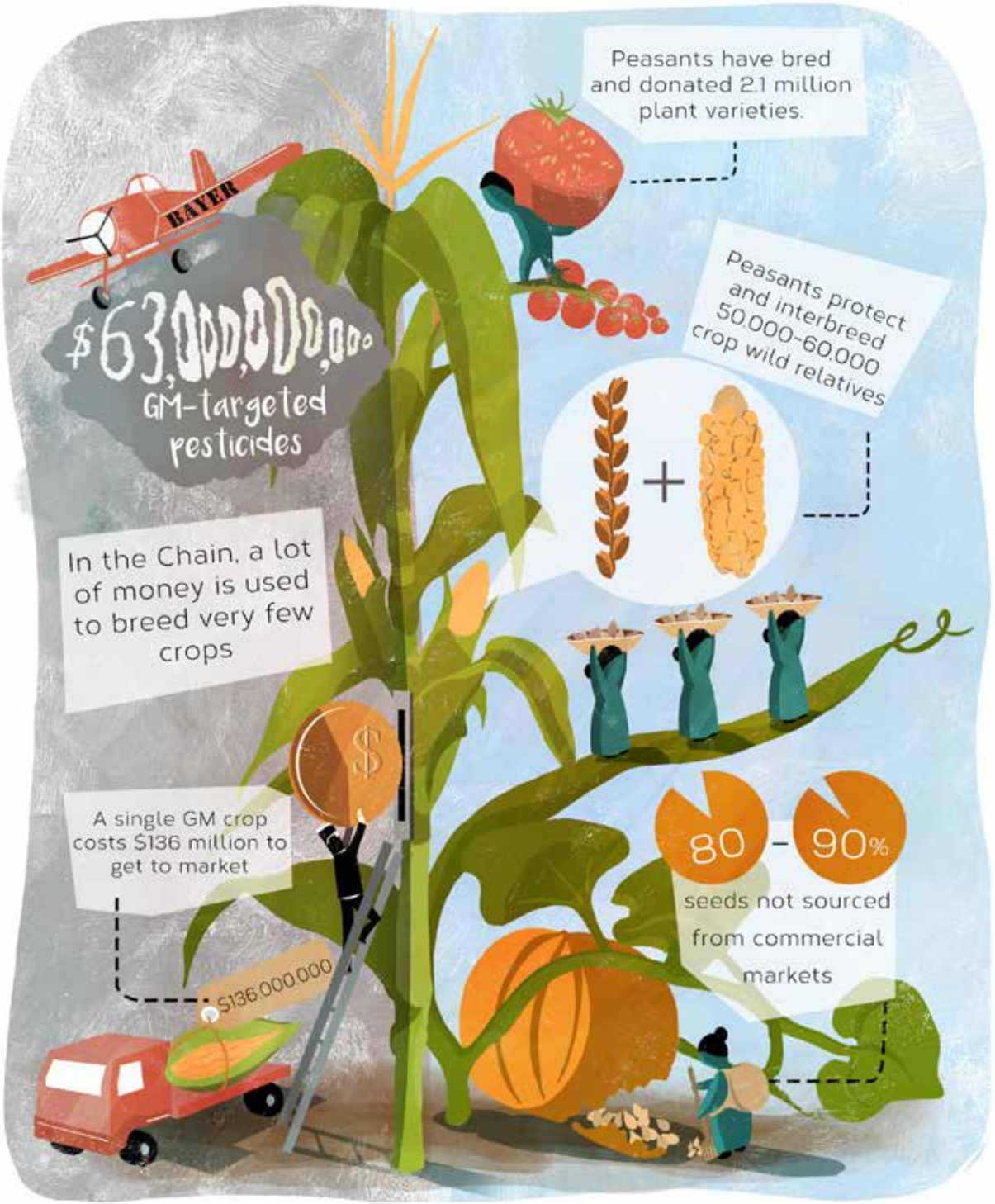
Nevertheless, the Chain is supported by $50 billion in public and private sector research p/a.[49] There is little data on the funding for peasant-directed research or agroecology but it is less than 1% of the Chain's R&D.[50] While cutting public R&D support for the private sector would benefit both people and planet, shifting that funding to agroecology would be game-changing.

5. Who breeds our food crops?

Peasants have bred and donated (to national and international gene banks) **2.1 million varieties**[51] of **7,000 domesticated plant species.**[52] 80-90% of peasants' seeds are saved, shared or locally traded (not purchased from the Chain).[53,54] Importantly for adapting to climate change, peasants protect and sometimes interbreed 50,000–60,000 wild relatives[55] of cultivated species at no cost, with a potential economic value of $196 billion.[56,57] While many of these species are minor crops, they may be important to countries or ecosystems where they could be essential "famine foods." Virtually none of them appear in FAO or national food statistics.

In the Chain, a lot of money is used to breed very few crops. Commercial breeders have **0.1 million varieties** under monopoly control, but 56% marketed in the European Union, for example, are ornamentals (e.g. roses, chrysanthemums) – not food.[58] Commercial breeders actually work with only **137 crop species,** and just 16 of these account for 86% of the world's global food production.[59] In fact, **one crop, maize, receives 45% of all private R&D spending.**[60] The Chain's breeding is also expensive: **a single GM variety costs $136 million to get to market.**[61, 62]

Who Breeds Our Food Crops?



What food crop variety is the Industrial Food Chain providing?

...of the global market is for only 16 food crops

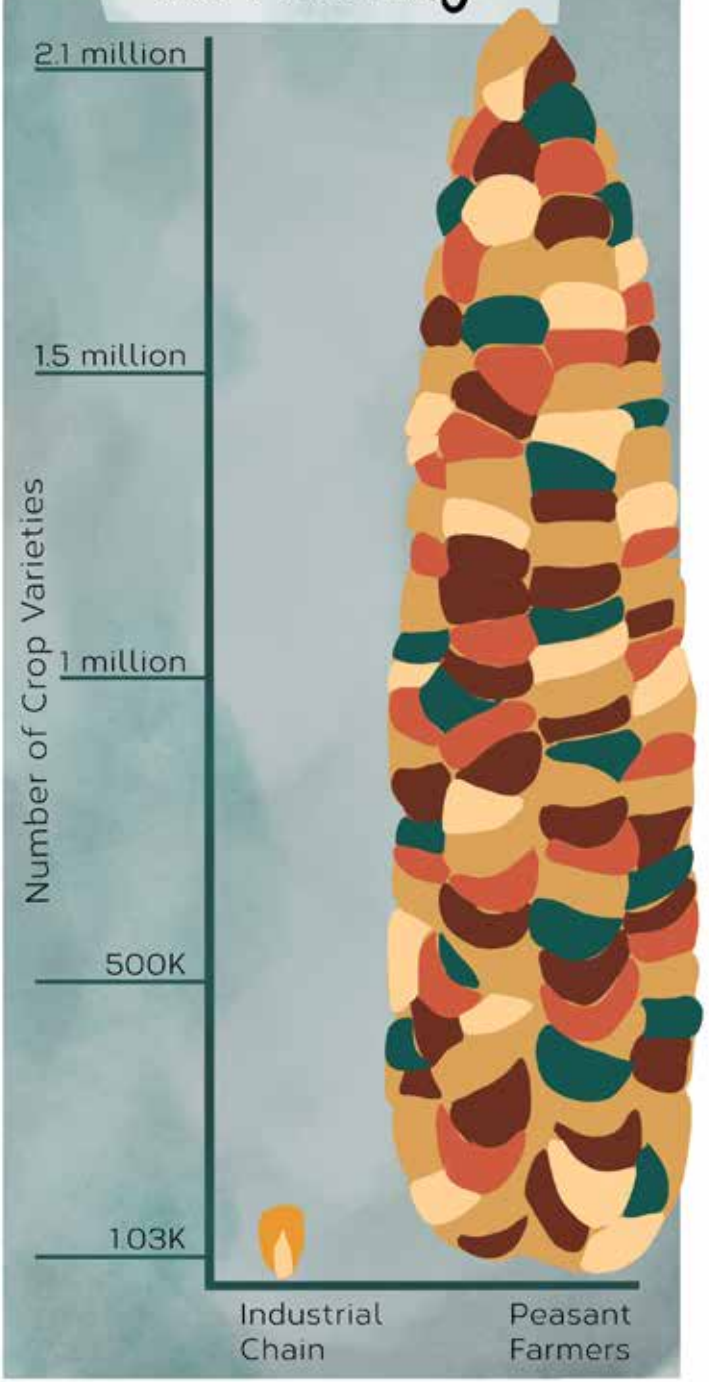
What does the Industrial Food Chain breed?

...of commercially bred seeds are ornamental

Which crops are funded by private research and development in the US?

...of all private R&D is spent on one crop: Maize

Who Contributes to Seed Diversity?



6. Who breeds our livestock and fish?

Peasants have domesticated at least 34 livestock species,[63] **continue to nurture and breed more than 8,774 rare breeds of these species**[64] and originally bred most of the animals now commercialized by the Chain.[65] This diversity is ensured by 640 million peasant farmers, 190 million pastoralists,[66] and 1 billion urban peasants who earn 33–55% of their household income from livestock.[67] 66% of urban peasants are women.[68] While peasants protect fisheries, there is little information about their role in breeding.

Meanwhile, **the Chain focuses almost exclusively on 5 livestock species** – cattle (meat & dairy); poultry (broilers & layers); pigs; sheep (meat & wool); and goats (dairy & meat). This collectively amounts to fewer than **100 commercial breeds**,[69] almost all of which were originally bred by peasants. Today, fewer than 7 corporate breeders dominate livestock genetics with 2–3 companies controlling virtually all commercial poultry and pig breeding.[70]

Similarly, 5 of the 7 big livestock genetics companies have segued into fish genetics, and breeding for the main marine species is dominated by 2–5 companies.[71] **Despite the availability of tens of thousands of marine species, the Chain focuses its R&D on 25 species.**[72] (Learn more about fishers in question 8.)


Peasant Food Web
>8774 rare breeds
Industrial Chain
<100 commercial breeds

7. Who looks after livestock health?

Peasants and pastoralists breed and protect livestock that have enormous resilience and resistance (e.g. camels that survive 14 days without water or drink salt water, sheep that digest seaweed, and other breeds that have immunity to diseases or tolerate extreme weather).[73] Peasants often rely on indigenous ethno-veterinary practices that are built around local resources.[74]

In the Chain, livestock vulnerability has created a huge industry. Global animal pharmaceutical sales total $23.9 billion p/a, and 10 companies control 83% of the market.[75] Yet, **60% of all human infectious diseases are transmitted through domesticated animals (e.g. avian flu epidemics),[76] significantly caused by extreme genetic uniformity.** The Chain, instead of using diverse, indigenous breeds, destroys indigenous poultry and pigs to protect their genetically-uniform breeds. A Korean-Chinese initiative aims to ship 100,000 cloned cattle p/a to China.[77]

Despite some bans,[78] antibiotics are still used as livestock growth promoters. Governments promised to eliminate abuses, but use increased by 23% in the US from 2009–2014.[79] Antibiotic resistance costs the US $55 billion p/a.[80] Only now, when it may be too late, governments recognize that **antibiotic resistance is a threat that may equal climate change**.[81]

8. Who safeguards our fisheries?

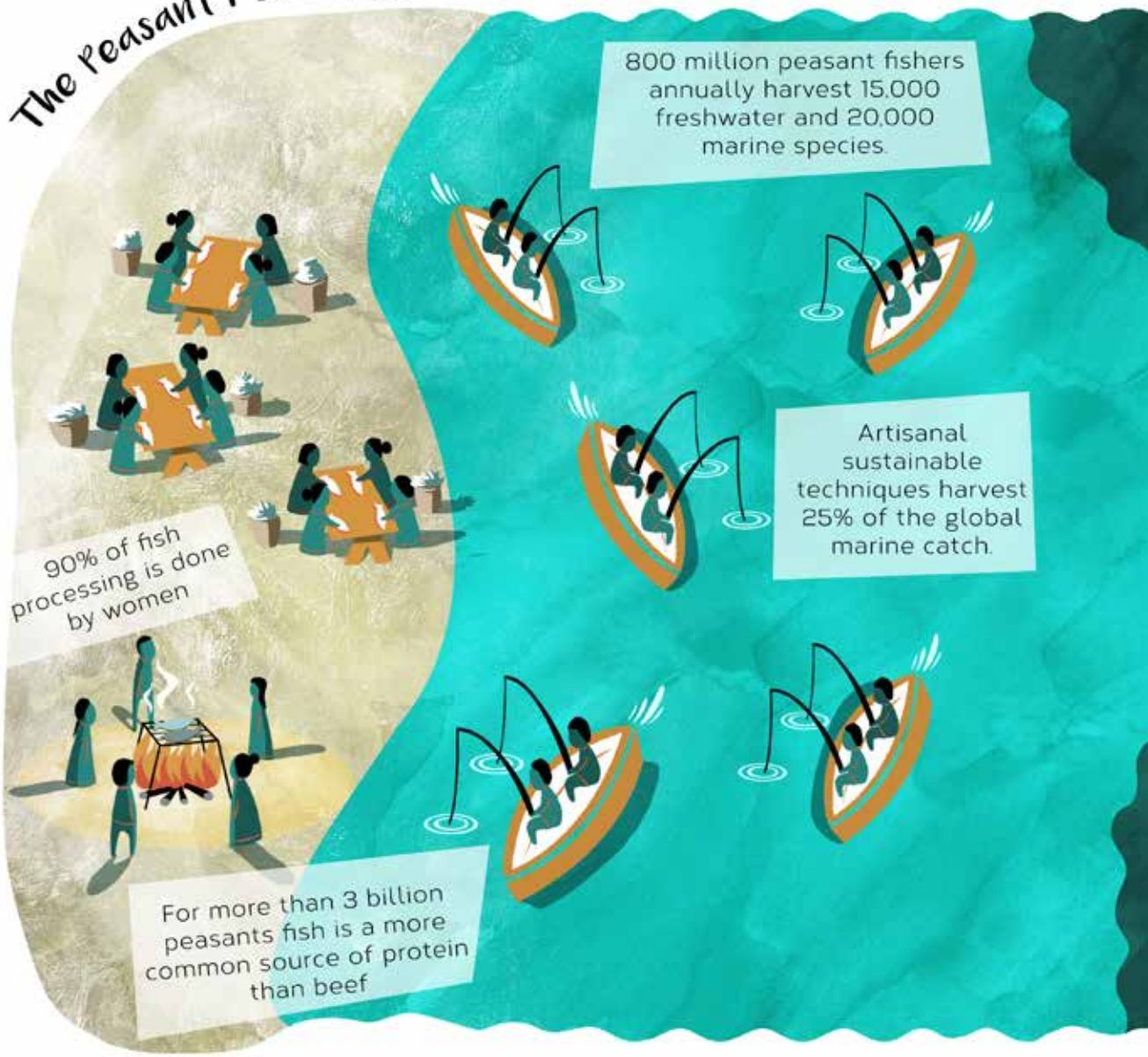
800 million peasant fishers[82] **harvest 15,000 freshwater**[83] **and 20,000 marine species.**[84] Artisanal sustainable techniques harvest 25% of the global marine catch.[85] 90% of fish processing jobs are held by women,[86] who make a critical contribution to the nutrition of more than 3 billion people, who in turn get 1/5 of their protein from fish (making fish a more important protein source than beef).[87,88]

The Chain catches 1,600 marine species and "farms" 500 others,[89] but 40% of their marine catch is composed of 23 species[90] and aquaculture production is dominated by only 25 species.[91] Although the Chain's use of diversity is narrow, its impact is broad: 91% of ocean fish stocks are overexploited or at maximum exploitation,[92] and since the 1970s there has been a 39% decline in marine populations and a whopping 76% drop in freshwater species harvested.[93] Because of this, **for every hour spent fishing, fishers today land just 6% of what their counterparts did 120 years ago**, despite the new fish-finding technologies.[94]

About **25% of the Chain's marine catch is illegal and unreported** (worth $10–24 billion p/a).[95, 96] In fact, 28 nations, accounting for 40% of the world's catch, routinely violate the FAO fishing code.[97] At least $50 billion p/a is lost through fisheries mismanagement,[98] equal to over 50% of the global trade.[99] 1/3 of seafood sold in US shops and restaurants is wrongly labelled.[100] Despite this, governments annually donate $35 billion in fuel subsidies and cheap insurance to commercial trawlers.[101] The commercial seafood industry is concentrating at breakneck speed so that today 10 companies account for more than 25% of the world market.[102]

Who safeguards our fisheries?

The Peasant Food Web




The Industrial Chain
40% of their marine catch is made up of only 23 species.
25% of the Chain's marine catch is illegal and unreported (worth $10-24 billion per year)
25%
>$50billion lost through mismanagement
$
91% of fisheries overexploited or at max exploitation
$35bn of fuel subsidies and cheap insurance

9. What is happening to food diversity?

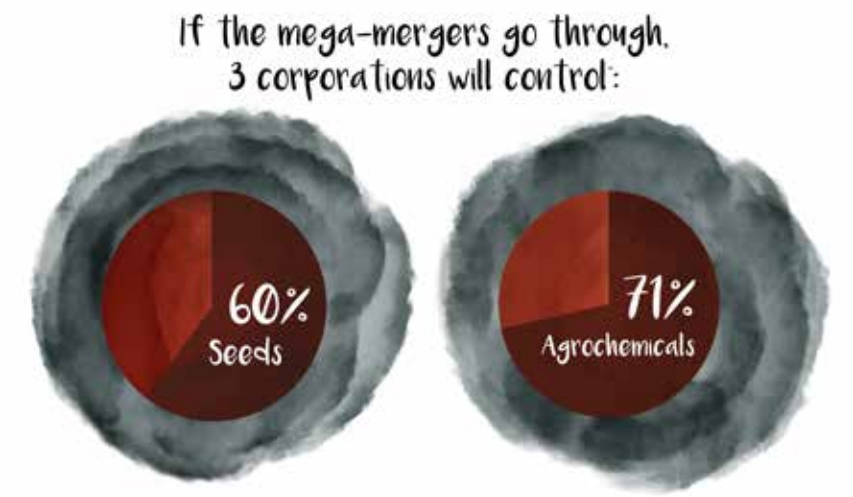
Peasant-led crop and livestock breeding promotes diversity for both food security and nutrition. Women, who do much of the seed selection and breeding,[103] especially focus on improving nutrition, seed and food preservation, and cooking characteristics. Diversified agroecology farming is based on the maximization of synergies between species. For example, in Kenya the push-pull mixing of maize and pasture for dairy has doubled the production of both milk and maize and rice-duck synergies in Bangladesh increased rice productivity by 20% in 5 years.[104]

Since 1961, in markets controlled by the Chain, there has been a 36% "implosion"[105] in the number of species preferred by processors and retailers (fewer millets, pulses and tubers; more maize, soybeans and salad vegetables). While these species haven't disappeared, their use has withered. Within species, there has been a **75% loss in the genetic diversity** available to science for plant breeding.[106] (Like the species, the genetic diversity is not necessarily extinct but has "disappeared" from common usage and may be found on only a few farms.) Beyond species and genetic loss, **the nutritional qualities of Chain-bred varieties have declined 5–40%** depending on the species (e.g. sweeter and therefore less nutritious maize, fruits and vegetables).[107]

10. Who controls agricultural inputs?

The Web uses mostly local inputs: locally-bred crop varieties and livestock breeds shared with the community; manure; and sustainable (often traditional) technologies to counter pests. Nearly 90% of the seeds that peasant farmers use come from their seed-saving or are bartered with neighbours in local markets.[108]

The Chain relies on the $41 billion commercial seed market – 55% controlled by 3 companies (Monsanto, DuPont and Syngenta). Industrial farmers are dependent on GM-targeted pesticides bought from 3 companies (Syngenta, BASF and Bayer) who control 51% of global sales worth $63 billion.[109] There have been more than 200 takeovers of smaller seed companies since the introduction of GM seeds 20 years ago,[110] and if the unprecedented mega-mergers being negotiated now are successful, the 3 surviving giants may monopolize 60% of commercial seeds and 71% of pesticides.[111] This will give them still-greater control over the combined market for herbicide-tolerant GM plant varieties.



11. Who protects our forests and forest foods?

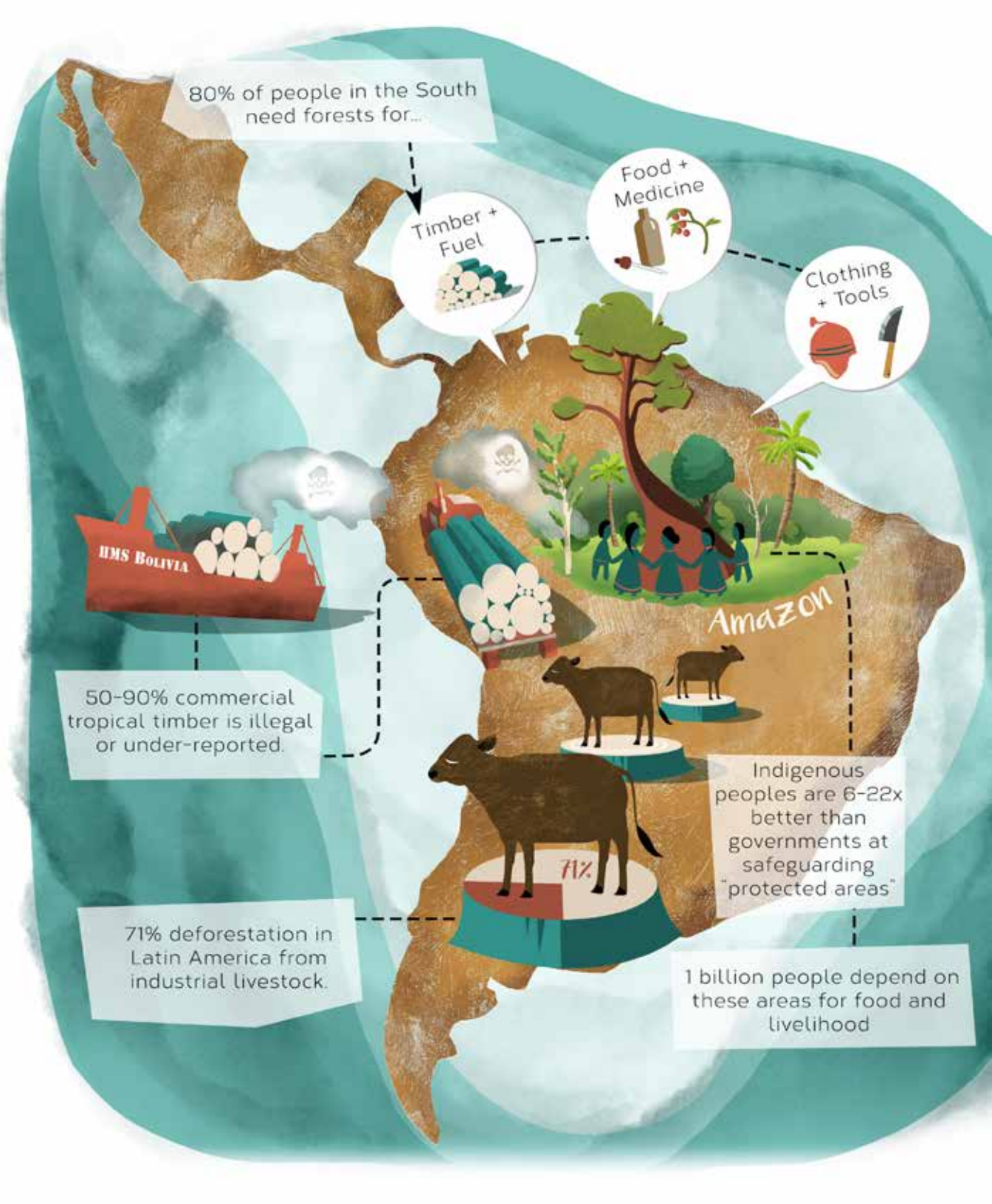
Peasant livelihoods depend on 80,000 forest species,[112] and 2.7 billion people cook with fuelwood.[113] Of these, more than 1 billion people use 513 million hectares of officially "protected areas" for food and livelihood security.[114] In total, 80% of the Global South looks to forests for timber, fuel, food, medicine, clothing and tools.[115] In one recent survey, **Indigenous peoples in Guatemala, Bolivia and Brazil were found to be 6–22 times more effective at safeguarding "protected areas" than governments.**[116]

Although peasants are accused of deforestation, in Indonesia, the fastest forest clearing nation in the world, about 90% of the palm oil driven deforestation is attributed to large private enterprises selling to even bigger transnational food processors.[117] In Latin America, industrial livestock increase causes 71% of forest loss.[118]

The Chain – and governments – have done a terrible job of monitoring forests, largely due to underreporting.

- According to UNEP, 50–90% of commercial tropical timber removal may be illegal and under-reported.[119]
- Satellites miscalculated the Amazon's biomass by 25%.[120]
- Between 1990 and 2010, the rate of tropical forest loss accelerated by 62% instead of slowing by 25% as claimed.[121]
- Science only recently learned that the life expectancy of tropical trees has decreased 33% since the 1980s: trees are growing faster but dying sooner.[122]

These miscalculations mean that since the 1990s, the amount of carbon stored in the Amazon p/a dropped from 2 billion to 1 billion tonnes.[123]


80% of people in the South need forests for...
Timber + Fuel
Food + Medicine
Clothing + Tools
HMS Bolivia
Amazon
50-90% commercial tropical timber is illegal or under-reported.
71%
71% deforestation in Latin America from industrial livestock.
Indigenous peoples are 6-22x better than governments at safeguarding "protected areas"
1 billion people depend on these areas for food and livelihood

12. Who safeguards our soil?

Less than 1/2 of peasant lands may use some synthetic fertilizer.[124] **Normally, peasants use manure, so-called crop wastes and soil micro-organisms to fix 70–140 million tonnes of nitrogen p/a**, roughly equivalent to $90 billion in nitrogen fertilizer sales.[125] Peasants have their own soil protection strategies – tree windbreaks, nitrogen-fixing and deep-rooted crops or mixed crop-livestock systems. Artisanal fishers protect biologically diverse and invaluable mangrove ecosystems, seagrass meadows and peatlands.[126]

In contrast, the Chain is responsible for almost all of the 75 billion tonnes of soil lost p/a, with damages costing $400 billion p/a.[127] The Chain dominates more than 75% of global agricultural land,[128] and uses most of the world's synthetic fertilizer, which costs an additional $365 billion in environmental damages p/a.[129] The synthetic fertilizer industry's annual sales are $175 billion[130] – **for every $1 spent on fertilizer, more than $4 are incurred in soil and environmental damages**. Only 1/2 of synthetic fertilizers reach the crop, and the Chain has no incentive to reduce the waste.[131,132]

80% of the Chain's synthetic fertilizer goes toward livestock,[133] and 80% of the Chain's agricultural land is used for livestock production.[134] The Chain warns that with population and wealth increase, the demand for meat and dairy products will climb 70% by 2050, requiring every ha of arable land, leaving no room for land for direct human consumption[135] – unless they can deploy their new technologies.

13. Who cares for our threatened crop pollinators and microbes?

In the Web, wild pollinators, including more than 20,000 species of bees and other insects, birds and bats, are protected partly because indigenous and peasant producers depend on the same habitats for hunting and gathering. These pollinators also pollinate 75% of the main global (often industrial) food crops.[136]

The Chain destroys natural pollinators, and 1/3 of its crops now depend on expensive commercial beehives.[137] $235–577 billion p/a[138] in productivity is threatened by a collapse in pollinator populations linked to insecticide abuse.[139] The Chain's solution? "Terminator" (gene editing) technologies that sterilize crops so they don't need pollination (but farmers will have to buy new seeds for every sowing).[140]

Only 1–5% of a pesticide application acts on the target pest, drastically damaging the ecosystem and jeopardizing our health.[141]

Genetically-uniform crops and livestock, combined with synthetic fertilizers and pesticides, have decimated beneficial agricultural microbes, which damages soils, reduces feed efficiency and makes animals vulnerable. Fertilizer Nitrogen deposition reduces peatlands' capacity to store carbon by killing bog-building moss *Sphagnum*.[142]

This strategy of mass production has also accelerated antibiotics use in humans and animals, reducing the diversity of bacteria in human and livestock microbiomes, and is believed to contribute to physical and mental health problems.[143]

14. Who wastes our water?

Peasants and Indigenous Peoples know the importance of water for life[144] and have used holistic methods such as rainwater harvesting (which reduces irrigation needs by 50%[145]) and crop rotation that increases water availability up to 20%.[146] **4 times fewer nitrates leach into groundwater from organic farms than from the Chain's fields.**[147]

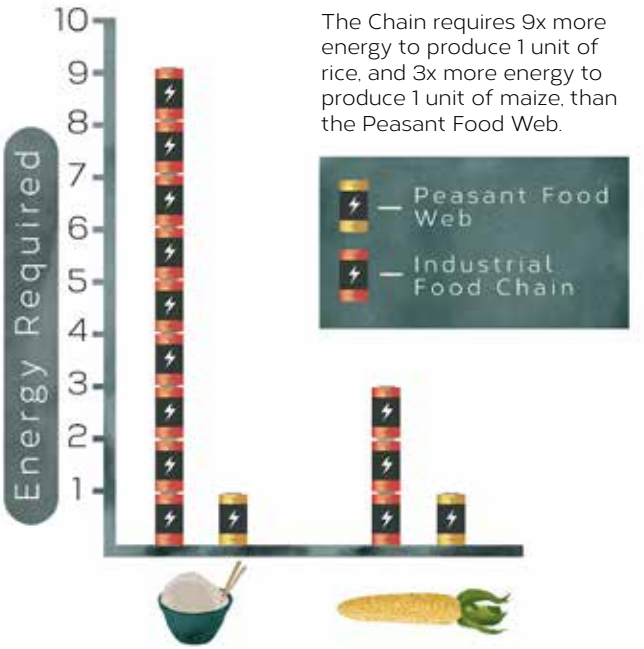
Agriculture uses 70% of the world's freshwater withdrawals[148] but the Chain soaks up most of it through irrigation, livestock and processing. 1/3 of major aquifers are distressed and approximately 2/3 are being depleted.[149] Livestock production alone accounts for 27% of our water use.[150] The Chain's focus on meat means producing animal calories that need 5 times more water than calories from vegetables.[151] **Coca-Cola's water footprint (direct and indirect) is sufficient to meet the personal needs of 2 billion people**.[152]

The globalization of food systems means that the food we eat uses water from someone else's country (e.g. **75% of UK food-related water use is extraterritorial**.[153])

15. Who needs more fossil carbon?

The Web uses 9 times less energy than the Chain to produce the same 1kg of rice, and 3 times less for maize.[154] Overall, the Chain requires 10 kcal of energy to produce 1 kcal of food energy while peasants spend 4 kcal energy to produce 1 kcal of food energy.[155]

Despite climate change, the Chain continues to use 3–5% of the world's annual natural gas supply to manufacture synthetic fertilizers.[156] 62 litres of fossil fuel are used in producing and distributing nitrogen fertilizers (per ha).[157] 50% of the energy the Chain uses to grow wheat is to manufacture the crop's fertilizers and pesticides.[158] **The average American uses 2000L of oil equivalents p/a to put food on the table.**[159]



The Chain requires 9x more energy to produce 1 unit of rice, and 3x more energy to produce 1 unit of maize, than the Peasant Food Web.

16. Who "processes" and who "preserves" food?

"Preserving" is a strategy to survive lean times. **Indigenous Peoples invented virtually every known method of preservation** (drying, smoking, salting, pickling, fermenting and freezing) long before the Chain invented vacuum sealing. Peasants and Indigenous Peoples developed more than 117 fermentation strategies that secured important vitamins and minerals.[160,161] At least 2 billion people in the South depend on artisanal processing.[162]

The Chain's goal is not to "preserve" but to "process" foods into more profitable packages. Processed foods make up 75% of Chain sales,[163] a 92% jump to $2.2 trillion p/a since 2002.[164]

3000 food additives are used by US processors today, compared to 704 additives 60 years ago.[165] These additives don't stop killing microbes when we eat them and could be contributing to additional gastro-intestinal problems. Nanoparticles such as titanium dioxide, silicon oxide and zinc oxide are added to hundreds of processed foods and consumed in growing amounts without adequate safety regulations.[166,167] Commercial processing not only undermines local markets, but also reduces diversity and encourages unhealthy eating, contributing to obesity.

Commercial processing also leads to pollution: an estimated 8 million tonnes of plastic leaks into the ocean p/a,[168] about 1/3 of which is discarded by the Chain.[169] **If unabated, by 2050 the ocean will contain more plastic than fish by weight.**[170]

17. Where is the waste?

Food loss in the Web is a significant problem. **In the world's most impoverished regions (sub-Saharan Africa and South Asia), 6–11 kg of food per person p/a is wasted at the household level**.[171] Beyond the household in these regions, 120–150 kg is lost per person p/a in other parts of the Web.[172] Minimal investments in improved storage and transport could cut these losses deeply and immediately. While this food is lost to humans, at least a portion is spread back into the soil or fed to livestock.

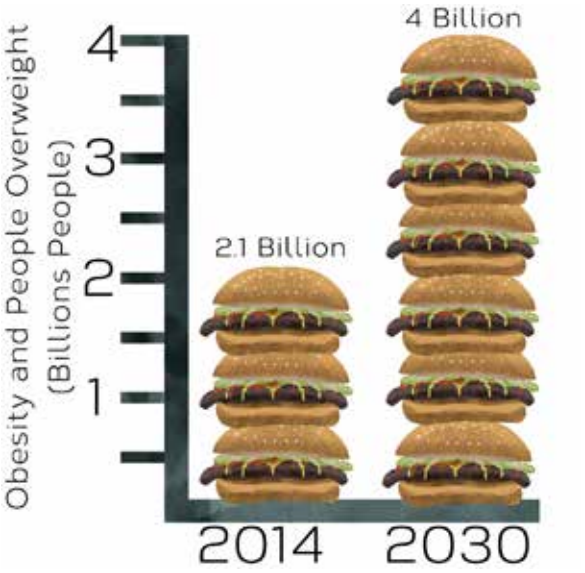
Waste in the Chain is serious and inexcusable. Less than 5% of the Chain's agricultural R&D addresses post-harvest losses.[173] **Of the 4 billion tonnes of food the Chain produces p/a, 33–50% is wasted along the Chain**,[174] costing consumers $2.49 trillion p/a.[175] The average American or European wastes 280–300 kg of food annually.[176] In the US alone, 350 million barrels of oil and 40 trillion litres of water p/a are wasted producing food that is never eaten.[177]

The Chain takes pride in its efficiency, but concedes that only 1/2 of its synthetic fertilizers (and even less of its pesticides) reach the crop at one end of the Chain[178] and that barely 1/2 of its food is consumed at the other end.[179]

18. Do we need all the "food" we consume?

Because of subsidies that lead to oversupply,[180] the Chain produces more food than is needed for healthy nutrition, and a lot of food that is unhealthy or harmful to eat, making 30% of the world obese or overweight (more than are hungry). For example, **Americans eat 25% more than they need**.[181] If everyone in the world ate as much as the average American, it would be like adding 1 billion extra mouths to feed.[182] In OECD countries, obesity cuts life expectancy by approximately 10 years – roughly the same impact as smoking.[183] The impacts of obesity cost $2 trillion p/a globally.[184]

The Chain will contribute to a predicted doubling of the number of people who are overweight or obese, up to 4 billion by 2030,[185] and a 50% increase in the number of people with diabetes by 2040.[186]



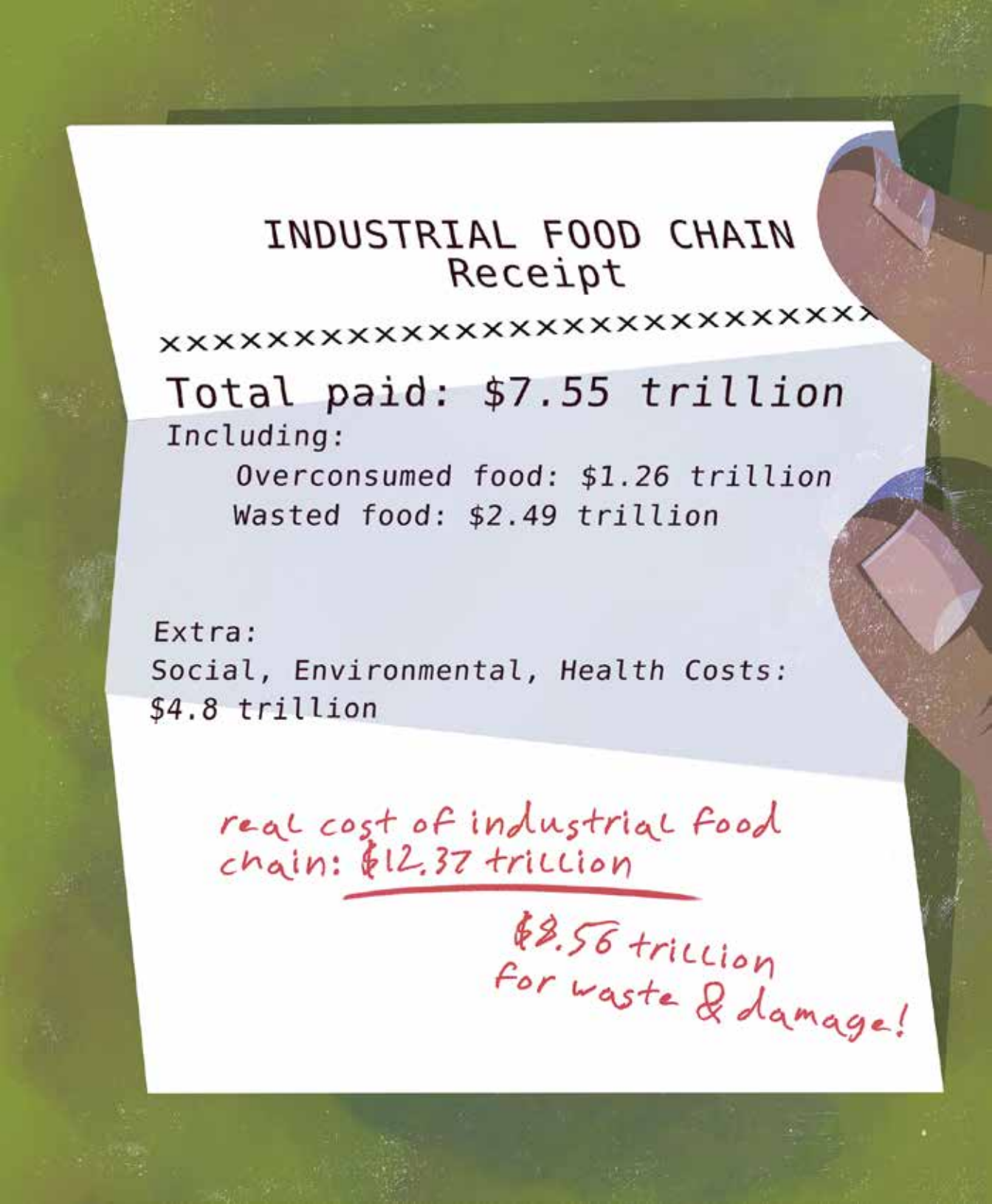
19. What does the Chain cost?

For every $1 global consumers pay to the Chain, we incur $2 of costs for managing the Chain's destruction: the "field-to-fork" waste of food we never eat (about 33% of the Chain's total production) as well as the cost involved in the food we overeat (about 17% of the Chain's total production[187]). The Chain's total cost includes not only the direct bill to consumers, but also the indirect costs to governments and society for health and environmental damages (which equal more than 1/2 of the Chain's direct food bill). Additionally, 75% of the Chain's food is processed, and of dubious value.[188] We could save people, our climate and trillions of dollars by supporting the Web.

Here is the math:
The direct food bill paid annually by consumers is **$7.55 trillion**.[189] The direct food bill includes **$2.49 trillion** lost or wasted along the Chain[190] and the **$1.26 trillion** price tag for overconsumption,[191] which together total **$3.75 trillion** (or 50%) of the direct bill paid for food.[192] Beyond the direct food bill, there is an additional **$4.8 trillion** indirect cost for social, health and environmental damages caused by the Chain,[193] which brings the true global bill to **$12.37 trillion**.[194] The cost of waste, overconsumption and indirect damages incurred by the Chain amounts to **$8.56 trillion**,[195] meaning 69% of the Chain's total cost is counter-productive. For comparison, **the Chain's real total cost equals 5 times the world's annual military expenditure.**[196] All this to feed 30% of humanity.

Still, these figures don't consider the catastrophic risk of epidemic zoonoses: diseases transmitted from diverse (including wild) animals to domesticated (genetically-uniform) livestock or transmitted in foods According to UNEP, if a global epidemic arises it could cost trillions.[197]

What Does The Chain Cost?


INDUSTRIAL FOOD CHAIN
Receipt
xxxxxxxxxxxxxxxxxxxxxxxxxxxx
Total paid: $7.55 trillion
Including:
Overconsumed food: $1.26 trillion
Wasted food: $2.49 trillion
Extra:
Social, Environmental, Health Costs:
$4.8 trillion
real cost of industrial food chain: $12.37 trillion
$8.56 trillion for waste & damage!

BOX 2: AGRICULTURE'S GHG EMISSIONS

The problem: From field to fork, agriculture is responsible for 44–57% of all GHG emissions,[198] 1/3 of which is attributed to livestock production.[199] Agricultural emissions are expected to increase 35% by 2050 – even as the world calls for a massive GHG cut.[200] Since the Chain commands more than 75% of the land, uses most of the farm machinery, fertilizers and pesticides and produces most of the meat (a meat-oriented diet has nearly double the emissions of a vegetarian diet),[201] it's fair to estimate that **the Chain is responsible for 85–90% of all agricultural emissions.** This estimate includes ocean trawlers that receive fuel subsidies to release 1 billion tonnes of CO_2 every year,[202] while smaller vessels can harvest the same amount of fish with 1/5 of the fuel.[203]

The solutions: Prioritizing peasant food production and reducing meat consumption would be big steps in the right direction. (1) The Web safeguards the culture and practices that nurture the land, water, livestock breeds and microbial diversity to reduce emissions while providing a plant-based healthy diet. (2) If the global population were to cut meat consumption by 1/2 compared to "business as usual" this alone would reduce the world's total GHG emissions by 10% and lower CO_2 atmospheric concentration by 30ppm, keeping the CO_2 level below 420ppm by 2050.[204,205]

20. Who encourages cultural diversity?

Indigenous Peoples discovered, protected or domesticated, and bred and nurtured every food species we use. The Web sees cultural diversity (different ways of knowing) as inherent to agriculture and in ensuring environmental sustainability. Cultural values influence production, consumption and our respect for Earth. As an economic strategy, diversity ensures more variety and possibilities of having enough to eat at all times than the uniformity demanded by the Chain.

The Chain regards cultural diversity as an obstacle to market monopoly, by dismissing the thousands of diverse ways of related to the Earth, it also contributes to the expected loss of 3,500 of the world's 7,000 languages (and cultures) in the 21st century.[206] Food and environmental security is threatened when **1/3 of South American soils are occupied by no one speaking an indigenous language capable of accessing the indigenous knowledge of the land**.[207] As men learn the language of the conqueror, women's intimate knowledge of flora, fauna and food disappears. **Pachamama could help us if it weren't for macho papas.**

Monoculture food systems disconnect consumers from peasants and land, changing our food choices and customs and accelerating the loss of diversity.[208] The Chain homogenizes modes of life, production and consumption even though our climates, living conditions and livelihoods make new and different nutritional demands on our bodies.[209] **For all the talk of Big Data and Artificial Intelligence, our generation may be the first in history to lose more life-supporting knowledge than it gains.**

21. Who protects livelihoods and Human Rights?

Around the world, organic farms provide 30% more livelihoods than Chain farms. In general, organic farm labour achieves higher returns per worker.[210] More than 2.6 billion livelihoods worldwide are derived from farming, fishing and pastoralism[211] and at least 2/3 of households in the Global South (often led by women) grow some food.[212]

The Chain respects neither livelihoods nor Human Rights:

- The Chain has wiped out most family farms in industrialized countries to focus on so-called "modern" farms that employ 50 million workers,[213] while driving rural families to cities.
- The Chain has exposed the remaining peasants and plantation workers to health risks from machinery and pesticides. Pesticides poison 3 million people p/a, leading to 220,000 deaths p/a.[214]
- Robots are eliminating agricultural workers – 1 out of every 3 bowls of rice eaten in Japan is already sprayed by drones,[215] and driverless tractors and combines are expected in rice paddies and fields in the early 2020s.[216]
- 52% of US fast food workers rely on food stamps. Allowing such low wages is an indirect subsidy of $7 billion p/a to the Chain.[217]

The Chain's labour practices violate Human Rights, including cases of slavery (e.g. Brazilian sugarcane production and shrimp aquaculture in Thailand and Bangladesh),[218] and close to 100 million child labourers.[219] The ILO estimates that 60% of child labourers work in agriculture,[220] including on palm oil and sugarcane plantations in countries like India and the Philippines, and in cocoa farms in West Africa.[221,222] **Violence against peasants and workers is tragically escalating as people are being driven off their land and criminalized or killed for saving their seed and feeding their families.**

22. Who really innovates?

Oligopolies dominate almost every link in the Chain, and innovation is suffering. E.g. without condoning the Chain's use of pesticides, 70 new active pesticidal ingredients were developed in 2000 but only 28 in 2012. Since 1995, the cost of bringing a new pesticide to market has increased 88%.[223]

Why? It costs less to use PR to hype innovation than to spend on R&D. The agrichemical majors know **it is cheaper (by half) to adapt plants to chemicals than to adapt chemicals to crops**: $136 million to breed a GM plant in the USA; $286 million to market a new pesticide.[224]

History shows that people can adapt their food strategies quickly when necessary. In Silicon Valley terms, the key is "crowd-sourced diversity."

- Before modern transport and communication, African peasants adapted a new species, maize, to most of the continent's ecosystems in a century;
- Peasants in Papua New Guinea adapted sweet potatoes as food and forage from mangroves to mountaintops across 600 cultures, also in a century;
- In the 1800s, US farmers adapted a wheat variety from New York to the Midwest, across growing conditions comparable to those projected with climate change throughout the 21st century.[225]

23. Why aren't the Chain's assumptions challenged?

The presumption that the Chain is feeding the world, and must continue to do so, goes largely unchallenged because we are dependent upon the limited statistics and interpretations volunteered by agribusiness. **Even as we are told that "agribusiness as usual" is unstoppable, less and less information about the reality of markets and market share is made public.** Since the late 1970s, individual companies and industry analysts have grown more secretive. This is partly because business analysts are consolidating as data itself becomes more profitable and proprietary. But the scope of "proprietary business information" is widening because – at any price – companies want neither the public nor politicians to know what they know. As a result, policymakers accept that myths such as the 'inevitable' increases in meat and dairy consumption and the need for agricultural chemicals are unchallengeable, and watchdog organizations can't access data to disprove the myths.[226]

Further, **statisticians and investment analysts rarely talk to peasants.** So-called Big Data ignores the essential Little – or Local – Data: the holistic analysis used by the Web.

Government and industry data is unreliable: grossly underestimating the global marine catch by at least 25% and severely miscalculating deforestation caused by feed crops and livestock because 50-90% of tropical logging is conducted illegally.[227] Then, too, the Chain's biggest companies are routinely and increasingly fudging their figures. *The Economist* estimates that the gap between real profits and the optimistic results spun by company accounts is distorted by 20%.[228] **While a lot of miscalculation is due to the complex nature of food and food systems, the Chain benefits from the misinformation.**

24. What policy changes are needed?

Food Sovereignty through the Peasant Food Web is the basis for the world's food security, and supporting the Web is our only realistic choice in the face of climate change. **But 'peasants as usual' are not an option.** Agriculture is 12,000 years old. By the end of the century, we may face climatic conditions the world hasn't seen in 3 million years. Peasants will not be able to feed the world without major changes.

With the right policies, land and rights, peasant-led agroecological strategies could double or even triple rural employment,[229] substantially reduce the pressure for urban migration,[230] significantly improve nutritional quality[231] and availability and eliminate hunger while slashing agriculture's GHG emissions by more than 90%.[232]

For the billions of peasants in the Peasant Food Web to continue feeding themselves and others, policies are needed that would:

1. Ensure agrarian reform including the right to territories (land, water, forests, fishing, foraging, hunting),
2. Restore the right to freely save, plant, exchange, sell and breed seeds and livestock,
3. Remove regulations blocking local markets and diversity,
4. Reorient public R&D to respond to peasants' directions,[233]
5. Institute fair trade, determined by peasant-led policies,
6. Establish fair wages and working conditions for food and agricultural workers.

(i.e. Food Sovereignty)

Sources & Comments

Key Messages

1. See question 1 for more detail.
2. See question 4 for more detail.
3. See questions 19 and 20 for more detail.
4. Global military expenditure in 2014 was estimated at $1,776 billion.

   See Sam Perlo-Freeman, Aude Fleurant, Pieter D. Wezeman and Siemon T. Wezeman, *Trends in world military expenditure*, Stockholm International Peace Research Institute Fact Sheet, 2014.
5. See question 4 for more detail.
6. See questions 5, 6 and 7 for more detail.
7. See GRAIN report for a data set of over 400 global land grabs. GRAIN, "Grain releases data set with over 400 global land grabs", 23 February 2012.

1: Where do most people get their food?

8. The percentage of the world's population dependent on peasants is therefore between 62 and 75%.
9. Note that while we are using the 2017 world population estimate, we are contrasting the 2017 figure with other data that may be 5–10 years older, somewhat distorting percentages.

   United Nations, Department of Economic and Social Affairs, Population Division. *World Population Prospects: The 2015 Revision*, 2015. Custom data acquired via https://esa.un.org/unpd/wpp/DataQuery/
10. In developing countries, especially in rural areas, 2.7 billion people still rely on biomass (e.g., fuelwood, charcoal, agricultural waste and animal dung) for cooking.

    See IEA, "World Energy Outlook Special Report 2011," *International Energy Agency*, 2011, p. 45.
11. ETC Group estimate based on studies about Farm Cooperatives in Europe and North America. See Susanne Schlicht, Peter Volz, Philipp Weckenbrock and Thomas Le Gallic, "Community Supported Agriculture: An overview of characteristics, diffusion and political interaction in France, Germany, Belgium and Switzerland," *Acteaon, Die Agronauten, Urgenci*, 2012. (www.urgenci.net)
12. In a 1996 UNDP publication, authors Jac Smit, Joe Nasr and Annu Ratta estimated that 800 million people were engaged in urban and peri-urban agriculture. 20 years later, and after personal communication with one of the authors (Joe Nasr), ETC Group cannot find a reliable update of this estimate. However, considering the urban population increase from 2.6 to 3.9 billion since 1996, and the FAO estimate that 2/3 of urban households in developing countries are involved in urban agriculture, ETC uses the conservative figure of 1 billion urban farmers in this publication.

    See UNDP, *Urban agriculture: Food, Jobs and Sustainable Cities*, United Nations Development Program Publications Series for Habitat II, Vol. 1, UNDP, New York, 1996.

    FAO, "Urban and Peri-Urban Agriculture – A briefing guide for the successful implementation of Urban and Peri-Urban Agriculture in Developing Countries and Countries of Transition," 2001.
13. This estimate includes fishers, fish workers and sellers: TNI Agrarian Justice Programme, Masifundise, Afrika Kontakt and World Forum of Fisher People, "The Global Ocean Grab: a Primer," September 2014, p. 6.
14. Jan Douwe van der Ploeg often discusses short-term circularity: a constant flow of peasants between cities and rural areas. See Jan Douwe van der Ploeg and Jinghong Ye, *China's Peasant Agriculture and Rural Society – Changing Paradigms of farming*, EarthScan, Routledge, 2016, p. 28.

    See also Jan Douwe van der Ploeg, *The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization*, EarthScan, 2008.
15. Famine foods also often have more nutritional value than conventional foods. See William A. Dando, "Food and Famine in the 21st Century, Volume 1", ABC- CLIO, 2012, p. 196.

2: Who produces the most food?

16. Leah Samberg et al, "Subnational distribution of average farm size and smallholder contributions to global food production," Environmental Research Letters, 20 November 2016.
17. FAO, "Urban and Peri-Urban Agriculture," SPFS, DOC 27.8 Revision 2, Volume III, 2001, p. 25.
18. UNCHS, " The State of the World's Cities 2001," UN Centre for Human Settlements, Ch. 3, p. 72-73.
19. Peter Fellows and Martin Hilmi, "Selling Street and Snack Foods," Diversification Booklet no. 18, Rural Infrastructure and Agro-Industries Division, FAO, Rome, 2011.
20. The contribution small-scale fisheries make to global fish catches is subject to debate because there is a lack of good reporting, and no consensus on the definition of artisanal fisheries. In the information gathered, we conservatively estimate that a minimum of 25% of the global catch (in weight) can be attributed to small-scale fisheries, but this share could be as high as 50% as FAO's study suggests.

    FAO, *Voluntary Guideline for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*, Rome, 2015.

    Daniel Pauly and Dirk Zeller, "Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining," *Nature Communications 7*, Article number: 10244, 19 January 2016.

    Telephone Conversation with Dirk Zeller, UBC Professor and Senior Researcher and Project manager of the Sea Around Us, February 2016. (http://www.seaaroundus.org)
21. 23% (in energy content) of the food produced for human consumption is traded internationally, 80% of which is for 15 products: wheat, soybean, palm oil, maize, sugar, rape and mustard seed and oil, rice, soybean oil, pig meat, sunflower seed oil, barley, cocoa beans, oil crops, poultry meat.

    See Jennifer Clapp, "Food self-sufficiency and international trade: a false dichotomy?" *The State of Agricultural Commodity Markets In Depth 2015-16*, Food and Agriculture Organization of the UN (FAO), 2016, p. 6.

    See also, Fader et al. "Spatial decoupling of agricultural production and consumption: quantifying dependences of countries on food imports due to domestic land and water constraints," *Environmental Research Letters*, March 2013, p. 15.
22. ETC Group, *Who Will Feed Us? Questions about the food and climate crises*, ETC Communique 102, 2009. Available online at http://www.etcgroup.org/content/who-will-feed-us

    ETC Group, *Who Will Feed Us? The Industrial Food Chain or the Peasant Food Web?*, Booklet, 2014. Available online at http://www.etcgroup.org/content/who-will-feed-us-0
23. The confusion over figures arises for a number of legitimate reasons: (1) researchers focus on crops and under-emphasize fishing, hunting and gathering and urban production; (2) researchers consider only the major food crops, ignoring other essential and nutritious crops that cover less land area and/or have little commercial value; (3) there is confusion in determining the amount of land that may be held by peasants. A peasant family may have 10 ha on a semi-arid hillside or 2 ha on better soils and slopes; (4) researchers tend to underestimate the food that is wasted or over-consumed by the Chain.

3: What happens to all the food produced by the Chain?

24. Globally, it is estimated that 36% of food crop calories to go livestock feed, but this is largely represented by the Industrial Food Chain: for example, in India, only 6% of the crop calories go to feed and 89% go directly to feed people. In contrast, in the USA, 67% of the crop calories go to feed livestock and only 27% feed humans directly. Based on these figures, ETC estimates half of the Chain's crop calories go to livestock.

    See Emily S Cassidy, Paul C West, James S Gerber and Jonathan A Foley, "Redefining agricultural yields: from tonnes to people nourished per hectare," *Environmental Research Letters* 8, 2013.
25. Global crop calories' allocation to biofuels and other industrial uses is estimated at 9% (in calories) and we assume that almost all of it is linked to the Chain.

    See Emily S Cassidy, Paul C West, James S Gerber and Jonathan A Foley, "Redefining agricultural yields: from tonnes to people nourished per hectare," *Environmental Research Letters 8*, 2013.
26. World average losses in transportation, storage and in processing are estimated at 15% (cal/cal) or 23% (wet g/wet g). The Chain is more responsible than the Web, and we consider this to be a fair but conservative estimate.

    See Peter Alexander, Calum Brown, Almut Arneth, John Finnigan, Dominic Moran and Mark D.A. Rounsevell, "Losses, inefficiencies and waste in the global food system," *Agricultural Systems 153*, p. 190-200, Table 1.

27. Households waste 24% of the Chain calories purchased – or 8% of the total crop calories produced.

Buzby, Jean C., Hodan F. Wells, and Jeffrey Hyman, "The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States", EIB-121, U.S. Department of Agriculture, Economic Research Service, February 2014. p.18.

28. Philip J. Cafaro et al., "American Food Overconsumption, Obesity and Biodiversity Loss," *Journal of Agricultural and Environmental Ethics*, vol. 19, 2006, p. 542.

29. If a daily energy requirement of 2342 kcal/person is assumed, the excess intake of 198 kcal/person (from 2540kcal/person available) is attributed to over-consumption – 8% of food eaten which represents 2% of the total crop calories produced.

Buzby, Jean C., Hodan F. Wells, and Jeffrey Hyman, "The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States", EIB-121, U.S. Department of Agriculture, Economic Research Service, February 2014. p.18

30. Plant and animal parts discarded in one culture are prized in another. Nutritionists insist that some classes and cultures dangerously over-consume meat and dairy products as well as carbohydrates.

4: Who is using up our agricultural resources?

31. GRAIN, "Hungry for land: Small farmers feed the world with less than a quarter of all farmland," May 2014.

32. 2 billion people are considered malnourished with micronutrient deficiencies. See WHO, "Nutrition: Micronutirent deficiencies," World Heath Organization, 2017.

33. Both here and in Question 12 when ETC discusses the share of agriculture's GHG emissions, fossil carbon, and water used by the Chain versus the Web, it is our educated best guess.

With respect to the use of fossil carbons and GHG emissions, given that: most peasants have limited or no access to farm machinery; that they use small amounts of synthetic fertilizer; and that their production is unprocessed and marketed locally, it is difficult to imagine that they are responsible for anything more than a small percentage of global agricultural resource demand. And, conversely, recognizing the heavy use of synthetic fertilizers, machinery, processing and long-distance transportation involved in the Chain's production, our estimate is conservative.

Likewise, with respect to water use, the heavy demand placed on water because of intensive livestock and dairy production, and the huge demand of food and beverage companies, suggests that the vast majority of agriculture's water is used by the Chain (see question 14). Considering that Coca-Cola alone – from irrigated crops, to the water content in soft drinks, to cooling and cleaning equipment, uses as much water as 2 billion people use to meet their sanitary requirements, our estimate is modest.

Still, that we cannot be precise about this indicates another gap in the world's knowledge of our food systems.

34. GRAIN, "Hungry for land: Small farmers feed the world with less than a quarter of all farmland," May 2014.

35. This is considered a conservative value: soil scientists have reported 12.1 billion tons of soil lost in India and China alone, which represents 13% of world's area. See David Pimentel, "Soil Erosion: A Food and Environmental Threat," *Environment, Development and Sustainability*, vol. 8, 2006, p. 123.

36. This is the estimated yearly loss of forest and other wooded areas between 2000 and 2010. See FAO, *Global Forest Resources Assessment 2015*, Rome, 2015, p. 9-20.

37. See Box 2: "Agriculture's GHG emissions"

38. See question 19, "What does the Chain cost?"

39. 2 billion people are considered malnourished with micronutrient deficiencies.

See WHO, "Nutrition: Micronutirent deficiencies," World Health Organization, 2017.

And 1.9 billion people in the world are overweight or obese, which is also a form of malnutrition.

See WHO, "Obesity and overweight," World Health Organization, 2017.

Box 1: Agroecology vs. Agribusiness

40. Peter Rosset, "On the Benefits of Small Farms," Food First, 1999.

41. Many examples of agroecological practices are given throughout the text. For a more comprehensive guide on Agroecology see: IPES Food. "From Uniformity to Diversity: A paradigm shift from industrial agriculture to diversified agroecological systems," International Panel of Experts on Sustainable Food Systems, June 2016.

42. FAO, "Centrepiece," in *Ceres No. 154 – The Green Revolution Revisited: new seeds, new strategies*. Ch 2. FAO, Rome, 1995.

43. Deepak K. Ray, Navin Ramankutty, Nathaniel D. Mueller, Paul C. West and Jonathan A. Foley," Recent patterns of crop yield growth and stagnation", *Nature Communications*, 18 December 2012, p. 5.

44. A. J. Ulltrup, "The impacts of the southern leaf corn blight epidemics of 1970-1971," *Annual Reviews*, 1972.

45. Christy Chamy, "Wheat rust: the fungal disease that threatens to destry the world crop," *The Independent*, 19 April 2014.

46. FAO, "Fight against Black Sigatoka must continue to save small Caribbean banana farms," FAO, Rome, 12 December 2013.

47. M.A. Khan, H. Hibino, V. M. Aguiero and R.D. Daquiag, "Rice and Weed Hosts of Rice Tungro-Associated Viruses and Leafhopper Vectors," International Rice Research Institute, Manila, 1991.

48. The History Place, "Irish Potato Famine," www.HistoryPlace.com, accessed December 2016.

49. Figure for 2008. See Carl E. Pary and Keith O. Fuglie, "Agricultural Research by the Private Sector," *Annual Reviews of Resource Economics*, 2015, Table 1.

50. ETC Group's estimate based on conversations with practitioners and experts.

5: Who breeds our food crops?

51. FAO, *The Second Report on The State of the World's Plant Genetic Resources for Food and Agriculture*. Commission on Genetic Resources for Food and Agriculture, FAO, Rome, 2010, p. 4.

    It is estimated that about 7.4 million accessions are currently maintained globally. However, only 25–30% of the total holdings (or 1.9–2.2 million accessions) are distinct. In the same chapter of this report, FAO advises that the Consultative Group on International Agricultural Research (CGIAR) and Asian Vegetable Research and Development Centre (AVRDC) gene banks collectively have 3,446 species in storage, but this includes an undetermined number of wild species.

52. Prof. José T. Esquinas-Alcazar (retired Executive Secretary to the FAO Commission on Genetic Resources for Food and Agriculture and the International Treaty on Plant Genetic Resources for Food and Agriculture) and others consistently estimate that peasants have domesticated 7,000 species based on their research and the data provided through the world's gene banks. However, this is a conservative estimate, with other publications estimating the number at 8,500. See, for example, Vandana Shiva, *Who Really Feeds the World? The Failures of Agribusiness and the Promise of Agroecology*, North Atlantic Books: Berkeley, 2016, p. 8.

53. CIAT, *Understanding Seed Systems Used by Small Farmers in Africa: Focus on Markets*, Practice Brief 6, 2014, p. 1.

54. La Via Campesina, *Our Seeds, Our Future*, Notebook No.6, 2013.

55. "In the hierarchy of biological classification, [species] is the lowest taxonomic rank and is considered as the most basic unit of biological classification." A crop variety or a livestock breed is a variation inside the bigger group: e.g. dog being the species and golden retriever the variety. Mango being the species and 'Alice,' 'Ataulfo,' and 'Duncan' the varieties. A wild relative would be the ancestor of the species, its origin traceable to the very center of origin (Vavilov), and though not domesticated, is still member of the species and able to breed with the domesticated varieties.

    For more biological background see "Species," www.biology-online.org (webpage), Accessed 25 July 2017, available at http://www.biology-online.org/dictionary/Species.

56. Price Waterhouse Cooper estimated the value of crop wild relatives to the future production of the worlds' 33 major crops (the Millennium Seed Bank's 29 current priority crops, plus maize, soya bean and sugar cane) at $196 billion. See Richard Thompson, Stephen Aherne, Kieron Blakemore, Tetsuya Ogino, "Crop Wild Relatives: A valuable resource for crop development," *Price Waterhouse Cooper's Valuations*, July 2013.

57. Susan McCouch, et al. "Feeding the Future," *Nature 499*, 4 July 2013, p. 23-24.

58. Community Plant Variety Office, "CPVO statistics on 31/12/2016," CPVO, 2017.

59. (In terms of energy.) The 16 crops are: barley, cassava, groundnut, maize, millet, oil palm, potato, rapeseed, rice, rye, sorghum, soybean, sugar beet, sugar cane, sunflower and wheat. See West et al., "Leverage points for improving global food security and the environment," *Science*, 2014, p. 385.

60. K. O. Fuglie, P. W. Heisey, J. L. King, C. E. Pray, K. Day-Rubenstein, D. Schimmelpfennig, S. L. Wang and R.Karmarkar-Deshmukh, *Research Investments and Market Structure in the Food Processing, Agricultural Input, and Biofuel Industries Worldwide*, USDA, Economic Research Report No. 130, December 2011, p. 39.

61. Phillips McDougall Consultancy, "The cost and time involved in the discovery, development and authorization of a new plant biotechnology-derived trait," A Consultancy Study for CropLife International, September 2011, p. 14.

62. D.I. Jarvis, B. Sthapit and L. Sears (eds.), *Conserving agricultural biodiversity in situ: A scientific basis for sustainable agriculture*, International Plant Genetic Resources Institute, Rome, 2000. See specifically Chapter VII, "Seed supply systems: data collection and analysis."

See also CIAT, "Understanding Seed Systems Used by Small Farmers in Africa: Focus on Markets," Practice Brief 6.

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63. FAO Commission on Genetic Resources for Food and Agriculture, "The Use and Exchange of Animal Genetic Resources for Food and Agriculture," Background Study Paper No. 43, July 2009, p. 4.

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64. B.D. Scherf and D. Piling, *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*, FAO, 2015, p. 30.

65. Rebecca J.H. Woods, *The Herd Shot Around the World: native breeds and the British Empire*, 1800-1900, PhD thesis, 2011.

66. FAO, "Invisible Guardians – Women manage livestock diversity," FAO Animal Production and Health Paper, No. 174, Rome, 2012.

See also: Helena Paul, Stella Semino, Antje Lorch, Bente Hessellund Andersen, Susanne Gura and Almuth Ernsting, "Agriculture and climate change: Real problems, false solutions," Bonn Climate Change Talks, 2009, p. 29.

67. M. Herrero, D. Grace, J. Njuki, N. Johnson, D. Enahoro, S. Silvestri, M.C. Rufino, "The roles of livestock in developing countries," *Animal 7* (s1), 2013, p. 3-18.

68. FAO, "Invisible Guardians – Women manage livestock diversity," FAO Animal Production and Health Paper, No. 174, Rome, 2012, p. 6.

69. FAO Commission on Genetic Resources for Food and Agriculture, "The Use and Exchange of Animal Genetic Resources for Food and Agriculture," Background Study Paper No. 43, July 2009.

70. EW Group, Hendrix/ISA, Groupe Grimaud (Hubbard) and Tyson (Cobb-Vantress) control 90% of layer and broiler genetics.

See Steven Leeson and John D. Summer, *Broiler* Breeder Production, Nottingham University Press, 2000. See also the USDA's Foreign Animal Disease Preparedness and Response Plan.

71. ETC Group, based on annual reports and company Websites; Intrafish 150, 2014.

72. TNI Agrarian Justice Programme, Masifundise, Afrika Kontakt and World Forum of Fisher People, "The Global Ocean Grab: a Primer," September 2014.

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73. The Rendille camel breed of Kenya can survive up to 14 days without water and the Chameau du Kanem and Gorane camel breeds of Chad are adapted to consuming salt water.

See SLRK, "People Profile: The Rendille of Kenya," *Strategy Leader Resource Kit*, 12 August 2015, accessed 8 March 2017.

See also IPES-Food, "Too Big to Feed: Concentration in the Agri-food Industry" (Working title), International Panel of Experts on Sustainable Food Systems, Thematic Report 3. *Unpublished Report to be released in 2017.*

74. Raymond Auerbach, Gunnar Rundgren, and Nadia El-Hage Scialabba (Eds), "Organic Agriculture: African Experiences in Resilience and Sustainability," Natural Resources Management and Environment Department, FAO, Rome, May 2013, p. 77.

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76. UNEP, *UNEP Frontiers 2016 Report – Emerging Issues of Environmental Concern*. United Nations Environment Programme, Nairobi, 2016, p. 18.

77. Charles Clover and Clive Cookson, "Science: The clone factory," *The Financial Times*, 27 November 2015.

78. The EU banned the use of antibiotics as a growth promoter in 2006. European Commission, "Ban on antibiotics as growth promoters in animal feed enters into effect," Press Release, 22 December 2005.

79. Food and Drug Administration (USA), *2014 Summary Report on Antimicrobial Sold or Distributed for Use in Food-Producing Animals*, December 2015, Table 9, p. 40.

80. US Department of Health and Human Services, *Antibiotic Resistance Threats in the United States: 2013*, Centers for Disease Control and Prevention, 2013.

Antibiotic resistance costs EU countries $1.6 billion p/a. See European Center for Disease and Prevention Control (ECDC), *EU action on Antimicrobial Resistance*, Brussels, January 2012.

81. Peter S. Jorgensen et al, "Use antimicrobials wisely," *Nature*, 537, 8 September 2016.

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83. Sam Fujisaka, David Williams and Michael Halewood, *The impact of climate change on countries' interdependence on genetic resources for food and agriculture*, FAO Commission on Genetic Resources for Food and Agriculture, Background Study Paper No. 48, 2011, p. 49.

84. The Global Marine Species Assessment (GMSA) provides an extinction risk assessment of 20,000 marine species. IUCN, "Marine Biodiversity Unit: Global Marine Species Assessment, 2015 Overview," *International Union for Conservation of Nature*, 2015, p. 5.

85. The contribution of small-scale fisheries to global fish catches is debated because there is a lack of good reporting, and no consensus on the definition of artisanal fisheries. In the information gathered, we conservatively estimate that a minimum of 25% of global catch (in weight) can attributed to small-scale fisheries but this share could be as high as 50% as FAO's study suggests.

FAO, *Voluntary Guideline for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*, FAO, Rome, 2015.

Daniel Pauly and Dirk Zeller, "Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining," *Nature Communications 7*, 19 January 2016.

Telephone Conversation with Dirk Zeller, UBC Professor and Senior Researcher and project manager of *Sea Around Us*, February 2016. (http://www.seaaroundus.org)

86. FAO, *The State of World Fisheries and Aquaculture (SOFIA)*, FAO, Rome, 2014, p. 31.

87. WWF, "Living Blue Planet: Crisis in global oceans as populations of marine species halve in size since 1970," World Wildlife Fund, 2015.

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See FAO, "Urban and Peri-Urban Agriculture," SPFS, DOC 27.8 Revision 2, Volume III, 2001.

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109. Sales figures for 2014. See ETC Group, "Breaking Bad: Big Ag Mega-Mergers in Play, Dow + DuPont in the Pocket? Next: Demonsanto?" Communiqué 115, December 2015.

110. The Economist, "Agricultural suppliers – Controversial hybrids," *The Economist*, 27 August 2015. Electronic edition.

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113. See IEA, "World Energy Outlook Special Report 2011," *International Energy Agency*, 2011, p. 45.

114. Caleb Stevens, Robert Winterbottom, Katie Reytar and Jenny Springer, *Securing Rights, Combating Climate Change – How Strengthening Community Forest Rights Mitigates Climate Change*, World Resources Institute and the Rights and Resources Initiative, Washington D.C., 2014, p. 2.

115. FAO Commission on Genetic Resources for Food and Agriculture, *Report of the second session of the intergovernmental technical working group on forest genetic resources*, CGRFA-14/13/10, Rome, 23-25 January 2013, p. 7-8.

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See Caleb Stevens, Robert Winterbottom, Katie Reytar and Jenny Springer, *Securing Rights, Combating Climate Change – How Strengthening Community Forest Rights Mitigates Climate Change*, World Resources Institute and the Rights and Resources Initiative, Washington D.C., 2014, p. 24-30

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A. Fonseca, C. Jr. Souza and A. Veríssimo, "Deforestation report for the Brazilian Amazon," SAD, Belém, Imazon, August 2014, p. 10.

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124. Personal communication between Pat Mooney, ETC Group, and the vice-president of Yara International, a fertilizer producer, in Oslo in 2007.

125. S. Fujisaka, D. Williams and M. Halewood, "The impact of climate change on countries' interdependence on genetic resources for food and agriculture," FAO Commission on Plant Genetic Resources for Food and Agriculture, Background Study Paper No. 48, April 2011, p. 39.

126. Pete Smith and Mercedes Bustamante et al, "Agriculture, Forestry and Other Land Use (AFOLU)," IPCC, WG3, AR5, Chapter 11, 2014, p. 824.

127. H. Eswaran, R. Lal and P.F. Reich, "Land Degradation: An overview" in E. M. Bridges, I.D. Hannan, L.R. Oldeman, F.W.T. Pening de Vries, S.J. Scherr, and S. Sompatpanit (eds), *Responses to Land Degradation. Proc. 2nd. International Conference on Land Degradation and Desertification*, Khon Kaen, Thailand, Oxford Press: New Delhi, 2001.

128. GRAIN, "Hungry for Land – Small farmers feed the world with less than a quarter of all farmland," May 2014.

129. The environmental damage caused by fertilizer use (ammonia emissions; decrease in water quality due to Nitrogen and Phosphorous eutrophication and nitrate contamination; and biodiversity loss due to Nitrogen and Phosphorous eutrophication) amounts to $97.89/ha/year. Considering an estimated 3.76 billion ha of agricultural land where fertilizer is used, we obtain a total cost of $368.56 billion.

For cost of environment damage, see FAO, "Full-Cost Accounting of Food Wastage: The Hidden Costs," 2014. p. 35.

For estimation of land occupied by industrial-type farming, see GRAIN, "Hungry for land. Small farmers feed the world with less than a quarter of all farmland," May 2014.

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131. FAO, "World Food Summit - Towards a New Green Revolution," FAO, 2006.

132. Considering the full Chain, on average 80% of Nitrogen and 25-75% of Phosphorous consumed end up lost in production, but remain in the environment.

See Mark Sutton et al., *Our Nutrient World: The challenge to produce more food and energy with less pollution*, Global Overview of Nutrient Management. Centre for Ecology and Hydrology, Edinburgh on behalf of the Global Partnership on Nutrient Management and the International Nitrogen Initiative, 2013, p. 19.

133. Mark Sutton et al., *Our Nutrient World: The challenge to produce more food and energy with less pollution*. Global Overview of Nutrient Management, Centre for Ecology and Hydrology, Edinburgh on behalf of the Global Partnership on Nutrient Management and the International Nitrogen Initiative, 2013, p.31

The share of fertilizer used for livestock production is about 85% in Europe.

See also Mark Sutton, "Too much of a good thing," Nature, Vol. 472, 14 April 2011, p. 159.

134. Up to 2,700 Mha of pasture and 100 Mha of cropland could be freed for other purposes in a transition from meat-based diet to vegetarian or low-meat diets.

See Elke Stehfest, Lex Bouwman, Detlef P. van Vuuren, Michel G. J. den Elzen, Bas Eickhout and Pavel Kabat, "Climate Benefits of changing diet," *Climatic Change*, Vol. 95, Issue 1-2, 2009, p. 83-102.

See also Institution of Mechanical Engineers, *Global Food: Waste Not, Want Not*, January 2013, p. 10. This research document uses 78% of agricultural land for livestock.

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In the previous edition of this report, we stated that "meat and dairy production would rise 70% by 2030" but that figure is the projection to 2050.

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CBD, *Implications of the IPBES assessment on pollinators, pollination and food production for the work of the Convention*, Convention on Biological Diversity, April 2016.

137. USDA Agricultural Research Service, *Honey Bees and Colony Collapse*, 7 May 2013.

138. CBD, *Implications of the IPBES assessment on pollinators, pollination and food production for the work of the Convention*, Convention on Biological Diversity, April 2016.

139. PANNA, "Pesticides and Honey Bees: State of the Science", Pesticide Action Network North America, May 2012.

140. Risa Ueta, Chihiro Abe, Takahito Watanabe, Shigeo S. Sugano, Ryosuke Ishiharam Hiroshi Ezura, Yuriko Osakabe and Keishi Osakabe, "Rapid breeding of parthenocarpic tomato plants using CRISPR-Cas9", *Scientific Reports 7*, Article number 507, 30 March 2017.

141. Vandana Shiva, Who Really Feeds the World?: The Failures of Agribusiness and the Promise of Agroecology, North Atlantic Books: Berkeley, p.33.

See also Anthony King, "Why a neonicotinoid ban isn't enough to protect the environment," New Scientist, 19 April 2017.

142. Mark Sutton, "Too much of a good thing," *Nature*, Vol 472, 14 April 2011, p. 159,

143. Michael R. Gillings and Ian T. Paulsen, "Microbiology of the Anthropocene," *Anthropocene*, Vol. 5, March 2014, p. 1-8. (See question 16 for more information.)

14: Who wastes our water?

144. "Water is the most life sustaining gift on Mother Earth and is the interconnection among all living beings. Water sustains us, flows between us, within us, and replenishes us." Assembly of First Nations, "Honouring Water," accessed 28 September 2016. http://www.afn.ca/en/honoring-water

145. Raymond Auerbach, Gunnar Rundgren and Nadia El-Hage Scialabba (Eds), *Organic Agriculture: African Experiences in Resilience and Sustainability*, Natural Resources Management and Environment Department, FAO, Rome, May 2013, p. 31.

146. IPES-Food, "From Uniformity to Diversity: A paradigm shift from industrial agriculture to diversified agroecological systems," International Panel of Experts on Sustainable Food Systems, June 2016, p. 35.

147. FAO, *Organic Agriculture and Food Security*, Meeting Report, FAO, 2007, p. 10.

148. United Nations World Water Development Report, *Water for a Sustainable World*, March 2015, p. 11.

149. UCI News, "A third of the world's biggest groundwater basins are in distress," University of California, Irvine, News Release, 16 June 2015.

150. Global animal production requires about 2,422 Gm^3/year, which is 27% of the global water footprint of humanity (9,087 Gm3/year [average for 1996-2005]).

See M. M. Mekonnen and Q.Y. Hoekstra, "The green, blue and grey water footprint of farm animals and animal products." Value of Water Research Report Series No.48, UNESCO-IHE, Delft, the Netherlands, 2010.

151. Arjen Y. Hoekstra, "The hidden water resource use behind meat and dairy," Twente Water Centre, University of Twente, the Netherlands, 2012.

152. Bartow J. Elmore, *Citizen Coke: The Making of Coca-Cola Capitalism*, WW Norton, November 2014.

153. Arjen Y. Hoekstra, "The hidden water resource use behind meat and dairy," Twente Water Centre, University of Twente, the Netherlands, 2012, p. 7.

15: Who needs more fossil carbon?

154. "This energy statistic does not account for the quantity of human effort used in developing countries for agriculture. In drawing conclusions, it is also important to consider the equity and

sustainability considerations when comparing energy use data."

FAO, *The Energy and Agriculture Nexus*, Environment Natural Resources Working Paper No. 4, FAO, Rome, 2000, Chapter 2, p. 16.

155. David Pimentel and Mario Giampietro, F*ood, Land, Population and the US Economy*, Carrying Capacity Network, Cornell University and Instituto Nazionale delli Nutrizione (Rome), 1994.

This includes packaging and all transport expenses but excludes household cooking. According to FAO, chemical agriculture uses 2 kcal of fossil energy to produce 1 kcal of food energy. See FAO, *Organic Agriculture's Contributions to Sustainability*, USDA Organic Farming Systems Research Conference, FAO, March 2013.

156. Institute for Mechanical Engineers, Global Food: Waste not, want not, January, 2013.

157. Ibid., p. 13

158. Ibid., p. 5. "In the modern industrialised agricultural process – which developing nations are moving towards in order to increase future yields – energy usage in the making and application of agrochemicals such as fertilisers and pesticides represents the single biggest component. Wheat production takes 50% of its energy input for these two items alone."

159. David Pimentel, Sean Williamson, Courtney E. Alexander, Omar Gonzalez-Pagan, Caitling Kontak and Steve E. Mulkey, "Reducing Energy Inputs in the US Food System," *Human Ecology*, 2008.

16: Who "processes" and who "preserves" food?

160. Michael Pollan, *Cooked: A Natural History of Transformation*, Penguin: New York, 2013.

161. K.H. Steinkraus, PhD "Fermentations in World Food Processing," *Comprehensive Reviews in Food Science and Food Safety*, Vol. 1, 2002, p. 23.

162. FAO Commission on Genetic Resources for Food and Agriculture, "Key Issues in Micro-Organisms and Invertebrates," Item 6 of the Provisional Agenda, 14th Regular Session, Rome, April 2013, p.6

163. Anand Grover, "Report of the Special Rapporteur on the right of everyone to the enjoyment of the highest attainable standard of physical and mental health – Unhealthy foods, non-communicable diseases and the right to health," UN General Assembly, A/HRC/26/31.

164. EUROMONITOR in The Economist, "Food for Thought: Food companies play an ambivalent part in the fight against flab," *The Economist*, December 2012.

165. Alissa Hamilton, *Squeezed – What you Don't Know About Orange Juice*, Yale University Press, 2009.

166. ETC Group, "The Big Downturn? Nanogeopolitics," ETC Group Communiqué #105, December 2010, Ottawa, Canada.

167. Alex Weir et al, "Titanium Dioxide Nanoparticles in Food and Personal Care Products," *Environmental Science & Technology*, January 2012.

168. World Economic Forum, *The New Plastics Economy: Rethinking the future of plastics*, January 2016.

169. 1/3 is a rough estimate based on data from OECD countries where the Chain dominates. It accounts both for food and beverage packaging as well as the plastic used for transportation of food products and fertilizers: 39% of the plastic market is for packaging, 69% of which is for food and beverages, i.e. 27% of the plastic production is for Industrial Food Chain packaging.

See StatCan, "Consumption of packaging products by manufacturing industries, portrait and trends," accessed 5 April 2016.

In addition, food products and fertilizers make up 32% of all road transportation, so the 14% of plastic purchased for the automobile industry is also related to the Chain. See French Ministry of Transportation, "Breakdown by nature of goods of the road transportation in France in 2001," Ministère Conférence L'énergie au quotidien, UPVD des transports 50, 13 January 2011.

170. World Economic Forum, *The New Plastics Economy: Rethinking the future of plastics*, January 2016.

17: Where is the waste?

171. FAO, "Global Food Losses and Food Waste: Extent, Causes and Prevention," Food and Agriculture Organization (FAO) and the Swedish Institute for Food and Biotechnology (SIK), Gothenburg and Rome, 2011, p. v.

172. Ibid.

173. UNEP, "Towards a Green Economy," UNEP, 2011, p.54.

174. Global food waste is estimated between 33–50% (in mass). The percentage seems smaller in caloric content, some references estimate around 25% (in calories).

See FAO, "Global Food Losses and Food Waste: Extent, Causes and Prevention," Food and Agriculture Organization (FAO) and the Swedish Institute for Food and Biotechnology (SIK), Gothenburg and Rome, 2011, p. v.

Dana Gunders, "Your Scraps Add Up: Reducing Food waste can save money and resources," Food Facts, Natural Resources Defense Council, 2012.

Jonathan Foley, "A Special Report: The Future of Food 2014," *National Geographic*, 2014, p. 20.

175. FAO, "Global Food Losses and Food Waste: Extent, Causes and Prevention," Food and Agriculture Organization (FAO) and the Swedish Institute for Food and Biotechnology (SIK), Gothenburg and Rome, 2011, p. v.

It is worth noting however that some studies point towards a larger percentage of food loss in developed countries – up to 40% of production. See Dana Gunders, "Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill," *Natural Resources Defense Council*, August 2012.

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177. UNEP, "Towards a Green Economy," UNEP, 2011, p. 19-20.

178. Mark Sutton, "Too much of a good thing," *Nature*, Vol. 472, 14 April 2011, p. 159.

179. See question 3 for more detail.

18: Do we need all the 'food' we consume?

180. Lisolette Shafer Elinder, "Obesity, Hunger, and Agriculture: The Damaging Role of Subsidies," *BMJ*, Vol. 331, 1333-1336, December 2005.

181. Philip J. Cafaro et al., "American Food Overconsumption, Obesity and Biodiversity Loss," *Journal of Agricultural and Environmental Ethics*, vol. 19, 2006, p. 542.

182. The Economist, "Food for Thought," *The Economist*, 15 December 2012.

183. OECD, "Obesity and the Economics of Prevention: Fit not Fat", OECD, 2010, p. 15.

184. Richard Dobbs et al, "Overcoming obesity: A initial economic analysis," *MGI*, November 2014.

185. Ibid.

186. International Diabetes Federation (IDF), "The Global Picture," in *IDF Diabetes Atlas Seventh Edition*, International Diabetes Federation, 2015, Ch. 7, p. 47-63.

19: What does the Chain cost?

187. It is estimated that 25% of the food eaten in the US is overconsumed. Here we have used that estimate for the overconsumption across the Chain. While we recognise that overconsumption is lower in other OECD compared to the US, we also need to consider the increase in calorie overconsumption in the Global South. Considering the 33% food waste, overconsumption represents 17% (25% of 100-33%) of the total food produced by the Chain (in weight).

See Philip J. Cafaro et al, "The Fat of the Land: Linking American Food Overconsumption, Obesity and Biodiversity Loss," Journal of Agricultural and Environmental Ethics, vol. 19, 2006, p. 542.

188. Anand Grover, "Report of the Special Rapporteur on the right of everyone to the enjoyment of the highest attainable standard of physical and mental health – Unhealthy foods, non-communicable diseases and the right to health," UN General Assembly, A/HRC/26/31.

189. 2014 figures. $7.55 trillion is the estimated total direct cost of global food, beverages and tobacco grocery spending projected for 2015 by Planet Retail GmbH chief economist. However, global expenditure in tobacco products is considered negligible. These estimates are based on studies in 211 markets and include not only large modern Chains but also traditional non-chain stores. However, using figures published by national statistics offices can show bias toward the modern urban scene.

190. ETC Group estimates that at least 33% of food in the Chain is lost or wasted during production, transportation, processing, and distribution and through household waste. Losses are included in the retail price.

See FAO, "Global Food Losses and Food Waste: Extent, Causes and Prevention," Food and Agriculture Organization (FAO) and the Swedish Institute for Food and Biotechnology (SIK), Gothenburg and Rome, 2011, p. v.

It is worth noting however that some studies point towards a larger percentage of food loss in developed countries – up to 40% of production.

See Dana Gunders, "Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill," Natural Resources Defense Council, August 2012.

191. $1.26 trillion represents 16.8% of the retail bill of $7.5 trillion. We estimate the food overconsumption at 25% of the food that is eaten.

See Philip J. Cafaro et al, "The Fat of the Land: Linking American Food Overconsumption, Obesity and Biodiversity Loss," *Journal of Agricultural and Environmental Ethics*, vol. 19, 2006, p. 542.

192. $3.75 trillion is the sum of $2.49 trillion (wasted) and $1.26 trillion (overconsumed) or 50% of the total retail bill of $7.55 trillion.

193. $4.80 trillion is the total of the $1.5 trillion cost of social, environmental and health damages caused by wasted food in the Chain; plus $590 billion in environmental costs of meat and dairy overconsumption; plus $2 trillion due to the economic impact of overeating; plus $736 billion in subsidies to agricultural producers in OECD countries. The $1.5 trillion indirect cost of food waste includes GHG emissions from production of food, disposal, deforestation and managed organic soil, water and land damages, biodiversity and livelihood loss, health impacts due to pesticides, conflicts due to water erosion and subsidies. See FAO, "Full-Cost Accounting of Food Wastage: The Hidden Costs," 2014, p. 6.

The $590 billion is calculated by analyzing the global environmental cost of livestock production estimated at $1.18 trillion. See FAO, "Natural Capital Impacts in Agriculture – Supporting Better Business Decision-Making," FAO, June 2015, p. 6.

Furthermore, Europeans consume 70% more protein than recommended and 40% more saturate fatty acids than recommended. See Weshoek et al, "The Protein Puzzle – The consumption and production of meat, dairy and fish in the European Union," PBL Netherlands Environmental Assessment Agency, the Hague, 2011.

Estimating that the Chain's consumers are eating an average of 50% more meat and dairy products than recommended, the environmental cost of the overconsumption of meat and dairy products is 50% of $1.18 trillion, or $590 billion.

The $2 trillion cost of the economic impact of obesity and overweight was estimated by McKinsey Global Initiative. Based in 2010 disability-adjusted life years (DALY), Global Burden of Disease database and 2012 economic indicators from the World Bank; including lost productivity due to disability and death, direct costs (health care) and direct investment to mitigate.

See Richard Dobbs et al , "Overcoming obesity: An initial economic analysis," *MGI*, November 2014.

The $736 billion in subsidies includes the Producer Support Estimate (PSE) of $601 billion plus $135 billion on general services that support the overall functioning of the sector. See OECD, "Agricultural Policy Monitoring and Evaluation 2015, Highlights," OECD, July 2015.

194. $12.37 trillion is the estimated total (direct and indirect) costs of the Industrial Food Chain including $7.55 trillion in retail charges plus $4.8 trillion in a variety of damages that must be borne by society.

195. $8.56 trillion is the total bill either wasted or harmful, including direct waste ($2.49 trillion); overconsumption ($1.26 trillion) and the indirect cost (hidden subsidies) in environmental, social and health damages ($4.8 trillion). This amounts to 69% of the $12.4 trillion direct and indirect industrial food bill.

196. Global military expenditure in 2014 was estimated at $1,776 billion.

See Sam Perlo-Freeman, Aude Fleurant, Pieter D. Wezeman and Siemon T. Wezeman, *Trends in world military expenditure*, Stockholm International Peace Research Institute Fact Sheet, 2014.

197. Michael R. Gillings and Ian T.Paulsen, "Microbology of the Anthropocene," *Anthropocene*, Vol. 5, March 2014, pp. 1-8.

Box 2: Agriculture's GHG emissions

198. GRAIN, "Food and Climate Change: The forgotten link," September 2011.

199. Based on a lifecycle assessment, FAO and Steinfeld et al (2006) estimate that the livestock sector emits 7.1 GT CO_2 eq/year, or about 18% of total global anthropogenic GHG emissions (which totals 38 GT CO_2 eq/year). To calculate the proportion of the Chain's GHG emission that relate to livestock production, we calculate that the Chain's GHG emissions are between :

$$44\% \times 38 \frac{GT\ CO_{2,eq}}{year} = 16.72\ \frac{GT\ CO_{2,eq}}{year}$$

and

$$57\% \times 38 \frac{GT\ CO_{2,eq}}{year} = 21.66\ \frac{GT\ CO_{2,eq}}{year}.$$

This represents between:

$$\frac{7.1\ GTCO_{2,eq}}{21.66\ GTCO_{2,eq}} = 31\%$$

and

$$\frac{7.1\ GTCO_{2,eq}}{16.71\ GTCO_{2,eq}} = 41\%$$

of the previously calculated GHG emissions attributed to the Chain. Taking into account estimates from different sources and the fluctuation of GHG emissions each year, we conservatively estimate that livestock production is responsible for at least 1/3 of the GHG emitted by the Industrial Food Chain.

See A.N. Hristov et al, "Mitigation of greenhouse gas emissions in livestock production – A review of technical options for non-CO2 emissions," FAO Animal Production and Health Paper No. 177. FAO, Rome, 2013, p. 18.

200. FAO STAT projects 6.317 GT in 2050 and 5.381 GT in 2030. FAOSTAT estimates are the most conservative compared to those of EPA and EDGAR. (www.fao.org/faostat accessed March 2017)

See IPCC, "Agriculture, Forestry and Land Use," Fifth Assessment Report, Ch. 11, Figure 11.4, 2015, p. 822.

201. Peter Scarborough, Paul N. Appleby, Anja Mizdrak, Adam B.M. Briggs, Ruth C. Travis, Kathryn E. Bradbury and Timothy J. Key, "Dietary greenhouse gas emission of meat-eaters, fish-eaters, vegetarians and vegans in the UK," *Climatic Change*, 125: 179–192, 11 June 2014.

202. See James W. Fourgureau et al., "Seagrass ecosystems as a globally significant carbon stock," *Nature Geoscience*, 20 May 2012.

The paper estimates that current rates of seagrass loss could result in the release of up to 299Tg of Carbon, or 299 million metric tonnes p/a. Since the molecular weight ratio of CO_2 to C is 44/12=3.67, we calculate that release to be equivalent to 299 x 3.67 of CO_2 or approx. 1 billion metric tonnes of CO_2 p/a.

203. John Driscoll and Peter Tyemers, "Fuel use and greenhouse gas emission implications of fisheries management: the case of New England atlantic herring fishery," *Marine Policy* 34, 353-359. 2010.

204. Daily amounts of beef, pork and poultry/eggs that are approximately 52%, 35% and 44%, respectively of the global average meat consumption in 2050 in the business-as-usual scenario.

See Walter C. Willett, *Eat, drink and be healthy: the Harvard Medical School guide to healthy eating*, Simon & Schuster, New York.

205. Reductions compared to the reference scenario. See Elke Stehfest, Lex Bouwman, Detlef P. van Vuuren, Michel G. J. den Elzen, Bas Eickhout and Pavel Kabat, "Climate Benefits of changing diet," *Climatic Change*, Vol. 95, Issue 1-2, p. 83-102.

20: Who encourages cultural diversity?

206. UNESCO, *UNESCO World Report: Investing in Cultural Diversity and Intercultural Dialogue*, Paris, 2009.

207. Pat Mooney, "The ETC Century: Erosion, Technological Transformation and Corporate Concentration in the 21st Century," *Development Dialogue*, Dag Hammarskjöld Foundation, 1999, p. 1-2.

208. Michael Pollan, *In Defense of Food: An Eater's Manifesto*, Penguin Books, 2009.

209. UNESCO, *UNESCO World Report: Investing in Cultural Diversity and Intercultural Dialogue*, Paris, 2009.

21: Who protects livelihoods and Human Rights?

210. FAO, "Organic Agriculture's Contributions to Sustainability," Crop Management. USDA Organic Farming Systems Research Conference, FAO, March 2013.

211. UNEP, Towards a Green Economy, United Nations, 2011, p. 38.

212. FAO, *Urban and Peri-urban Agriculture – A briefing guide for the successful implementation of Urban and Peri-urban Agriculture in Developing Countries and Countries of Transition*, Rome, July 2001, p.3.

213. Michel Pimbert, "Towards Food Sovereignty: Reclaiming autonomous food systems," International Institute for Environment and Development, 2009, p. 8.

214. FAO, *Organic Agriculture's Contributions to Sustainability*, USDA Organic Farming Systems Research Conference, FAO, March 2013.

215. Kana Inagaki, "Yamaha aims to unlock US and EU markets with agricultural drone," *Financial Times*, US edition, July 2015.

216. Leo Lewis, "Japan in race to build driverless tractor," The Financial Times, (online edition), 20 August 2017.

217. The cost of public assistance to families of workers in the fast-food industry is nearly $7 billion p/a. See Silvia A. Allegretto, Marc Doussard, Dave Graham-Squire, Ken Jacobs, Dan Thompson and Jeremy Thompson, "Fast-Food, Poverty Wages: The Public Cost of Low-Wage Jobs in the Fast-Food Industry," UC Berkeley Labor Center, 15 October 15, 2013.

218. Kate Hodal, Chris Kelly and Felicity Lawrence, "Revealed: Asian slave labour producing prawns for supermarkets in US, UK," *The Guardian*, 10 June 2014.

219. International Labour Organization, "Child Labour in agriculture," accessed March 2017.

220. Ibid, accessed April 2016.

221. Joe Sandler Clarke, "Child Labour on Nestlé farms: chocolate giant's problems continue," *The Guardian*, 2 September 2015.

222. S. Monsalve Suárez and M.S. Emanuelli, "Monocultures and Human Rights," FIAN, p. 16.

22: Who really innovates?

223. Phillips McDougal, "The Cost of New Agrochemical Product Discovery, Development and Registration in 1995, 2000, 2005-8, and 2010 to 2014. R&D expenditure in 2014 and expectations for 2019." A Consultancy Study for CropLife International, CropLife America and the European Crop Protection Association, March 2016.

224. Ibid.

225. Richard M. Adams, Brian H. Hurd, and John Reilly, "Agriculture & Global Climate Change: A Review of Impacts to U.S. Agricultural Resources," Pew Center for Climate Change. February 1999, retrieved May 28, 2002, pp. 1-13.

23: Why aren't the Chain's assumptions challenged?

226. Another factor contributing to the "unquestionable" Chain narrative: The FAO, which is perceived as a trust-worthy, objective institution, progressively changed the metrics for assessing global hunger in favour of the Chain's narrative. For more background and analysis, See Jason Hickel, "The true extent of global poverty and hunger: questioning the good news narrative of the Millenium Development Goals," Third World Quarterly, 5 February 2016.

227 See question 11.

228. The Economist, "Corporate propaganda: Sweet little lies. How to read between the lines of companies' accounts," The Economist, 30 April 2016. Electronic edition.

24: What policy changes are needed?

229. FAO, *Organic Agriculture's Contributions to Sustainability,* USDA Organic Farming Systems Research Conference, FAO, March 2013.

230. Assuming the projected migration increase does not happen because many peasants take advantage of new opportunities and return to farming.

231 Assuming that the Chain's commercial varieties are replaced by genetically-diverse peasant species, hopefully supported by public sector research, the nutritional benefit could be 5-40% with an average improvement of 10-20%.

232. ETC Group's own projections based on our understanding of the capacity of the Peasant Food Web to respond to positive incentives and the removal of barriers.

233. In Brazil, since 2003, agroecology has been public policy and has its own bill. See A. Wezel, S. Bellon, T. Doré, *Agroecology as a science, a movement and a practice - A review*, 2009, p. 507.

LOOK WHO'S TALKING: 70%

Since the 2009 and 2014 editions of Who Will Feed Us, ETC Group has estimated that the Peasant Food Web produces as much as 70% of the world's food, using vastly fewer resources than the Chain. This figure has been accepted by UN officials, academia, and even industry:

"...families run about 9 out of 10 farms [...] and produce about 80 percent of the world's food." **José Graziano da Silva**, Forward to The State of Food and Agriculture: Innovation in family farming, FAO, Rome, 2014, p. vi.

"The peasant system is not only here for good, it's arguably more efficient than the industrial model. According to the ETC Group [...], the industrial food chain uses 70 percent of agricultural resources to provide 30 percent of the world's food, whereas what ETC calls 'the peasant food web' produces the remaining 70 percent using only 30 percent of the resources." **Mark Bittman**, "How to Feed the World," New York Times, 14 October 2013.

"Responsible for producing up to 70 percent of world's food needs, many [peasant] farmers cultivate only a few hectares of land and own just a handful of livestock." **Sarah Murray**, "Camera Drones and cow fitness trackers help drive farm yields," Financial Times, 20 January 2016.

Small-scale producers [...] are responsible for producing some 70% of what is consumed in the world." **Nora McKeon**, Food Security Governance, Routledge, 2015, p. 3.

"Yet the reality is that only 30 percent of the food that people eat comes from large-scale industrial farms. The other 70 percent comes from small-scale farmers working on small plots of land." **Vandana Shiva**, Who Really Feeds the World? The Failures of Agribusiness and the Promise of Agroecology, North Atlantic Books, 2016, p. xii.

"Small scale producers grow about 40% of traded agricultural produce and about 70% of the world's food." **United Nations Global Compact**, Sustainable Agriculture Business Principles: White Paper, July 2013, p. 11.

Did you know that...

- **70% of the world is fed by the Peasant Food Web on only 25% of the resources?**
- **For every dollar paid for industrial food, it costs another 2 dollars to clean up the mess?**
- **The damage caused by the Industrial Food Chain costs 5 times the world's military expenditures?**

We are told that the Industrial Food Chain, through globalization and consolidation, will help us survive climate change and address nutritional deficiencies by commercializing next generation, "climate-smart" technologies. **The assumption that the Industrial Food Chain, driven by commerical interest, will feed the world has no factual basis.**

ETC Group's booklet builds on the 2009 and 2013 editions, updating our research contrasting the Peasant Food Web and the Industrial Food Chain. We have found many contradictions in the Chain's narrative, but one of the most significant findings is that there are numerous information gaps surrounding global food production and consumption. Look for updates and watch the accompanying videographics (in English, Spanish and French) at *www.etcgroup.org*. Give feedback and contribute new information or examples at *whowillfeedus@etcgroup.org*.

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