MANIFESTO

FOOD *for* HEALTH

Cultivating Biodiversity, Cultivating Health

INTERNATIONAL COMMISSION ON THE FUTURE OF FOOD AND AGRICULTURE

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CULTIVATING BIODIVERSITY, CULTIVATING HEALTH

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NAVDANYA INTERNATIONAL

"چه سی ک ذر بد ندم گ عود می دهد؟"

"Who sows wheat sows justice"

— Zarathustra. 9th – 18th century B.C.

"To keep the body in good health is a duty, otherwise we shall not be able to keep our mind strong and clear."

— Buddha (566-486 B.C.)

"Αφήστε τα τρόφιμα να είναι φάρμακα"

"Let food be thy medicine and medicine be thy food."

— Hippocrates (460-370 A.D.)

"Dis-moi ce que tu manges, je te dirai ce que tu es."

'You are what you eat'

— Anthelme Brillat-SAVARIN, 1826

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PREAMBLE

TRANSFORMING FOOD SYSTEMS THAT ARE DEGRADING THE PLANET AND OUR HEALTH TO FOOD SYSTEMS THAT REGENERATE HEALTH AND WELLBEING

"If we do not create the future, the present extends itself"
– Toni Morrison (Song of Solomon)

The people of the world are facing a health crisis that arises from multiple degradations in the manner of producing and marketing food. These degradations affect every dimension of the food systems upon which we all depend, from soil, water and seeds to production and processing and distribution, and involve, above all, the abandonment of natural and organic food systems, and accompanying diets that were the foundation of human health throughout the world, throughout most of known human history.

The root of the problem is the growing dependence on a dysfunctional productive paradigm that relies on chemicals such as pesticides and economies of scale to accelerate the quantities of food produced, not taking into account their nutritional quality and the harmful effects of these modes of production on people's health and the ecosystem. These health effects adversely affect every stage of human life and range from still widely prevalent and growing undernutrition and malnutrition to a wide variety of chronic diet related diseases that are now the leading contributors to premature death and disability across the world.

Alarmingly, the harmful health effects of the globalised industrial food system extend across generations through transmissible epigenetic effects, commercial conditioning of family diets and health impact of climate change. We are creating a dark, uncertain future for our children, as evidenced by the growing epidemics of childhood obesity and early onset of diabetes. We cannot continue to create a society where our children and their children will be deprived of nutritional security because of the actions of commercial interests and inaction on part of governments and other stakeholders in society.

The justification for this emphasis on industrial agriculture, with its fossil fuel based chemical intensive agriculture and chemical intensive systems, centered around maximising production, is the need for sufficient food to feed a growing global population. However, nutrition empty commodities loaded with pesticides and toxics are not providing nourishment and health. They are, on the contrary, degrading the environment and our health by diminishing nutritional quality and diversity of food. Furthermore, the

industrial agri-food system consumes an immense amount of fossil energy (producing almost a third of all global greenhouse gas emissions), thus contributing to altering the ecosystem in the short term (climate variability) and in the long term (climate change).

It is evident that, despite its exploitation of resources, industrial agriculture is not able to guarantee food security. Most of the food we eat is still produced by small and medium-sized farmers, while the vast majority of industrialised crops, such as corn and soya, are primarily used as animal feed or converted into biofuel.

This shift away from traditional farming based on time tested principles of agroecology - working in harmony with, not against, nature - along with the lack of significant investment in independent research and innovation by scientific institutions and governments, is due to the influence of a series of mega-corporations take-overs, driven by the quest for maximum profits and minimum regulation. These multinationals, which are steadily taking over land throughout the world, rely on huge quantities of chemical fertilisers, pesticides, herbicides, and modified seeds responsible for the loss of micro-nutrient content that is the foundation of healthy food, while poisoning citizens indiscriminately, from producer to user. This push-for-profits is packaged as 'smart agriculture' as remedy to adverse impacts of agriculture on climate change. It is crucial to recognise that the agriculture sector is a major component of what can be best described as 'predatory globalisation,' the control and management of the world economy to ensure the efficiency of capital rather than the wellbeing of people and the planet.

There is now a growing refusal of this way of satisfying the growing demand for food to implement the right to food for all while protecting the right to health as integral elements of human rights. The logic of the market is unfriendly to social and economic rights, and seeks to avoid recognizing the right to adequate, healthy, accessible and affordable food for all. To achieve food security for everyone on the planet depends on discarding policies and practices that lead to the physical and moral degradation of the food system while destroying our health and endangering the planet's ecological stability, and endangering the biogenetic survival of life on the planet.

Not only is the nutritional quality of food sacrificed to reach quantitative goals but the great benefits of biodiversity are seriously reduced with the growing dependence on a handful of globally traded commodities coming from chemical monocultures, with harmful effects on the quality and range of seeds as well as the biodiversity of all species, including the contamination of soil and ground water, leading to a significant contribution to climate change. These high environmental and health costs are largely excluded from the pricing of food, creating the illusion that food produced with high financial, ecological and health costs is "cheap".

Yet there exists a vibrant and growing alternative approach to food security and food production – Agroecology - based on biodiversity, which combines quantity and quality and maximizes the benefits to the health and wellbeing of the planet and its people. A new generation of farmers across the globe is increasingly conscious of their role in farming, in the defense of biodiversity, the defense and care of the land and

the environment and in producing good and nutritious food. Across the world, farmers' agroecology networks are springing up, becoming custodians of the emerging sustainable food production and agriculture practices while promoting the essential shift from the present extractive, linear approach to agriculture and food production, to one based on circularity, reciprocity and sharing, that lead lead to a brighter future for humankind.

This emerging paradigm of agriculture, food, nutrition and health is an alternative to the chemical based monoculture paradigm that degrades our land, our food, our health, and instead regenerates the health of the planet's ecosystems and communities.

This new, and at the same time time-honoured approach is displacing the current damaging trends with policies, practices, and knowledge that ensure renewal. We interpret renewal to mean above all a revived reliance on the health potentialities of the natural food systems that work in harmony with nature, are based on food sovereignty and the return of seed into farmers' hands, that are mindful of environmental impacts and contribute to preventing global warming caused by greenhouse gas emissions produced by industrial agriculture and long distance trade.

The right to health can be realised only if the right to good nutrition is recognised, respected and realised. It is possible to create good health through good nutrition. For this we have to transform our food systems. This task is pivotal, not only for reaching the Sustainable Development Goals of 2030 but also for ensuring human and planetary health for generations to come.

The transition to a new paradigm, based on the realisation of rights to health and food security, will depend on the commitment of civil society, the private sector, governments and global institutions. We believe that the renewal and adaptation of the best scientific and medical knowledge is necessary and possible, leading to a historic collaboration between popular movements and those experts attuned to the renewal of natural systems of food production and congenial social movements and initiatives, and a moral commitment to food justice as well as to human health.

This manifesto is, above all, a call for responsible citizenship, which at once acknowledges the planetary dimensions of the challenge, calling for the supplementing of conventional ideas of citizenship of sovereign states with a boundary-less vision of planetary citizenship.

It also recognises that the new paradigm can only come into being through a felt reality of global community; a future-oriented project, through the rise of citizen pilgrims, those recognising that a journey to a more humane future is essential for safeguarding the health and life prospects of unborn generations.

In effect, we recognise that the renewal we call for is based on new, yet available, knowledge, and a moral commitment to food justice as well as to human health. We believe that the renewal and adaptation of the best scientific and medical knowledge are necessary and possible, and highly desirable, generating a historic collaboration between popular movements and those experts attuned to the renewal of natural systems of food production and congenial social movements and initiatives.

SECTION 1

THE HEALTH EMERGENCY: NONCOMMUNICABLE CHRONIC DISEASES

The quality of food, an essential element to health, is intrinsically linked to the quality of soil, air, water and the environment. The quality of the food that comes to our table depends as well on what agronomic and veterinary practices are employed on crops and in farms. Unfortunately, the now pervasive presence of toxic substances in the environment, due to various agro-chemicals and emissions, of which a substantial % comes from the food industry, has led to the progressive degradation of our habitat. These toxins accumulate in the food chain, with considerable risks for human health. The underlying negative consequences are most vividly expressed within our own bodies, in our cells and tissues, and overall health.

Industrial agriculture and industrial food processing have steadily been degrading our diets and our health, both by removing nutrition and health from the food system and by adding chemicals and contaminants across the food chain, from production, to processing, to distribution. Emerging independent science is confirming the age-old maxim "we are what we eat". Good and nutritious, biodiverse, ecological, fresh, local foods are the basis for health. When we eat bad industrial, nutritionally empty, and chemical-based food commodities, we risk disease and ill health.

There is a two-fold health burden from industrial agriculture and food processing. The first is the loss of biodiversity and diversity of nutrients in our diets that are essential to good health. The second is the health costs resulting from the toxins and contaminants in our food. Chemicals are being added to food and farming more than ever. More than 80,000 new chemicals and 20 million byproducts have been commercialised since the second world war[1].

There are multiple pathways through which industrial agriculture and industrial processing degrade our food and our health.

First, industrial, chemical-based, degraded food commodities are not food which nourish, and furthermore trade in food commodities does not create food economies that nourish people. 90% of the corn and soya grown today are for commodities, for producing biofuel and animal feed, not for feeding people. Increase in trade of these commodities means less real food grown and accessible to people. Increased trade means more land and water, energy and public money diverted from producing food adapted to the diversity of cultures and climate, translating into more hunger, poverty, malnutrition, and disease, threatening also the food sovereignty of entire communities[2].

Second, chemical agriculture degrades the soil and the nutrition in our seeds and plants and reduces the biodiversity of our crops and food.

Mineral fertilisers compromise symbiotic colonisation between fungi, mycorrhizae[3] and roots, which enables the exchange of nutrients; homogeneous, hybrid seeds are by definition altered crops that lead to more quantity (and less quality); the use of pesticides weakens plant's defense, resulting in less polyphenols which are crucial for human health as anti-oxidants.

The difference between small-scale and industrial production lies mainly in the fact that industrial monocultures are bred for responding to chemicals, in order to increase mass quantities, which results in nutritionally empty commodities, measured falsely as "Yield per Acre". Substituting diversity with uniformity, and confusing "mass" with "yield" for nutrition and quality, decreases the much more relevant and essential parameter of "nutrition per acre". Biodiversity increases nutrition per acre. Research is increasingly showing that traditional varieties bred by farmers for nutrition and quality produce more nutrition and health. To achieve higher yields, industrial agriculture releases toxic substances into the soil, water and air, which in one way or another enter the food chain and threaten human health.

In health terms, our food is further degraded and impoverished through the industrial processing of food. Examples include irradiation during storage after harvest, or all additives and stabilisers used during processing to extend shelf life. If it is the intended purpose of agricultural and food systems to serve the needs of human health by ensuring adequate and appropriate nutrition to every person, globally there has been failure to do so. This is because agriculture and food systems have parted from their principal mission to meet human needs of healthy and nourishing diets. The world today witnesses the many faces of malnutrition- hunger, wasting, stunting, underweight, overweight, obesity and a variety of micronutrient deficiencies. These also open the body to a variety of diseases that can lead to premature death, severe disability and prolonged suffering.

The dangers of low quality, less nutritious diets pose the grave threat of chronic diseases that are often described as 'lifestyle diseases' but are in reality driven by faulty food systems. Energy dense diets, high in calories but poor in nutrients and diets with undesirably high levels of unhealthy fats, sugar and salt have been associated with high risk of noncommunicable diseases (NCDs). These now account for 70% of deaths globally, accounting for 40 million lives lost each year. About 15 million of these occur below 70 years of age. The low and middle income countries account for 80% of all global NCD deaths and 90% of NCD deaths between 30-69 years of age. Major NCDs include cardiovascular diseases, diabetes, cancers and chronic respiratory diseases. A large proportion of NCDs are diet related, due to unhealthy diets causing disease through biological risk factors like blood pressure, blood sugar, blood lipids and body fat, which in turn trigger pathologic processes of inflammation, atherosclerosis of blood vessels, thrombosis and induce carcinogenesis through epigenetic effects.

Alongside these already very worrying figures, it should be stressed that the claim that industrial agriculture is necessary to solve the problem of hunger in the world is totally unfounded and has been refuted in practice. Malnutrition continues to affect a large number of children and adolescents, women in reproductive age and the elderly throughout the world: more than two billion people suffer from serious deficiencies in vitamins and minerals, over 200 million children are stunted or wasted[4], with undernutrition being attributable for deaths of over three million children under five every year[5]. Apart from susceptibility to a variety of infections and early death, childhood undernutrition leads to hampered cognitive development and loss of brainpower at a critical phase of human development.

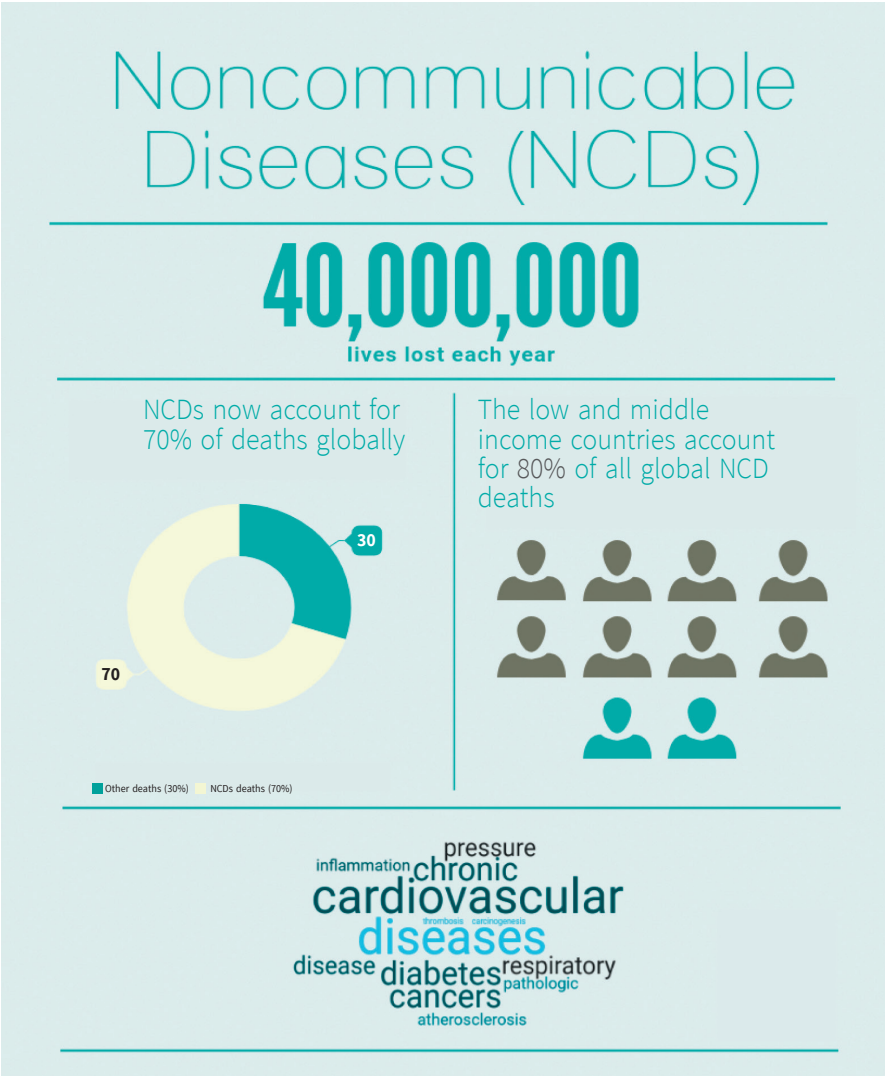

FIGURE 1: NONCOMMUNICABLE DISEASES - DESIGN: CHLOÉ GENIN

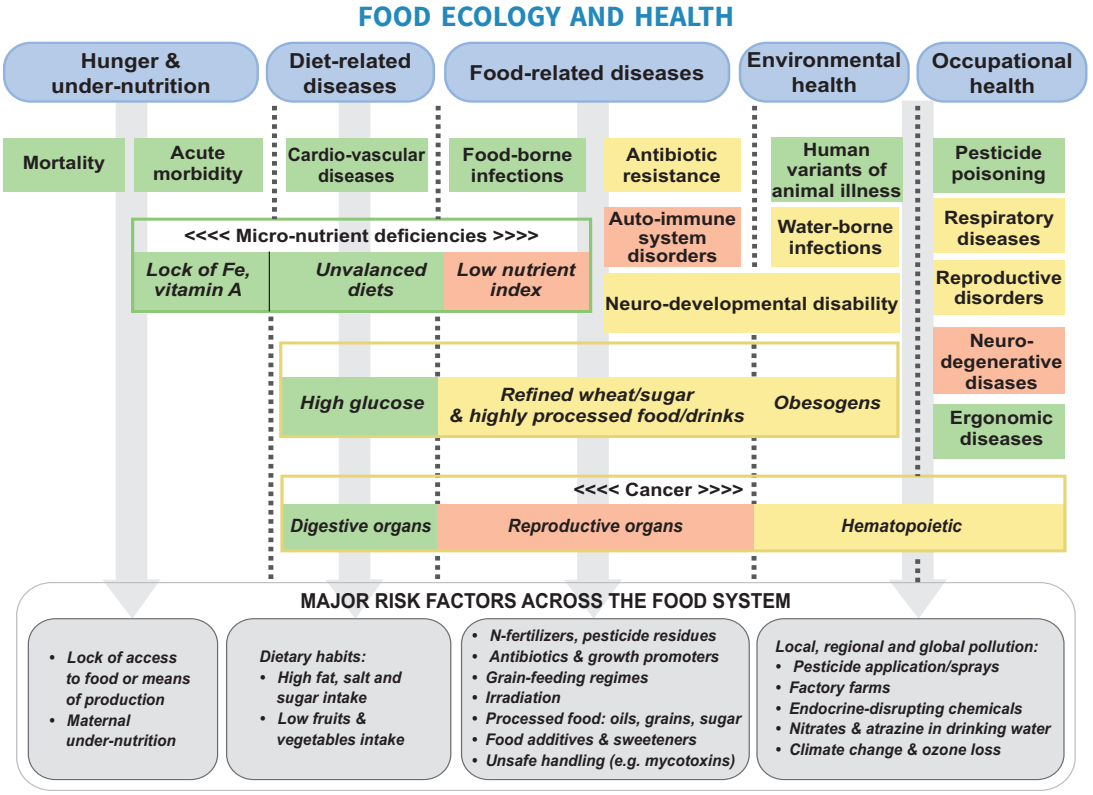

FIGURE 2: AN ILLUSTRATIVE DIAGRAM OF THE FOOD SYSTEM APPROACH TO DISEASES.

Source: Nadia El-Hage Scialabba, Eco-Agri-Food Ecology And Human Health, in *Achieving the Sustainable Development Goals through Sustainable Food Systems*, forthcoming (2019), Springer International Publishing.

Note: The colour coding of the boxes relates to the level of certainty in the literature: green is documented/recognized, yellow is emerging evidence, red is disputed outcomes

At the same time, nearly two billion persons across the world are overweight or obese. While chronic undernutrition is on the decline, albeit slower than hoped for, the rise of overweight and obesity has more than offset the health gains of such a decline. Commercial compulsions of current global agricultural and food systems, compounded by high levels of economic inequality, have made healthy diets unavailable or unaffordable to large sections of the population in every part of the world. Unless these systems are reoriented to the goal of providing nutrition security to every person throughout life, high burdens of preventable disease and disability will continue to haunt humanity imposing high financial costs of health care and lost productivity. The costs to society are already huge and it will be increasingly difficult in the future to tackle the burden of disease globally if this system is not corrected. **It is also morally indefensible to carry on in this trajectory, as it would create adverse living conditions for future generations. That would be a civilisational failure of monumental magnitude.**

1.1 HEALTH IMPACTS OF CHEMICALS IN FOOD PRODUCTION

Since the onset of the Green Revolution[6], synthetic chemicals have been welcomed as simple solutions to complex challenges in mass food production. However, after over a half century of following this approach, we now have overwhelming empirical evidence of associated negative consequences.

As the academic and philosopher Gregory Bateson presaged in the 1970's[7], there are no quick-fix technological solutions, which will not give birth to a multitude of new problems. In short, these are not sustainable solutions. Bateson, alongside his contemporary Rachel Carson[8], recognized industrial agriculture as the key culprit and chose DDT as his main illustrative example. Though now much time has passed and DDT is thankfully banned in most though not all countries[9], the underlying paradigm of quick-fix synthetic chemical solutions has not yet been eliminated.

Pesticides, fertilisers and agrochemicals in general are the emblem of industrial agriculture, which has tried to impose itself on a planetary level after the 2nd world war. The damages produced to human health concern above all the farmers, who currently use chemical pesticides and herbicides, but consumers also, due to the presence of pesticide residues in food. Additionally, indirect damage must be considered, for example groundwater and air pollution. Chemical fertilisers as well as pesticides and herbicides pollute the waters of rivers, lakes and therefore the sea, damaging an essential food source for many populations of the planet[10]. In Asia, the phenomenon has already reached a warning level, with over a billion people being forced to draw their drinking water from the groundwater table[11].

Globally, outdoor air pollution leads to 3.3 million premature deaths annually; after emissions from residential energy use such as heating and cooking, agriculture is the second leading cause of outdoor air pollution, accounting for 20% of the total disease burden, or 664100 deaths per year[12]. Atmospheric pollution from factory farms and pesticide drifts from aircraft spraying are particularly associated with respiratory diseases. In addition to tobacco smoke and frequent lower respiratory infections during childhood, risk factors include atmospheric pollution from factory farms that increases by 20%[13]. Exposure to chemicals and dusts (fine particulate matter) is estimated to cause 12% of deaths due to chronic obstructive pulmonary disease[14].

Organophosphate pesticides first entered industrial agriculture in 1940, together with the first herbicides to fight pests and unwanted herbs on a vast scale[15]. It should be noted that the first toxic substances, including organophosphate developed by I.G. Farben under Hitler's Germany, were synthesised for war purposes, as in the case of the gases used by the Nazis in the concentration camps or the Agent Orange in the Vietnam War. Though brought to justice for crimes against humanity after the Second World War, these same companies subsequently shifted their market for their poisonous products to the agricultural sector. But rather than resolving a problem they instead created many others.

Chemical pesticides have not only damaged the environment and human health, but have also failed to eliminate pests and weeds from farms. On the contrary, in forty years of escalating pesticide use, their numbers are rising[16]. Parasitic insects have shown extraordinary genetic plasticity, and are able to continuously transform themselves to resist pesticide chemical aggression[17]. A case in point is how the drastic increase in the use of the herbicide Roundup, following the introduction of Roundup Ready crops[18] on the market, is due to the fact that weeds have begun to develop resistance[19].

What are pesticides?

The Food and Agriculture Organization (FAO) defines pesticides as: "any substance, or mixture of substances, of chemical or biological ingredients intended for repelling, destroying or controlling any pest, or regulating plant growth"[20]. The term is generically used to address all the substances that interfere with, obstacle or destroy living organisms, be they microorganisms, virus, moulds, fungi, insects, "weeds" etc.[21]; therefore, they are "synthetic molecules selected to contrast harmful organisms and therefore generally dangerous for all living organisms" and, potentially human beings. Moreover, pesticides have toxic, persistent and bio-accumulative properties with associated negative impacts not only on the living species they are created for, but on the entire ecosystem, on the physical and chemical properties of soils and human health itself.

FIGURE 3: PERCENTAGE VARIATIONS SALE OF PESTICIDES IN THE EU: % VARIATIONS FROM 2011-13 VS 2014/15

GLYPHOSATE: WHEN CORPORATIONS ARE STRONGER THAN THE PRECAUTIONARY PRINCIPLE

The EU, at the end of 2017, reauthorised use of Glyphosate for another five years after a year long heated political debate over its safety and impact on the environment and health. At the centre of the debate on the dangerous elements in agricultural production are genetically modified organisms (GMOs) commonly used in conjunction with glyphosate-based herbicides. Despite clear evidence of its adverse health effects, glyphosate continues to be the most widely used herbicide in the production of mass-consumption foods.

Since 1974 in the U.S., over 1.6 billion kilograms of glyphosate active ingredient have been used or 19% of estimated global use of glyphosate (8.6 billion kilograms). Globally, glyphosate use has risen almost 15-fold since so-called "Roundup Ready," genetically engineered glyphosate-tolerant crops were introduced in 1996[22]. A US EPA report of 2011 estimates the amount of world pesticide used in 2006 and 2007 to be approximately 5.2 billion pounds[23]. According to another 2013 study, Europe is the world's largest pesticide consumer[24]. The USDA (US Department of Agriculture) in its 2011 report found glyphosate and AMPA residues in soya samples for human consumption in 90.3% and 95.7% of cases respectively[25]. In Europe it has been found in pasta[26], bread, biscuits[27], lentils[28], beer[29], but also in meats and foods of animal origin such as cheese and milk[30].

There is ample evidence of other important toxic actions of this product, touted as harmless and biodegradable[31]. In particular, Roundup has been shown to be more toxic than its active ingredient glyphosate, due to adjuvants increasing glyphosate bioaccumulation and bioavailability[32]. Roundup also negatively affects in vivo human placental cells and aromatase (the enzyme responsible for estrogen), affecting enzymatic activity at doses up to 10 times lower than those in agriculture[33]. Similar results were found in a study where liver cells were exposed *in vivo* to sub-agricultural doses of glyphosate, resulting in anti-androgenic and anti-estrogenic endocrine disrupting effects with associated adverse impacts on sexual and other cell differentiation, bone and liver metabolism, as well as potential links to hormone related cancers, such as breast and prostate cancer[34].

Recent research on glyphosate hypothesise that the selection pressure of the herbicide on bacteria resistance could lead to shifts in microbiome composition, resulting in transfer of antibiotic resistance from soil to plants, animals and humans through the food web, even in urban and hospital environments. Although the link between glyphosate and antimicrobial resistance is still scarce, there is an urgent need to better understand indirect health risks for glyphosate residues in water, food and feed, through research on the associations between low-level chronic herbicide exposure, distortions in microbial communities, expansion of antibiotic resistance and the emergence of diseases[35].

In March 2015, glyphosate was classified by the International Agency for Research on Cancer, IARC, as a probable carcinogen (2A) for Non-Hodgkin's lymphomas, based on sufficient evidence of genotoxicity and oxidative stress on animals and limited on humans[36].

The results of IARC also received considerable backlash from the industry, which tried in various ways to discredit the work of the UN agency[37]. After 6 months, the European Food Safety Authority (EFSA), re-evaluating its toxicological profile, concluded that "glyphosate is unlikely to pose a carcinogenic hazard to humans"[38], while proposing new safety levels for glyphosate residue control in foods. In September 2016, the U.S. Environmental Protection Agency (EPA) published an assessment document[39] in which it stated that, having reviewed a number of recent studies, including that of IARC, glyphosate is "probably not carcinogenic in humans"[40] [41]. Lastly, in March 2017,even the ECHA (European Chemicals Agency) has announced that there is no conclusive evidence on the carcinogenicity of glyphosate[42].

Numerous criticisms were raised on the scarce transparency and the presence of conflicts of interest in the risk assessment processes of the various agencies. Among the criticisms directed towards the European authorities was that not classifying glyphosate as a carcinogen does not seem coherent, and is in effect a direct violation of guidance documents and applicable guidelines[43].

The EU subsequently found itself at the centre of a new wave of criticism. In November 2017, the EU Appeal Committee - consisting of experts from the EU member states and the European Commission - has approved the renewal of glyphosate license for 5 years[44]. This decision was vigorously contested and opposed by civil society, numerous organisations and movements, independent scientists, journalists and lawyers. The protest was supported by several European parliamentary groups[45] and massively supported by more than 1,300,000 signatures collected by the European Citizens Initiative to ban glyphosate[46].

The long and controversial process preceding this decision highlighted the pressure from large agrochemical groups on European decision-makers as well as the strategies implemented by industry to keep its products on the market: from lobbying[47] to interference in government agency processes[48], to mega mergers and acquisitions, to aggressive attacks on independent science in collusion with institutions. This has been amply illustrated by various investigations, such as the Monsanto Papers[49] and Poison Papers[50], where, in addition to clear cases of corruption, there is evidence of the extent of the collusion between industry, regulatory agencies and numerous members of the scientific community.

With the hundreds of published independent scientific studies exposing the disastrous impact of glyphosate herbicides on human health and the environment, it is clear that the European vote chose to ignore the precautionary principle and that representatives of European member states missed a crucial opportunity of asserting their role and responsibility as defenders of citizens' will against the interests of multinational corporations.

Exposure factors

Pesticide exposure may occur in a multitude of ways, including direct exposure, particularly amongst pesticide factory workers, pesticide sellers in developing countries and farmers applying pesticides[51]. Other means of exposure occur via residues in surface waters from agricultural run-off, well and groundwater contamination, wind dispersal following aerial spraying, or persistent residues in fruits and vegetables from systemic pesticide application[52].

In the production phase, agro-toxins such as pesticides, herbicides and fungicides result in a broad range of health complications, including cancers and neurological disorders with impacts varying between sub-lethal outcomes and fatality[53].

Exposure to pesticides leads to a statistically significant increase in the risk of chronic-degenerative diseases, such as cancer, diabetes, respiratory diseases, neurodegenerative diseases, cardiovascular diseases, reproductive sphere disorders, male infertility, metabolic and hormonal dysfunction, autoimmune diseases, renal dysfunction that are increasingly prevalent today. These effects, initially highlighted by professional exposures, today affect the entire human population.

It has been shown that pesticides do alter the human body's homeostasis, as they are capable of inducing multiple and complex dysfunctions of practically all the apparatuses, organs and systems, thus leading to endocrine, nervous, immune, respiratory, cardiovascular, reproductive, renal diseases. There is now evidence of a strong correlation between exposure to pesticides and a steady increase in diseases such as cancer, respiratory diseases, Parkinson's, Alzheimer's, amyotrophic lateral sclerosis (ALS), autism, attention deficit and hyperactivity, diabetes, infertility, reproductive disorders, fetal malformations, metabolic and thyroid dysfunction[54]. Given the hundreds of active ingredients on the market and the marketing of ever new molecules, the detailed knowledge of their toxic action on humans, especially if in minimal doses and prolonged over time, is undoubtedly complex and difficult to exhaust. However, a growing amount of scientific and laboratory studies has shown that these molecules can act on a wide range of all the vital functions of human cells by inducing:

- genetic and epigenetic modifications
- imbalances in the receptorial function with "endocrine interference" action
- mitochondrial dysfunction
- perturbation of neuronal conduction by alteration of ion channels
- alteration of the enzymatic activity, especially by interference with acetylcholinesterase
- oxidative stress
- endoplasmic reticulum stress and altered protein aggregation.

Chronic exposure to pesticides

Researchers are increasingly focusing on the issue of chronic exposure to pesticides and the consequent risks for human health as, even at minimal doses, pesticides can be extremely harmful to human health and therefore represent a very real public health problem. These substances can come into contact with our organism both by skin absorption, thanks to their liposolubility (organophosphates, carbamates, organochlorines, DDT, lindane, aldrin and chlordane) and by inhalation or ingestion (pyrethroids, herbicides, chlorophenols). "Chronic exposure" means exposure to small but prolonged doses, which occurs already in the uterus or even before conception by the action of these molecules on germinal cells. The issue is highly complex and often difficult to quantify, both for the diversity of the methods used to analyse the exposure (occupational questionnaires -residential, biomonitoring) and the variability of factors such as age, sex, nutritional status, personal habits, individual genetic variability which highly influence susceptibility to pesticides.

Professional exposure

This kind of exposure can occur during production, transportation, preparation and pesticides application. Main factors involved in this kind of exposure include the intensity, frequency, duration and methods used for pesticides application, as well as compliance with safety standards, the use of individual protection equipment, and the physical-chemical and toxicological profiles of the pesticides themselves. Even family members of those who use pesticides can have considerable risks from accidental spills, leaks, incorrect use of the equipment and non-compliance with safety and guidelines.

Environmental and residential exposure

Living near areas where pesticides are used, produced or disposed can significantly increase human exposure by inhalation and contact with air, water and soil. Of particular concern is the drift effect, in which pesticide particles disperse in the air, and rather than reach targeted crops, spread to surrounding environments and communities instead. Often intensive agriculture borders private residences or public places, such as schools, kindergartens, parks, etc., increasing the probability of contaminating residents and the local population.

Dietary exposure and residues in water and food

Residues of pesticides are found not only in fruit and vegetables (Ministry of Health, 2015), but also in meats, fish and dairy products, due to their bioaccumulation and biomagnification in the food chain. For example in Italy, the latest report *Pesticides in the water*[55] highlights the wide diffusion of contamination and the detection in surface and deep waters with as many as 55 substances in a single sample. Pesticides residues have been traced in 67% of the monitored superficial waters and in 33.5% of groundwater.

Industrial agriculture is a major cause of water pollution, especially in the majority of high-income countries and in many emerging economies, where it has overtaken contamination from settlements and industries as a major factor in the degradation of inland and coastal waters (e.g. eutrophication). Agricultural nitrate is the most common chemical contaminant in the world's groundwater aquifers. In the European Union, 38% of water bodies are under strong pressure from agricultural pollution[56].

Direct pesticide exposure

The most extreme form of direct exposure is ingestion resulting in poisoning. Estimates vary as to the global fatality rate from acute pesticide poisoning. The WHO cites 200,000 deaths per year from organophosphorus pesticides alone, noting that half of acute pesticide poisoning cases occur in China[57]. In India, 25,000 farmers committed suicide between 1997 and 2005, often imbibing agrotoxins directly[58] (Shiva and Jalees, 2005). Globally, the Pesticide Action Network (PAN) estimates the number of people affected to be between 1 and 41 million people[59] (PAN, 2010). Unintentional poisoning of children is a further tragic outcome of widespread pesticide use and access. In the United Kingdom, the majority of unintentional Acute Pesticide Poisoning (APP) cases were in the 0 – 4 years old age category[60] (Perry et al., 2014). Documented acute pesticide poisoning cases are much higher in the developing than in the developed world, as a result of weak governance, lack of legal protection and a policy gap in pesticide regulations[61] (Hvistendahl, 2013).

Can we keep calm if pesticide residues are within legal limits?

Reading the latest press release of EFSA[62] on pesticide residues in food, we get a very reassuring message as it states that: "97.2% of the samples analysed was within the legal limits allowed by EU legislation. 53.3% of the analysed samples had no quantifiable residues, while 43.9% contained residues that did not exceed legal limits". However, the analysis involved only 11 foods: aubergines, bananas, broccoli, virgin olive oil, orange juice, peas, peppers, table grapes, wheat, butter and eggs.

The current risk assessment for chronic pesticide exposure cannot be considered to be adequate with regard to the protection of human health, for several reasons:

- The multiplicity of the sources of exposure: limits are set for food or water but not for residential or air and ground exposure
- The fact that the metabolites can be more toxic than the original molecule
- Only the single pesticide is considered without considering interactions between multiple residues and the cocktail of molecules to which we are exposed.

The issue of food contaminants is known to the legislator in Europe who acknowledged the definition of The Codex Alimentarius[63], "For contaminant is intended any substance not intentionally added to foodstuff, but which is present as a result of the production,

manufacture, processing, preparation, treatment, packing, packaging, transport or conservation of the foodstuff, or as a result of environmental contamination." Limits have therefore been set for the most significant contaminants with EU Regulation, 1881/2006[64] and later modifications, and it is acknowledged that "environmental contaminants represent a source of danger for human health, are extremely diverse and act with multiple effects; particularly, as far as food contamination is concerned, maximum knowledge on the levels of contaminants in the food itself is required". It is of concern that the cocktail effect is not taken into account in the risk assessment while each individual pesticide is assessed individually, underestimating the potential toxicity of the mixture[65].

Traces of pesticides present in fruit are measured, as also the presence of nitrates in water, the colourants in sweets, and the amount of hormones in meat, but nobody considers the set of these elements as a whole and their final effects over time.

This approach, combined with the widely questionable theory that minimum doses are not dangerous, is intended to reassure consumers; these accumulations and mixtures are one of the huge unknowns in toxicology. A study shows for instance that an average British citizen has more than 300 to 500 chemicals in his body, compared to fifty years ago[66].

It is precisely the difficulty of identifying a direct link between the disease and the cocktail of chemicals that prevents us from measuring with absolute certainty what role food actually has in a typically multifactorial disease such as cancer.

But if medicine cannot clarify the complex dynamics of the interaction between hundreds of chemical substances, epidemiological research can help us to understand the general picture and the importance of diet.

For example, Asian women are 5 times less likely to contract breast cancer in their life than Western women[67]. But they lose this prerogative within a generation, if they migrate to the West. In the last 30 years studies have shown that food uniformity has caused damage to the populations of the South. In the case of Italy, where, in the Center-North, the food economy has been mainly industrial whereas in the South mainly traditional food culture, the globalisation and standardisation of the diet have destroyed the diversity of diets that the southern population possessed and which protected them against noncommunicable disease[68].

Other limitations of the current risk assessment on chronic exposure to pesticides include:

- Attention being paid only to the active ingredient, neglecting numerous other substances present (adjuvants, preservatives, diluents, emulsifiers, propellants, etc.), which significantly increase the toxicity of the final product, i.e. glyphosate[69]
- Legal limits refer to an adult person of 70 kg and it is not considered that even minimal doses and well below the limits of the law can be dangerous especially in crucial phases of life (embryos, fetuses, children), particularly for endocrine disrupting substances

- Differing susceptibility to pesticides in relation to genetic factors, age, gender, nutritional status, personal habits is not taken into account[70]
- The documentation of the proponent and not the available scientific literature is taken into consideration and this leads to discordant opinions among which, once again, glyphosate is an emblematic example.

Increased cancer incidence from pesticide exposure

Pesticides are undoubtedly an important risk factor for the onset of cancer both in childhood and in adults and all the main classes of substances (insecticides, herbicides, fungicides, pesticides as a whole) proved to be responsible. A number of reviews and meta-analyses found that pesticide exposure increases cancer risk and incidence[71], including but not limited to kidney cancer[72], bladder cancer[73], lung cancer[74], childhood cancer following parental pre-natal exposure[75] and the most empirically verified, Non-Hodgkin Lymphoma[76] (Chiu and Blair, 2009; Shinasi and Leon, 2014), amongst others. In terms of specific compounds, 21 pesticides based on a preceding IARC review were linked to cancers whilst controlling for confounding variables[77].

From the first studies conducted on the large cohort of U.S. farmers since the 60s (AHS[78]), but now extended in many areas of the world, even on non-professionally exposed populations, there has been an increase in risk for all types of cancer. A recent review has extrapolated 243 studies associating pesticides with statistically significant risks for the following neoplasms: adult and child brain tumors, neuroblastoma, esophagus cancer, stomach, colon, liver, bladder, kidney, pancreas, tumors' bone, soft tissue sarcomas, prostate, testis, breast, ovary, cervix, larynx, mouth, tongue, lung, thyroid, melanoma[79]. The most involved substances are aldrin, chlordane, heptachlor, lindane cyanazine, (banned or not approved in the European Union), mancozeb (approval expired on 31/01/2018), glyphosate, pyrethroids, chlorpyrifos (approved). The risks are particularly high for hemolymphopoietic system tumors, in particular NH lymphomas and myeloma.

In uterus exposure is particularly at risk: a review of 13 case-control studies published between 1987 and 2009 to investigate the risk of childhood leukemia and residential exposure to pesticides showed that the highest risk, more than double the expected, was the one of exposure to pesticides for domestic use during pregnancy[80]. A further meta-analysis confirmed, for "indoor" exposure (in particular to herbicides), a statistically significant increase for childhood leukemia of 46% and 26% for lymphomas[81]. Similar results have recently emerged from a large cooperative group which also included Italian researchers, and from which in particular a statistically significant increase of 55% of myeloid leukemia in offspring for pesticide exposure during pregnancy emerged[82].

However, preconceptional fathers' exposure to pesticides as well represents a risk factor for the insurgence of cancer in children: for cerebral tumors, for example, the highest risk (OR=2.3) is specifically in correspondence to this factor, which thus turns out to be even more dangerous than in uterus or childhood exposure[83].

It is not only emolinfophoietic system and cerebral tumors that are subject to an increase of the risk. A study conducted in Spain on 3,350 cases of childhood cancer and 20,365 health controls analysed the presence and intensity of agricultural activity within one kilometer of the children's residence. It has emerged that all types of childhood cancer, from neuroblastomas to sarcomas, from liver to renal tumors, have increased, often in high and statistically significant neurological disorders[84].

Neurological disorders related to pesticide exposure

The main neurodegenerative diseases related to pesticides are: Parkinson's disease, Alzheimer's disease and Amyotrophic Lateral Sclerosis (ALS); the long-term and low-dose exposure to paraquat, maneb, dieldrin, pyrethroids and organophosphorus is particularly relevant. Moreover, the role of early in utero exposure in neurodegenerative diseases that occur in adulthood is also increasingly emerging. There is a growing body of knowledge that highlights serious risks from pesticide exposure for the developing brain and subsequent neuropsychological sequelae in childhood. Various studies and meta-analyses show the correlations between direct exposure to pesticides and neurodegenerative and neurodevelopmental diseases[85].

Parkinson's disease

In the study conducted on the large cohort of American farmers (AHS) it was found that residential exposure also represented a risk factor. The categories of pesticides most responsible for the onset of Parkinson's were organophosphorus, carbamates, organochlorines, pyrethroids. A 2012 meta-analysis that reviewed the updated literature, including 39 case-control studies, 4 cohort studies and 3 cross-sectional studies, showed that the exposure to insecticides and herbicides resulted in an overall increase in the risk of statistically significant Parkinson's + 62%[86]. In 2013, Parkinson's disease was recognised as a professional disease in France[87].

Alzheimer's disease

Alzheimer's disease: in this case the etiopathogenetic role of pesticides appears lower than in Parkinson's; however, very interesting evidence has recently been added. In 2010, a large longitudinal cohort study was published which showed that elderly people living in an agricultural area show a higher rate of cognitive performance deficit and Alzheimer's risk[88]. Another ecological study conducted in Andalusia also found that people living in the areas most contaminated by pesticides have an increased risk of Alzheimer's disease, as well as other neurodegenerative diseases (Parkinson, multiple sclerosis) and psychiatric disorders (psychosis and attempts to suicide)[89].

Amyotrophic Lateral Sclerosis (ALS)

It's the most common form of motoneuron diseases characterised by invariably fatal outcome, and there are many hypothesised risk factors including exposure to chemical

agents. A large case-control study conducted by McGuire and colleagues in 1997 was the starting point for investigations that related pesticides and ALS[90].

In this study, professional exposure to three groups of chemicals was evaluated: solvents, metals and pesticides; the results showed the predominant role of the latter. In 2012 a meta-analysis conducted in the large AHS cohort was published and it showed a +95% increase in the risk of ALS (statistically significant) for pesticide exposure as a whole[91].

Effects on the developing brain

Many pesticides are lipophilic and during the fetal phase, the brain, which is the only organ in which adipose tissue is present, becomes a real target organ for these agents.

In 2006 an alarming article appeared in the journal *The Lancet* with a list of 202 substances, including 90 pesticides, known to be toxic to the human brain[92]. More recently, the authors highlight the role of chlorpyrifos in early neuro-development and urge for global prevention policies[93]. Specifically, children with higher levels of trace insecticide metabolites, such as organophosphorus derivatives, have almost double the risk of developing attention deficit and hyperactivity compared to control groups with 'normal' levels of contamination[94].

Other independently conducted studies at the University of Berkeley[95], Mt. Sinai Medical Center[96] and Columbia University[97], have demonstrated with accurate biomonitoring assessments (measurements of metabolites in urine or after birth on umbilical cord) that women exposed during pregnancy to pesticides, are more likely to give birth to children less intelligent than the average. A cohort study conducted on 329 children who were aged 7 years of age for IQ assessment and in which organophosphate metabolites were dosed both on maternal urine during pregnancy and later in early childhood, showed for children more exposed in uterus, a decrease of up to 7 points of the IQ[98]. A 2013 review examined the effects of pesticides on neurodevelopment and in particular on the sensory, motor, cognitive, IQ and brain morphology with magnetic resonance. The study found that 26 of 27 studies show neuro-behavioural effects, with a dose-response relationship in 11 of 12 studies[99]; in addition 10 longitudinal studies, which evaluated prenatal exposure, found behavioural effects at the age of 7 years and motor changes especially in newborns. In 2 groups of 20 children each, with medium / high and medium / low levels of chlorpyrifos evaluated on the umbilical cord, a MRI performed in school age showed more or less marked cerebral changes in relation to the different exposure[100]. An additional systematic review that examined 134 studies confirmed that prenatal exposure in utero is the one that entails the greatest risks[101].

Some results indicate that the neurodevelopmental impacts of pesticides, such as organochlorines, extend to children exposed prenatally or during childhood, resulting in impaired short-term memory, increased reaction times, abnormal reflexes, impaired mental development, and persistent developmental problems[102]. Moreover, significant

impacts on mental health have also been found with a positive correlation between direct pesticide exposure and depression[103].

Respiratory disorders

Numerous symptoms and changes in lung function are observed for pesticide exposure, in particular: dyspnoea, respiratory tract irritation, dry throat / sore throat, cough, chest tightness, rhinorrhea. Asthma, chronic bronchitis and chronic obstructive pulmonary disease (COPD) were the most correlated diseases[104]. Asthma in particular, has been recognised as the most common pulmonary disease related to occupational exposures: among U.S. male farmers a statistically significant association has been proven, ranging from + 100% to + 134%, between onset of atopic asthma in adulthood and use of coumaphos, eptachlor, parathion, dibromoethylene and an 80/20 mixture of carbon tetrachloride / carbon disulfide[105]. Among women, exposure to pesticides such as carbaryl, coumaphos, DDT, malathion, parathion, permethrin, phorate, herbicides (2,4-D and glyphosate) and a fungicide (metalaxyl) was more associated with atopic asthma than with the not atopic.

In a case-control study on farmers in India there was a 154% increase in chronic bronchitis risk for organophosphate and carbamate exposures[106]. Similarly, in the large cohort AHS it was found that the exposure to organochlorines (heptachlor, chlordane, DDT, lindane and toxaphene), organophosphorus (coumaphos, diazinon, dichlorvos, malathion and parathion) carbamates, permethrin, chlorophenoxy herbicides (2,4,5- TP 2,4,5-T) and two herbicides (chlorimuron-ethyl and petroleum oil) involved a statistically significant risk of chronic bronchitis[107].

Diabetes

The study conducted on the AHS cohort showed that for aldrin, chlordane, eptachlor, dichlorvos, trichlorfon, alachlor and cyanazine there was an increased risk of diabetes both for continuous use and for a use of at least 100 days during the course of life; in the latter case, due to exposure to aldrin, chlordane, heptachlor, the increase in risk was 51%, 63%, and 94%, respectively[108].

A further investigation, conducted on the large cohort of the AHS cohort wives who had reported never to have personally applied or prepared pesticides, showed that three organophosphorus, organochlorine and the herbicide 2,4,5-T / 2,4,5 -TP were associated with occurence of diabetes with statistically variable risks from + 50% to + 99%[109].

Cardiovascular diseases

Hypertension and lipid trim were altered in relation to persistent organic contaminants (POPs[110]), including pesticides, both among U.S.A veterans and for residential exposures. Among the healthy residents of the Monsanto industrial site there was a correlation between the highest levels of PCBs (polychlorinated biphenyls) and pesticides and the

increase of total lipids, triglycerides and total cholesterol with different patterns between the different PCB congeners and the different pesticides[111].

Particularly interesting are the results emerging on the link between prenatal exposure to DDT and the onset of hypertension before the age of 50: in pregnant women between 1959 and 1967, serum samples were collected and stored before delivery, on which DDT was measured; decades later the incidence of hypertension on the daughters at ages between 39 and 47 years was evaluated. Prenatal exposure to medium / high levels of DDT and the increase in the risk of hypertension proved to be 260%; for the lowest 150%[112].

An AHS study found that even hypertensive disorders in pregnancy, including eclampsia, are statistically associated with both occupational and residential exposure to pesticides during the first trimester of pregnancy[113]. Particularly interesting in this regard is what emerged from a recent study conducted in Norway on 28,192 pregnant women: the risk of eclampsia in the group which had routinely consumed during pregnancy **an organic** diet was almost halved (OR = 0.76) compared to the group who had a conventional diet[114].

Reproductive disorders, infertility, malformations and developmental defects

Most pesticides, especially organophosphorus, can alter the quality of the seed in various ways: reduction of density, motility and number of spermatozoa, inhibition of spermatogenesis, increase in DNA abnormalities and changes in their morphology, reduction in volume and weight of testicles, epididymis, seminal vesicles and prostate[115]. There may also be alterations in testosterone levels due to inhibition of testicular activity, changes in pituitary hormones and activity of antioxidant enzymes in the reproductive organs: all these effects are well understandable if one considers the action of endocrine disruptors carried out by many of these substances.

Increased spontaneous abortion, altered male / female relationship, antiandrogenic effects with demasculinisation and changes in pubertal development were observed mainly due to exposure to DDT, aldrin, chlordane, dieldrin, endosulfan, atrazine, vinclozolin. Important correlations between exposure to pesticides (in particular herbicides), malformations, intrauterine death, growth delays, alterations in the implantation have come from experimental studies and epidemiological surveillance studies on the American veterans of Vietnam cohort, in which an increased risk of spina bifida and anencephaly was documented. A higher risk of hypospadias emerged for both maternal and paternal prenatal exposure[116]: it is interesting to note that a recent study showed that an organic diet during pregnancy proved to be protective against hypospadias[117]. Other side effects include infertility, reduced fertility and birth defects.[118]

Thyroid diseases

A study conducted within the AHS evaluated the risk of hypo-hyperthyroidism among the wives of American farmers in relation to the use / non-use of organochlorines: a prevalence

of 12.5% clinically diagnosed thyroid disease has emerged with a respectively 6.9% and 2.1% prevalence of hypothyroidism and hyperthyroidism. Exposure to organochlorines and fungicides, in particular, has led to a considerable increase in the risk of hypothyroidism, while for mancozeb exposure there was a statistically significant increase in both hypo and hyperthyroidism[119]. A further study in the same AHS cohort, this time considering the 22,246 males, evaluated the association between the use of 50 different pesticides and thyroid diseases and also in this case an increased probability of hypothyroidism with the use of 2,4-D, 2,4,5-TP herbicides, alaclor, dicamba and petroleum oil emerged[120].

Kidney damage

The scientific literature on the nephrotoxic effects from pesticides in humans is rather limited and most of the knowledge comes from studies on experimental animals. However, studies conducted in El Salvador, Nicaragua, and Sri Lanka have shown a higher presence of chronic diseases and renal insufficiency among agricultural workers, compared to the general population. Higher levels of organochlorine pesticides have been found in patients with reduced glomerular filtration and even exposure to pesticides that inhibit acetylcholinesterase increases the risk of renal failure. In some regions of Sri Lanka in particular, chronic kidney diseases, up to renal failure, represent the major problem of public health: many hypotheses have been made and the prevailing one is that it is a toxic nephropathy linked to environmental factors. A strong association was observed, in fact, between the consumption of hard water and the occurrence of pathology in areas where rice is grown and glyphosate as herbicide is massively used. A recent work has hypothesised a causal role of the association between water hardness and glyphosate for the chelating action of the herbicide metals[121]. The role played by glyphosate-metal complexes could explain similar situations observed in Andhra Pradesh (India) and in Central America.

Recently, the problem of end-stage renal failure has been investigated in the large cohort of American farmers and their wives. With regards to the exposed workers, a positive and statistically significant association was found between the disease and exposure to alachlor, atrazine, metolachlor, paraquat, pendimethalin and chlordane. Even for hospital admissions due to renal failure from pesticides, there was a higher risk of over 3 times than expected[122]. Even among wives using pesticides, the risk of end-stage renal failure was particularly high, while among those exposed only indirectly to the husband's activity the greatest risks emerged for paraquat and butylate[123 124].

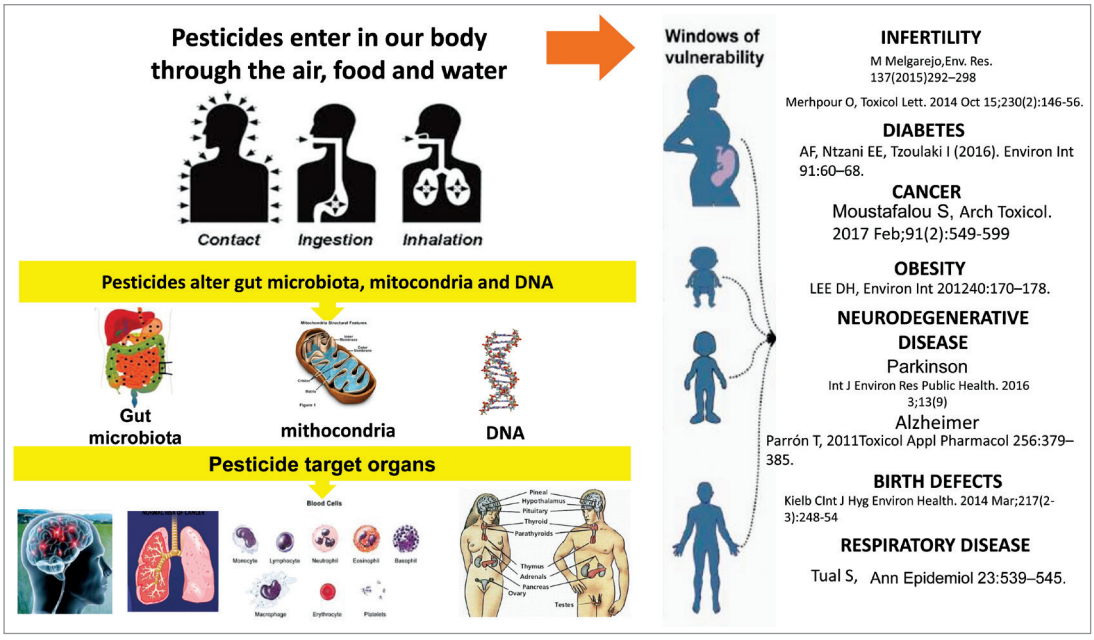

FIGURE 4: HEALTH EFFECTS OF PESTICIDES (INFOGRAPHIC: RENATA ALLEVA)

1.2 IMPACT ON HEALTH OF CHEMICALS USED IN INDUSTRIALLY PROCESSED FOOD

At the consumption end of the chain, toxins from previous production and processing stages accumulate into the products found on our supermarket shelves, home pantries and restaurant menus. For instance systemic pesticides applied on agricultural fields during production phases and food additives, such as high fructose corn syrup, introduced during the processing phase are now ingested at the consumption stage. The result is an epidemic of noncommunicable diseases, such as diabetes, obesity, hypertension, metabolic syndrome and nutrient deficiency[125]. If it is true that often few varieties of food (corn, rice, wheat, potatoes) form the essential basis of an infinity of products that we find at the supermarket[126] it is also true that the prevailing food offered by the market is an industrial product (processed food). We are facing a food entirely reconstituted by industrial manipulation, which is independent of the changing seasons and that is omnipresent on the supermarket counters at any time of the year. Here we have a food that the writer Johanna Blythmann has called "permanent global summer time"[127] (PGST).

Today on one hand we have food produced in abundance, which has also allowed poor people in advanced societies to access a cheap diet, **but on the other hand this situation goes hand in hand with an openly failed side in terms of human health**. At one point, it was discovered that cheap food caused a veritable obesity epidemic. Nowadays, obesity has not only become significantly prevalent as a pathological

component of the population in industrialised countries, especially in the USA and the UK, but also in the so-called developing countries. In India today, we are witnessing the paradox of coexistence of obesity and undernutrition[128].

The processing phase between farm and table is where more synthetic chemicals enter our foods. Processing is not 'bad' per se, and many traditional food preparations include various methods of processing and preservation, such as fermentation and oil extraction; however it is industrial food processing that warrants further scrutiny[129]. Approximately three quarters of global food sales are processed foods[130]. Thus, health implications of processed foods have global ramifications. Some critical commentators consider ultra-processed foods, referring to highly industrial processed food sources with additives, a 'world crisis'[131]. Moreover, highly processed foods, heavy in fats and sugars, and high on the glycemic index, are most likely to induce addictive eating behaviours[132].

Plastics, preservatives, organic solvents, hormones, flavour enhancers and other food additives are all commonly introduced into our diets during industrial processes. These vary between intentional food additives, such as artificial sweeteners, taste enhancers, food dyes, etc., and unintentional food additives, such as Bisphenol A (BPA) and pesticides[133]. Intentional food additives such as monosodium glutamate, high fructose corn syrup, hydrolysed vegetable protein and artificial sweeteners all carry negative health effects[134]. Several studies and meta-analyses link increased industrial food additive use to rising incidence of autoimmune disease via tight junction dysfunction and increased intracellular transfer and intestinal permeability, resulting in entry of antigens and triggering autoimmune responses[135],[136].

Indeed, the integral interconnectivity of our guts and immune systems are increasingly recognized as tantamount to human health and wellbeing[137] [138]. Various reviews and meta-analyses have also targeted and identified food additives as risk factors for autoimmune diseases. In other cases, food additives, as well as pesticides and other environmental pollutants, have been shown to selectively target autism genes, exacerbating sensitivity of autistic persons, as well as contributing to the ongoing autism epidemic[139].

Some food additives are endocrine disrupting chemicals and there is substantial evidence that these contribute to the risk of various cancers, particularly sex differentiated cancers, developmental problems, diabetes, possibly obesity, and most likely infertility and sub-fertility (De Coster and van Larebeke, 2012). Incidence and prevalence of these diseases have increased over the last 50 years, and correlate to increased food additive use, though it is difficult to establish causality[140]. Some theories as to the health effects of food additives, such as the "chemical obesogen" hypothesis, still need to be confirmed[141].

The effects of many food additives remain unknown. For instance, most artificial food colourings have not been tested for toxicity or allergic reactions in long-term use, nor are their interactions with other components and additives known. Their effects on children's behaviour likewise remain unknown[142]. Similarly, links between ADHD and food colouring remain disputed[143]. In addition, some legislation regulating artificial food dyes is highly outdated and based on science from a half century ago. For instance, a

risk assessment for titanium oxide was conducted only once in 1969 by the Joint FAO/ WHO Expert Committee on Food Additives; yet legislation continues to be based on their findings[144]. In light of mounting evidence, organisations such as The Endocrine Society, advise application of the precautionary principle as regards food additives[145]. They further call for public awareness campaigns and urgent updates of legislation on food additives based on recent scientific findings.

Processed food must be analysed in a distinct and detailed manner. Its nutritional deficits and its harmfulness depend on many factors, which must be examined step by step. The original susbstances (e.g. vitamins) are neutralised and instead additives remain active: salt, sugar (one of the elements responsible for obesity) and chemical flavours are chemical additives with which food is artificially flavoured. (It would be interesting to know if there are studies on what happens also to proteins and other industrially manipulated nutrients). In the USA, in the territory of New Jersey, there is the largest concentration of industries, both American and of other countries, which produce chemical flavourings intended to make artificially tasty industrial food all over the world.

What happens to meat, such as hamburgers and chickens? It is well known that both the process of breeding and fattening of animals, slaughtering and processing of meat, have ended up spreading, for example, in the USA, a large number of pathogens that make hundreds of thousands of Americans sick each year, causing hundreds of deaths. It is the case of *Escherichia coli 0157: H7*, but also of *Listeria monocytogenes, Cryptosporidium parvum*, and other bacteria that attack the human digestive system[146].

The chicken meat has become particularly dangerous as they are raised intensively, day and night (thanks to artificial light) without the possibility of movement, filled with antibiotics and therefore their meat, formed in a few months of life, brings with it all the infernal suffering of their short existence, and constant medication to prevent them from dying. But even the industrial processing of their meat is no less disturbing than their breeding. They are quartered through automatic processes and then the various pieces - which are a pulp of blood, bones, meat and dung - are placed in a chlorine bath for sterilisation and turned into food[147].

The subject of meat and breeding has a fairly broad spectrum of human health issues. It must be considered that the increasingly intensive form of breeding, both of pigs and of cattle, takes place in large lagers, which produce huge quantities of dung, destined to pollute the air for kilometers around as well as the surrounding water tables. These are real "zoopolies", where animals must be constantly medicated to prevent the explosion of a great variety of diseases.

The heap of animals often coming from various parts of the world to replenish the stocks of the stables, can create a "biological bomb": because the viruses they carry, modified by the chemical molecules present in the various medicines, can give life, through unknown recombination, to unpredictable and devastating epidemics[148].

ANTI-MICROBIAL RESISTANCE

Anti-microbial resistance (AMR) is the heightened resistance of microorganisms, i.e. bacteria, fungi, viruses and parasites, to anti-microbial agents. AMR may result from natural adaptations; however it most frequently develops as a consequence to indiscriminate use of antibiotics, fungicides or other anti-microbial substances. In the agricultural sector, the primary catalyst of rising AMR is intensive livestock production[149]. For instance, there is a high prevalence of Campylobacter strains exhibiting multi-drug resistance (MDR) in intensive pig farms in the United States of America[150]. Consumption of contaminated food products is thought to be the primary pathway of transmission of AMR from livestock to humans, although conclusive evidence is still lacking[151]. Nevertheless, there is consensus in the literature that there is spillover of AMR strains from livestock to humans, though the extent and degree of transmission is disputed. Water is considered to be another transmission source, as contaminated water may be consumed directly by humans, or indirectly via irrigated crops. The globalisation of food systems is considered to be another risk factor in the spread of AMR, as resistant strains may now quickly travel and spread to other regions of the world. In addition, demand for livestock products is rapidly growing in highly populous regions, such as China and India, driving intensification of livestock production systems, and increasing risk of AMR[152]

Once AMR contaminated products are ingested by humans, anti-microbial medicines that were once effective, lose their potency[153]. A recent review commissioned by former Prime Minister of the United Kingdom, David Cameron, estimated 700,000 human deaths each year from AMR infections. In the absence of mitigating and adaptive policies, this figure is expected to rise to 10 million deaths per year by 2050, more fatalities than from cancer[154]. In the year 2014, multi-drug resistant strains of tuberculosis led to the deaths of 190,000 people and the prevalence of drug-resistant infections was higher than ever before[155]. In light of these growing concerns, AMR has been recognised as a paramount global public health threat by key international institutions, such as the World Health Organisation[156] and the Food and Agriculture Organisation[157].

However, institutional focus tends to remain firmly fixed on developing newer drugs or reducing, rather than banning, anti-microbial substance abuse in agriculture, whilst more holistic solutions continue to be ignored. A case in point is the FAO action plan for AMRs which does mention the importance of Good Agricultural Practices in AMR prevention but makes no explicit mention of organic agriculture[158]. This contrasts a recent review which considers reduced threat of AMR development to be the greatest benefit of organic agriculture to public health as synthetic antimicrobial substances are prohibited in certified organic production systems[159]. Moreover, if we consider that the animal health market totaled 22 billion USD in 2011,[160] then rechanneling investments from pharmaceuticals to organic livestock production can undoubtedly be considered a cost-effective means of AMR prevention.

JUNK FOOD AND DISEASES

"Junk food" and, in general, the industrial processing of food are responsible for a long series of diseases and disorders. Here are some examples of industrial food processing.

High Fructose Corn Syrup (HFCS)

Industrial sugar contributes to the onset of metabolic diseases such as obesity and diabetes. High Fructose Corn Syrup (HFCS) is increasingly being used as a sweetener for industrial soft drinks and sweets. Coca Cola and Pepsi Cola are leading users of HFCS. This processed sweetener leads to skyrocketing of insulin production, while it suppresses the response to leptin which regulates the appetite.[161] With the disruption of its regulatory mechanisms, the body starts to store fat and obesity is the result. In a meta-analysis involving 294,617 participants it was found that the group with the highest degree of consumption of sugar-sweetened beverages (SSBs) had a 24% greater risk of cardiometabolic disease than the group with the lowest consumption.[162] Another study investigated the effects of fructose on health after 6 months of consuming 1 litre of cola a day and found increases in triglycerides, total cholesterol, blood pressure, and visceral, liver, and muscle fat.[163]

Artificial food colouring

Soft drink companies also use additives to colour. The artificial caramel colouring in colas is made by heating ammonia and sulphites under high temperature - which produces a cancerous substance called v4 methylimidazole (4 -MEI). In 2007, a US government study[164] concluded that 4 MEI caused cancer in mice. A 2011 study by the International Agency for Research on Cancer determined that the chemical is a probable carcinogen[165].

Transfats/Trans fatty acids (TFA)

It was in the early 20th century that industrially produced TFA made it to our food supply (packaged food, fried food, cooking oil etc.), as a way to increase the food's shelf life by lowering its oxidation potential. With time though there have been various scientific studies showing a positive correlation between increased consumption of TFA and rise in coronary heart disease due to increased levels of LDL (bad) cholesterol and decreased levels of HDL (good) cholesterol[166]. Globally, more than 500,000 deaths in 2010 have been attributed to an increased consumption of trans fatty acids[167]. Realising how harmful the latter is, eliminating industrially-produced transfats from the global food supply has become one of the priority targets of WHO's strategic plan, which will guide the work of WHO in 2019 - 2023[168].

Wheat and flour

The methods used in the industrial processing of wheat for the production of pasta and bread and other derivative products have different consequences for our body

compared to the methods of artisanal processing. For instance, ionising radiation may destroy or reduce valuable vitamins, i.e. A, B1, C, E and K, thereby reducing food quality[169 170]. Moreover, food irradiation can increase gluten levels in products, as well as affect intestinal permeability[171]. For instance, Celiac disease is an autoimmune disorder characterised by strong reactions to gluten in grains, caused in part by damaged gut lining and heightened gluten levels in agri-food products[172]. Other food processing, storage and preparation methods, such as heating, microwave cooking or ionising radiation may induce migration of polymer particles[173]. Similarly, extrusion cooking, explosion pressurisation, in sanitisation are all processes to which food is subjected at extremely high temperatures and pressures, leading to structural changes in the food, which in turn has consequences on health.

1.3 DARKENING THE FUTURE OF OUR CHILDREN AND THEIR CHILDREN: INTERGENERATIONAL HEALTH EFFECTS

Fetal life and early childhood are especially vulnerable periods for exposure to neurotoxicants and endocrine disruptors. Several epidemiological studies have shown an association between prenatal domestic pesticides use or proximity to agricultural fields and adverse effects on child neurodevelopment, fetal growth, or congenital malformation. Particularly the developing brain is extremely susceptible and pesticides are among the most important causes of what can be defined as a "silent pandemic".

Chronic residential exposure to pesticides, even at low concentrations, may result in increased damage and reduced DNA repair activity.

This is what emerges from a study carried out on a sample of population living in the Val di Non (Trento, Italy), known for its intensive culture of apple orchards. The study found that DNA repair systems are ineffective in countering pesticide-induced damage[174] and how, similarly, exposure to organophosphate pesticides would cause DNA damage[175]. In a specific case study on the main factors of exposure of children to organophosphate pesticides, their parents' activity also has been included, as they were farmers spraying pesticides. The study revealed a significant association between the extent of DNA damage and the children's age, the time they lived in the area, the presence of pesticides in the environment and in food.

In particular, it was found that children who frequently consumed apples had a significantly higher risk of DNA damage compared to those who consumed apples less frequently.

On a molecular level, in vitro animal and human tests of several classes of pesticides, including endocrine disruptors, persistent organic pollutants, arsenic and several herbicides and pesticides, exhibit modifications of epigenetic markers[176]. Other scientists consider the harmful epigenesis of pesticide-induced neurotoxicity and neurodegeneration[177]. These compounds may alter gene expression and transfer altered genetic traits to future

generations. Future generations may thereby effectively inherit the legacy of the pesticides of the present in the expression of their very genes.

Impact of unhealthy diets

Health damaging effects of inadequate or imbalanced diets and chemicals in our food are not confined to a single generation. Nutrition provides nourishment that is vital for health and wellbeing at every stage of human life. This linkage commences even prior to conception, with the nutritional status of the adolescent girl who is a prospective mother, and continues later during periods of pregnancy and lactation as a critical determinant of child development. Nutrition during the first 1000 days of life has a especially profound influence on human development, not only affecting child development but also influencing vulnerability to both infectious and chronic diseases across life through immunological and metabolic programming[178]. Apart from physical health, mental and emotional health too are now recognised to be influenced by balanced nutrition.

Maternal malnutrition affects the fetus in the womb through epigenetic effects of impaired fetal nutrition. These influences continue in early childhood. When restored to even near normal nutrition in later childhood, the metabolically maladapted child responds with 'rebound adiposity', with a larger proportion of body fat and less lean muscle mass. That sets the stage for diabetes, cardiovascular diseases and even certain cancers in adulthood. The shadow of nutritional mismatch is thus cast long across the life course.

The epigenetic effects may extend across several generations.

Even when fetal and early childhood nutrition has not been impaired, later exposures to unhealthy diets can induce epigenetic changes that can lead to NCDs.

If a malnourished pregnant woman is nutritionally starving a female fetus in her womb, epigenetic changes may be induced not only in the fetus but also in the ova that are developing in that fetus. The inter-generational transmission of these epigenetic effects thus affects not only the yet to be born girl but also her yet to be conceived child.

Even the microbiome can mediate intergenerational effects of malnutrition. A malnourished mother does not produce, in her breast milk, the oligosaccharides needed for the microbiome of the child. Though these are not directly utilised by the baby, they are needed for the healthy growth of the microbiome which thrives on them. The adverse effect on the microbiome impairs the child's nutrition. Since it is above all the early exposures, in particular in uterus, the most dangerous ones and since the protective effect of the organic diet has already been demonstrated, we believe that the population must be adequately informed so as to make more conscious choices and that it is from now on guaranteed during pregnancy, lactation and in childhood[179].

Besides these biological effects, unhealthy diets have intergenerational effects through sociological effects on dietary behaviours. Children who grow up accustomed to unhealthy diets, are conditioned to continue them in later life. The addictive effect of high fat,

sugar or salt in the diet compounds this by converting conditioned cultural preference to craving and compulsion to consume.

Access is a key pillar of food security and nutrition and features in the formation of obesogenic environments. Access to healthy foods is limited in some urban centres in a phenomenon known as 'food deserts,' mostly in low income or ethnic minority neighbourhoods. In general, ethnic minorities typically exhibit poorer health than ethnic majorities, resulting in greater social inequalities expressed within the food system[180]. The difficult access to fresh and healthy food is accompanied by the relative ease of access to fast food, which in itself has a negative impact on human health. This is the case of fast-food restaurants, deliberately placed near schools, which have caused an increase in the incidence of obesity in pupils.

Good nutrition is not merely an essential support for good health but it allows and enables the development of other human capabilities to full potential. Good health enhances opportunities for accessing and assimilating quality education, acquiring an array of skills, securing gainful livelihoods and performing well in all dimensions of life. Denial of health promoting nutrition is a denial of the right to health and deprives an individual of the opportunity to develop his or her capabilities to full potential[181]. Access to good health, through good nutrition, should therefore be regarded as a commitment to social justice.

ENDOCRINE DISRUPTORS IN PEDIATRICS: CURRENT EVIDENCE[182]

S. BERNASCONI, S. CESARI, L. MELANDRI, F. SAVINA

The environment in which we live has been gradually contaminated with many man-made chemicals, which, through a variety of sources and routes, are responsible for damage to the ecosystem and the health of the population. In the last 40 years there have been studies that have suggested the possible interference of these chemical substances with hormonal systems of living organisms. Numerous international organisations that deal with environmental health have focused on the problem of so-called Endocrine Disrupting Chemicals (EDCs), defined as "any substance or exogenous material that can alter one or more functions of the endocrine system and consequently cause adverse health effects of a healthy organism and its progeny" (European Commission, 2001). Currently on the market there are over 100,000 chemical substances, and only a fraction of them could be identified as potential EDCs; in this category mainly pesticides, industrial chemicals (including polychlorinated biphenyls, or PCBs, phthalates and alkylphenol) and natural compounds of plant origin, such as phytoestrogens have been identified. Most of these substances have been studied in relation to their possible estrogenic effects, which is why they are referred to as xenoestrogens; however many EDCs

are also able to interfere with other hormonal systems in testicular, adrenal and thyroid, with mechanisms agonism and / or antagonism. Many of these compounds (e.g. pesticides) persist in the environment and accumulate at different levels of the food chain; the main source of exposure for humans is represented by diet, although other ways exist: inhaled air or drinking water, in addition to direct skin contact (from products for household cleaning, cosmetics, clothes...). Newborns and infants can also be potentially vulnerable to this type of exposure even in an indirect way, through the placenta or through breast-feeding[183]. The main effects of EDCs on organisms in the field of reproductive function show higher incidence of testicular neoplasms and infertility, as well as an increased frequency of cryptorchidism and hypospadias. Secular changes in growth and human development, as average height and age of onset of puberty were correlated significantly to progressive changes in the environment, socio-economic conditions, sanitation and nutrition, and it is therefore possible that exposure to EDCs may have played a role in these processes of change[184]. An example of this can be accounted for by the higher incidence of precocious puberty in children living in developing countries[185]. The action of exogenous factors on the male reproductive function seems, however, also supported by a genetic predisposition substrate, which is the basis of what is termed Testicular Dysgenesis Syndrome (TDS); the etiological hypotheses related to this condition relate to the possible estrogenic and anti-androgenic actions of exogenous substances, which not only can act by antagonizing hormone ligands, but can also operate at the molecular level by influencing the expression of genes involved in the regulation of reproductive function[186]. The time of exposure to EDCs, as well as the gender of the exposed individual, can have a significant importance in the occurrence of alterations in the pre and postnatal development; studies in animal models have shown that prenatal administration of phthalates can cause cryptorchidism in male rats, and is also responsible for early puberty in females[187]. Studies on the effects of EDCs on humans are still limited and poorly substantiated; some of the current knowledge is based on clinical experience of the past, as in the case of prenatal exposure to DES, once administered to pregnant women, which later turned out to be responsible for an increased incidence of urinary genital malformations such as hypospadias and cryptorchidism[188]. To define the modalities and the concentrations capable of causing adverse effects is a complex problem. The potential toxic effects of other compounds, which so far have never been investigated, need to be tested. Finally it will be necessary to evaluate the risk of exposure in the population and strategies to avert or limit the sources of EDCs.

SECTION 2

ONE PLANET ONE HEALTH: THE EMERGING SYSTEMS OF SCIENCE FOR AGRICULTURE, FOOD, AND HEALTH

2.1. THE CHANGE OF PARADIGM: GOING FROM A MECHANISTIC AND REDUCTIONIST PARADIGM TO AN ECOLOGICAL AND SYSTEMIC PARADIGM

"Observe nature deeply, only then you will really understand everything"
–Albert Einstein

The agricultural industrial paradigm, still dominant today and rooted in the mechanistic and reductionist ideology, is incapable of dealing with the current health crisis it has helped to create, since dealing with the links between food and health is incompatible with its essential principles. There is a refusal to see the interconnections between industrial agriculture and industrial food and the consequent harm to the health of people and the environment and the chronic diseases it has given rise to. The industrial system of food production does not have the epistemic, political or economic potential to offer real solutions to the disease epidemic that is occurring in every part of the world.

There are two paradigms for agriculture, food, and health, based on two paradigms of knowledge: one being systems based and ecocentric, the other being reductionist and egocentric. The first, based on a systems approach, recognises the interrelationships between how we produce, process and distribute our food. It embodies the idea that human beings are not separated from nature, but are part of it and of its complex living processes.

The ecocentric paradigm recognises the self-organising capacity, from microbes and cells, to our bodies, and planet earth. Planetary health and our health are one health. In this perspective, ecological degradation and disease are seen as an impairment in this capacity of self-organisation, self-regulation, self-healing and renewal of living systems. In the ecological paradigm, agriculture, food production and health are internal inputs into systems, which have an internal capacity and potential to produce what they need. The earth, food and our bodies are interconnected living systems. The health of the planet and our health are a continuum.

The second paradigm is mechanistic and reductionist, based on seeing human beings as separate and apart from nature. Nature, food and our bodies are viewed as

machines, to be managed with external inputs, control and regulation. The mechanical worldview is static, non dynamic, non interactive, divisive and separating. It insulates itself from a living and lived reality, creates artificial and abstract constructions which are disconnected from reality, and unconcernedly calls these abstract constructions "objective knowledge" and absolute truth.

Genetic reductionism and genetic determinism reduce a complex organism to one constituent, the DNA, and assign it determining power over the entire organism. Thus, industrial agriculture is viewed as an external input system, based on purchase of high cost patented seeds and toxic agrichemicals. Health, too, is viewed as an external input system, based on purchase of high cost patented pharmaceuticals, additives, and "fortification". The mechanistic paradigm sees food as "mass", which can be manufactured, manipulated, substituted and engineered.

When food is seen through the lens of nutritional or genetic reductionism, causation is artificially reduced to one cause, one effect, with both the cause and effect being decontextualized.

However, as Goethe has emphasised, "Life as a whole expresses itself as a force that is not to be contained within any one part. The things we call the parts in every living being are so inseparable from the whole that they may be understood only in and with the whole"[189].

Both food and our bodies are complex self-organised systems. In living systems, causality is systems causality, which encompasses both process and context. Properties and behaviours are potentials and their expression depends on the context, relationship, process, and complexity. Giulia Enders writes in her best seller *GUT* which brought the word 'microbiome' into every day usage: "The important thing is not to reduce the human body to a two dimensional cause-and-effect machine. The brain, the rest of the body, bacteria and the elements in our food all interact with each other in four dimensions. Striving to understand all these axes is surely the best way to improve our knowledge"[190].

Plants, consumed by humans and other animals, are a vital part of our nutrition. Their nutrient composition is influenced by the nutrient composition of the soil in which they grow. Even the animals that humans feed on source their nutrients from plants. Our bodies are not machines, and food is not fuel that runs the machine on Newtonian laws of mass and motion. **Food is not merely mass; it is living, it is the source of life and the source of health. Our bodies are living ecosystems with sophisticated regulatory systems that transform good food into health and bad food into disease.**

Unmindful of these connections, we have altered the chemical composition, texture and water levels of soils through agricultural and industrial practices, which have impacted on the nutrient quality of our plant-sourced foods. This non-ecological approach to food production, coupled with unhealthy food processing and commercially obsessed manipulative marketing practices, has created propulsive pathways for disruptive diets that produce ill-health. A non-reductionist, ecologically sensitive and human welfare-

oriented approach to food systems is therefore needed to ensure that adequate and appropriate nutrition is available to every person now living, and those yet to come, at every stage of life.

2.2. BEYOND GENETIC REDUCTIONISM: THE KEY ROLE OF NUTRITION IN GENE- ENVIRONMENTAL INTERACTIONS THAT DETERMINE HEALTH

Genetic determinism would have us believe that health and disease are principally determined by pre-set genetic influences which are dominant and that environmental effects have little role in modifying them. However, that dogma is being shattered by the growing knowledge of epigenetic pathways that mediate the effects of environmental exposures, especially nutrition, on gene expression. This knowledge further strengthens the conclusions drawn from a huge body of epidemiological evidence that demonstrates strong and consistent associations between diet and health outcomes.

Diet is what we consume through food and drink. Nutrition is what our body extracts from the diet for obtaining the nourishment that is vital for maintaining health and wellbeing across the life course. Nutrition is the life giving force that is essential at every stage of life. From the pre-conception nutrition of the future parents, to maternal nutrition during pregnancy and lactation and early childhood nutrition, the most important contributor to child survival as well as physical and cognitive growth is supportive nutrition. Health has both intrinsic and instrumental value. The former provides a sense of wellbeing and confidence while the latter enables a person to access education, play sport and engage in productive livelihoods apart from playing the reproductive role of propagating the human species. When obtained through a balanced and palatable diet, nutrition too has intrinsic and instrumental values, the former reflected in the enjoyment of what we consume as food and drink while the latter is realised in good personal health obtained and secured through protective nourishment as well as through the social bonding that convivial collective meals promote.

The links of health and nutrition have evolved through knowledge obtained from several streams of enquiry, ranging from observed experiential wisdom of community practices to rigorous scientific research that explores nutrient-human body interactions at the molecular level. **Unfortunately, the explosion of scientific knowledge on human nutrition, over the last century, has led us on to a reductionist path of trying to identify the isolated role of individual nutrients and synthesising them as commercial products. Interactions between various nutrients were largely ignored.** This is due to genetic reductionism and genetic determinism that reduce a complex organism to one constituent, the DNA, and assign it determining power over the entire organism.

Even in nutritional epidemiology, health and disease associations were sought with specific nutrient biomarkers or at most with individual food items rather than

with composite dietary patterns. The well-funded fascination of biomedical and even epidemiological research with the genetic basis of health and disease led to the sidelining of environmental factors, especially nutrition, as independent or interactive influences that extend beyond the purely genetic determinants. The limits of such reductionism have been exposed in recent years. Even as the Mediterranean diet has been hailed as a proven protector against several diseases, especially cardiovascular diseases and cancers, it has been acknowledged that no single component of that composite diet has a demonstrable protective effect by itself.

While nature versus nurture debates long bedeviled a rational approach to human health and polarised the scientific community into genetic determinists and environmental-change advocates, the growing science of epigenetics throws light on complex gene-environment interactions that influence health over the lifetime. We now have insights into how several environmental exposures, including nutrition, modify gene expression without changing the gene's DNA composition. Up-regulation or down-regulation of specific gene functions, resulting from environmentally triggered but structurally non-damaging chemical changes in the gene, are now known to be linked to nutrition. These changes lie in the pathway between health and disease, warranting a re-look at what constitutes healthy nutrition even from a geneticist's view.

AGRO-NUTRITIONAL CONTROVERSIES

A few examples of uncertain and controversial scientific decisions, which resulted in wrong regulatory measures can be drawn from the agro-food sector[191]:

- The US Food and Drug Administration, recently banned partially hydrogenated oils (PHO) in foods within the US because they are no longer "Generally Recognized as Safe". This came after an extensive evaluation of epidemiological health data that shows that PHOs increase the risk of cardiovascular disease. Such oils have been used since the 1950s, but until today, under the WTO law, it would have been very problematic for another WTO member (e.g. Europe, where they have been banned for years) to stop PHOs from being used.
- Glyphosate (chemical name for Monsanto's Roundup), a popular herbicide used in conjunction with genetically modified Roundup resistant soybeans, was originally believed to be safe for use and was touted by its manufacturer as a working example of the success of biotech products. However, recently, and many years after its approval for use, the World Health Organization determined that glyphosate is a probable carcinogen. Although the question is still scientifically debated, many studies consider glyphosate unsafe.

  In November 2014, the FDA stated that Bisphenol-A (BPA), a popular raw material used in the epoxy lining of cans, was safe under its current use conditions

within the food industry. More recently, the Environmental Working Group (EWG) released information that contradicts the FDA position and suggests that the FDA is "rushing to judgment" ostensibly because the FDA studies were superficial. The EWG points out that the US Environmental Protection Agency has proposed new regulations that specifically highlight that BPA is "a substance that may present an unreasonable risk of injury to the environment on the basis of its potential for long-term adverse effects on growth, reproduction and development in aquatic species at concentrations similar to those found in the environment".

- In the middle of the 1990s, in the UK and then in other European countries, the so-called "mad cow disease" (Bovine Spongiform Encephalopathy) was found in bovines bred in Europe, and there it proved to affect humans. In this case, the experts considered feed given to the cows as safe, even if some scientists claimed they were dangerous for both the animals and humans. The epidemic outbreak that derived by that wrong assessment spread all over the continent, with many cases of the Creutzfeldt-Jakob disease, which killed more than two hundred people.
- The arbitrary use of science is visible in several disputes decided before the Dispute Settlement Body (DSB) of the World Trade Organization (WTO), in accordance with the Agreement for the Adoption of Sanitary and Phytosanitary Measures (SPS Agreement). In all of them, the DSB has decided against the party that restricted trade (to protect health), as the latter was not able to provide a scientific demonstration of the rational relationship between the alleged risk and the trade-restrictive (at the end deemed protectionist) measures adopted for health reasons.

  The DSB decisions and the relative literature on them show that while global law requires exclusively a science-based measure in order to derogate free trade, at national or regional level the regulatory approach is open to allow wider discretionary powers on behalf of regulatory authorities, for instance admitting the application of the precautionary principle when science is uncertain[192]. Such a principle does not apply at the international level, as it is considered a potential cause of arbitrariness, disguising protectionism and limiting free trade. Nonetheless, at the same time, the scientific evaluations on which the free-trade oriented measures are based cannot always be considered sound, objective and universal.
- These examples highlight that the "existing science", which would be relied on to perform a risk assessment, can be quite unreliable in predicting certain risks. Further, prejudices or pressures may affect science significantly by lobbying for the use of certain chemicals or technologies.

2.3 BIODIVERSITY IS HEALTH: FROM OUR FARMS, TO OUR PLATES, TO OUR GUT MICROBIOME

From an egotistic anthropocentric view, that perceived all non-human life as inferior, subservient or inimical to the human, we are now increasingly recognising the interdependence of all life on our planet and the importance of biodiversity for supporting and sustaining human life.

What agricultural and nutritional local systems from all over the world have in common, is, in different ways and expressions, the awareness of the value of natural balances, as well as a strong culture of land conservation for the survival of the present and future generations, which finds expression in the safeguarding of agricultural biodiversity, in rotations, on organic fertilisation, in manual or mechanical weeding, in natural antagonists to fight pests. The industrial agriculture model has profoundly altered the quality of food coming from the countryside of the world. Food systems, starting from the way our food is grown, can be the basis of human health and wellbeing or one of the most important direct and indirect risk factors. Today, industrialisation and globalisation characterise the entire food system in all its phases, influencing food, lifestyle, health and wellbeing in general, and are driving a global dietary transition in which traditional diets are replaced by diets higher in refined sugars, refined fats, oils and meats.

Presently, food production systems and the environment are engaged in a mutually damaging relationship. Agriculture and food processing systems are degrading the environment through greenhouse gas production, pesticide use, soil erosion and water depletion as well as energy intensive production methods. The same systems that put our health at risk also have a devastating impact on environmental health. In a vicious circle, environmental degradation is also reducing the quality of basic nutrients.

Local farming, which returns us to natural foods and reverses the harmful impact of industrial scale agriculture, food processing and marketing, will provide the recipe for such a reinvention of ecologically friendly and health promoting food systems that regenerate our soils, biodiversity, the environment and our health.

Biodiversity rich agriculture is essential for proper nutrition & good health

Diverse peoples, with diverse cultures, have always eaten diverse plants. Farmers have been developing hundreds of different farming techniques and evolving countless varieties of species, they have built up an extraordinary reservoir of biodiversity. The application of reductionist methods based on uniformity to plant breeding, however, has led to the substitution of traditional local varieties, which were evolved over hundreds of years by our farmers, by widespread genetically homogeneous varieties, spurring a dramatic loss of diversity.

There has been a historical reduction of biodiversity and the depletion of diversity of nutrients in food. 75% genetic diversity has disappeared in one century[193]. From 10,000 species originally, barely more than 150 species are now under cultivation and the great majority of mankind is now living off no more than 12 plant species[194].

What happened in the contemporary age is exemplary. The green revolution, which introduced the "improved seeds", extended the monocultures, reduced or canceled the peasant farming for food, has also drastically reduced both natural and agricultural biodiversity. Today, we ignore and therefore underestimate the extraordinary biodiversity, above all the plants which the peasants of past centuries enjoyed and the vast knowledge they had of species and variety.

What effect has the reduction of so many varieties of plants and food, of micronutrients, proteins, vitamins, minerals had on the human organism? We know very little of it, because no history has yet been made of such phenomena. But we must reflect on the fact that the genetic construction of human beings took place over millennia and that we have lost in a few centuries - and in an accelerated way, the last decades - biological components, which had long been part of our diet and to which our body had become accustomed.

Over thousands of years, local communities and cultures have been breeding seeds in order to obtain as many varieties as possible, which are constantly evolving and able to adapt to the specific environmental characteristics and climatic conditions of each particular territory[195].

Human beings have domesticated wild plants and animals since millennia to ascertain nutritional requirements, availability of seasonal food and ecosystem conservation. The evolutionary interactions between man and nature led to a participatory selection of food biodiversity and celebration of knowledge on agro-ecosystem management. The resilience and longevity of this approach bequeathed a healthy planet to new generations. This sustainable human-environment interaction preserved and created new genetic diversity that is being irreversibly lost by industrial agricultural practices. The introduction of new, synthesised molecules into a balanced agro-ecosystem leads to a logarithmic loss of biodiversity, which is accelerated by the tendency of modern plant breeding towards uniformity[196].

Today, most varieties are pure lines, hybrids or clones depending on the crop and on the market, and this decline in diversity has increased the vulnerability of crops[197] [198] [199] because their genetic uniformity makes them unable to respond to environmental changes such as those expected in the near future. In addition to the increased uniformity of the varieties that we grow, plant breeding has also contributed to the decrease of the

number of crops with only about 30 plant species supplying 95% of the global demand for food[200] and with the four biggest staple crops (wheat, rice, maize and potato) taking the lion's share[201].

The less the biodiversity, and its ecological functions for renewing soil fertility, controlling pests, and weeds, the higher is the dependence on chemicals. The monoculture, typical of industrial agriculture, is strictly connected with the use of an increasing need of agro-chemicals, especially fertilisers and pesticides. New research is showing that traditional farmer-bred varieties are richer in nutrition than modern industrial varieties. Since nutrition and nourishment is the real value of food, 'Nutrition Per Acre'[202] is the more relevant metric for food security than yield per acre for nutritionally empty food.

We must not forget that food is derived from the seeds and that the primary cause of health problems that afflict the world today is to be sought in the way seeds are produced to be uniform and to respond to chemicals, not for their nutritional density And because seeds - that later produce the food that has all those effects on our health described already - are produced by the science called genetic improvement, in order to change things we must rethink how breeding is done, and shift from "cultivating uniformity" to "cultivating diversity".

Today, much of the "institutional" plant breeding, and not only the private, has as its objective industrial agriculture. Therefore it is based on the selection of uniform varieties performed by research centres, – in compliance with seed laws – aimed at producing as much as possible with the support of fertilisers and pesticides. There is no breeding for organic farming, and if there is, it is very modest in size. Therefore, one of the reasons for the difference in production between conventional agriculture and organic farming is that in the latter, lacking suitable varieties, the same varieties are grown that are selected for conventional agriculture; they obviously find themselves in a completely different situation from the one for which they have been selected, and therefore produce less. Conventional varieties have been selected for intensive agrochemical inputs and irrigation and their use in organic farming inevitably produces low yields. The way to select varieties for organic farming can be efficiently done in a rapid and economical way with the evolutionary genetic improvement[203], which consists in creating populations of mixed seeds, obtained by crossing between different varieties, and by letting them evolve, using them to grow crops, or to make the selection of the best plants. This offers the possibility to adapt seeds and crops not only to climate change in the long run, but also to climatic variations from year to year, as well as to control weeds, diseases and insects without resorting to pesticides. Thanks to the natural crossings that always occur within them, these populations are constantly evolving (for this reason they are called "evolutionary") and farmers have the possibility to adapt the crops to the particular way in which each of them practices organic farming.

PLANT BIODIVERSITY AND CULTURAL HERITAGE FOR SAFER AND HEALTHIER FOOD: THE PRESERVATION OF FRUIT VARIETIES IN SARDINIA

During the last century, the industrial farming model has led to the erosion of agrobiodiversity and loss of local seasonal fruits and vegetables in Sardinia[204]. Already in 1914, Baur[205] pointed out a shrinking of available cereal landraces caused by their replacement with more productive, but less sustainable varieties.

Several statistics highlight the "beneficial effects" of what was the 'Green Revolution'[206], whereas side effects, such as an increase of noncommunicable diseases in developing countries, environmental pollution, and biodiversity loss receive less attention[207]. Intensive farming, by using herbicides, has significantly reduced the genetic diversity of wild edible plants (WEP)[208]. Several WEPs embody an integral part of local diets worldwide and they are crop wild relatives useful in sustainable breeding programs[209]. In addition, foodstuff production by large-scale agriculture has produced a restraint on human diet quality (reducing the number of rice, wheat, and maize varieties that account for about 60% of the calories and 56% of the protein daily supply in developing countries), undermining the self-sufficiency of small-scale farmers, and threatening environmental sustainability[210 211].

The Mediterranean basin owns a great biodiversity of fruit tree landraces and varieties due to the long domestication history[212]. The domestication process has involved all typical Mediterranean fruit trees and has been greatly influenced by local and dominating civilisations.

Significant changes occurred in fruit culture, since intensive farming started. New, more productive varieties replaced traditional landraces and trade became global with few varieties. In contrast, a great variability within species, especially concerning morphologic characteristics, harvesting time and health properties, was traditionally available on local markets. The study conducted on Sardinian pear, apple, and plum ancient landraces evidence that fruit trees are scattered and most of the ancient genetic diversity is still available. Recent studies on nutraceutical and functional properties have evidenced that several landraces have very high antioxidant properties due to extraordinary levels and chemical variability of polyphenols. In addition, dietary fiber contents are high and total sugars in most fruit are low. Concerning bioactive secondary metabolites of fruit, a group of pear landraces evidenced a strong control towards Penicillium expasum infection and the synthesis of patulin, a mycotoxin with genotoxic properties, is inhibited.

Compared to new varieties, the landraces are generally less uniform and have a shorter shelf life. Still, the great number of landraces, which have different harvesting time, provide fruit from June until late November. The availability of pear landraces

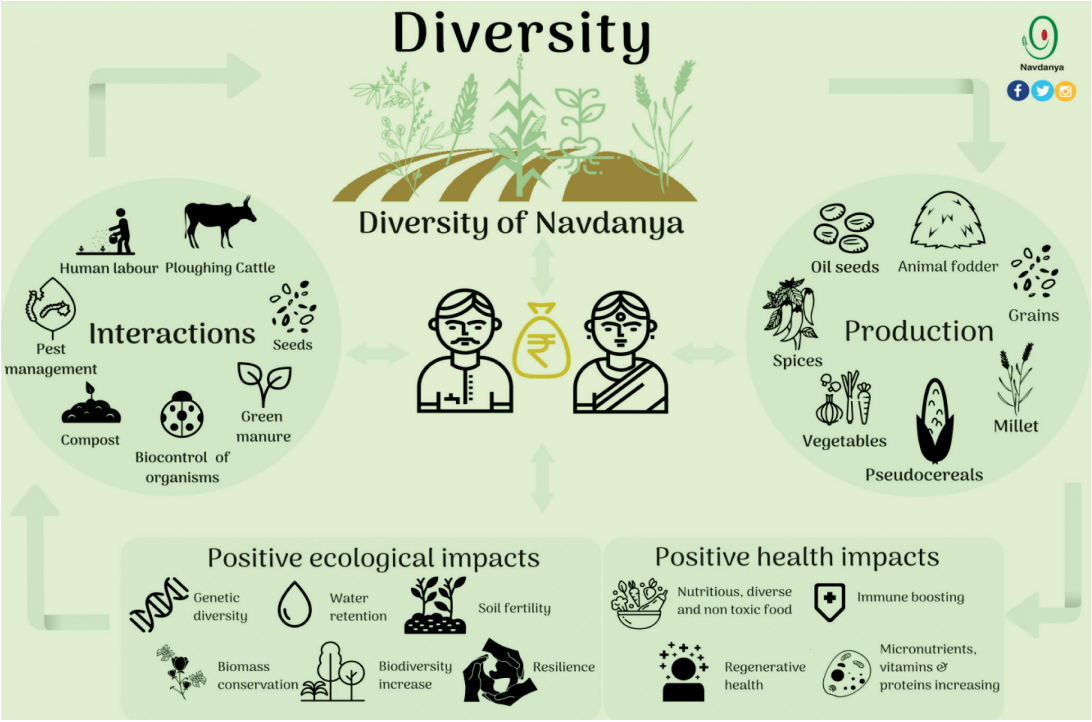

FIGURE 5: DIVERSITY OF NAVDANYA - DESIGN: CHLOÉ GENIN

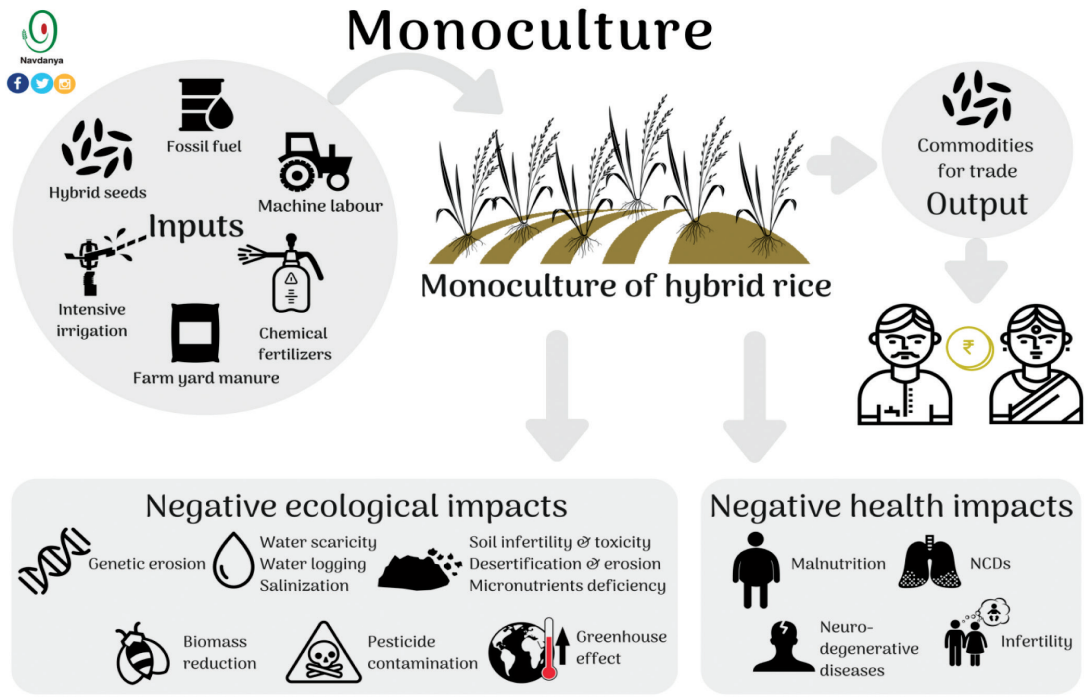

FIGURE 6: MONOCULTURE - DESIGN: CHLOÉ GENIN

with such a broad harvesting period within the island evidences one of the selection criteria adopted in the past by local inhabitants, in order to obtain fresh pear fruit for several months.

In addition, clinical studies on internal browned fruit evidenced a better gut behaviour and some varieties have a selective control on pathogenic bacteria of the oral biome. The nutritional and functional properties of most landraces fit with the actual health characteristics requested by consumers and novel products other than fresh fruit may be an alternative way to promote landrace renewal. In this regard, studies on processed products such as dried fruit, jams, fermented fruit drink, fruit vinegar etc. are underway[213] [214].

2.3.2. Biodiversity of chemical free food is vital for a healthy gut microbiome

Our gut is a microbiome, which contains trillions of bacteria[215]. There are 100,000 times more microbes in our gut than people on the planet.

To function in a healthy way, the gut microbiome needs a diverse diet, and a diverse diet needs a diversity in our fields and gardens. A loss of diversity in our diet creates ill-health. Because we are more bacteria than human, when the poisons (such as pesticides and herbicides) we use in agriculture reach our gut through food, they can kill beneficial bacteria. The gut is increasingly being referred to as the second brain. Our bodies are intelligent organisms. Intelligence is not localised in the brain. It is distributed. And the intelligence in the soil, in the plants, in our bodies makes for health and wellbeing. A substantial amount of emerging research is indicating that the gut microbiota has a significant impact on human health. Diet composition plays an important role in the control of gut microbial populations and, thus, in the prevention, management and treatment of certain diseases such as cancer and diabetes. The diet strongly influences the microbiome, and a change in the diet changes its composition in just 24 hours; it takes 48 hours, after changing the diet again, before the microbiome returns to the initial conditions[216]. The Mediterranean diet, which is based on a balanced intake of fruits, grains, monounsaturated fat, vegetables and polyunsaturated fats, is considered the standard for a healthy lifestyle. It has been found that such diets have anti-inflammatory capabilities and can be used to reduce inflammation in diseases.

Just as, when we apply urea to soil, the rich biodiversity of soil microorganisms that create the diversity of soil nutrients, is destroyed, and the soil becomes diseased and desertified, in a similar way, when we eat poisons or too many antibiotics, our gut microbiome starts to get desertified.

The microbiome, which weighs an average of two kilograms – consider that the human brain weighs an average of one and a half kilograms – plays a number of important functions, from the synthesis of vitamins and essential amino acids, to the breakdown of what has not been digested in the upper intestinal tract. Some of the products of these activities represent an important energy source for intestinal wall cells and

contribute to intestinal immunity. Most importantly, there is clear evidence that bacteria-dependent metabolism of pollutants modulates the toxicity for the host. In fact, gut microbes have an extensive capacity to metabolise environmental chemicals that can be classified in five core enzymatic families (azoreductases, nitroreductases, β-glucuronidases, sulfatases and β-lyases) unequivocally involved in the metabolism of 430 environmental contaminants. Conversely, because of the antimicrobial activity of some pesticides, pesticides have the potential to change the gut microbiome and induce other symptoms in animals.

Environmental contaminants from various chemical families have been shown to alter the composition and/or the metabolic activity of the gastrointestinal bacteria, which may be an important factor contributing to shape an individual's microbiotype. The physiological consequences of these alterations have not been studied in details but pollutant-induced alterations of the gut bacteria are likely to contribute to their toxicity. In conclusion, there is a body of evidence suggesting that gut microbiota is a major, yet underestimated element that must be considered to fully evaluate the toxicity of environmental contaminants[217].

Science has recently begun associating the decline of biodiversity with the increase of inflammatory diseases ranging from inflammatory bowel disease, to ulcerative colitis, to cardiovascular disorders, to various liver diseases and to many types of cancer. This increase in the frequency of inflammatory diseases has been associated with a decrease in our immune defenses[218]. Even more recently, the microbiome - namely the complex of bacteria, viruses, fungi, yeasts and protozoa that is in our intestine (sometimes called microbiota) – has been associated with our immune system and then with the possibility or not to contract inflammatory diseases[219]. Researchers have shown that patients suffering from melanoma and capable of responding to immune therapy had a microbiome that differed both by composition and by diversity from patients who did not respond[220]. The research concluded that the composition and the diversity of the microbiome are important in determining anti-tumor immunity. The response of laboratory mice that had received a fecal transplant from human patients who had responded to the therapy supported the results. Fecal transplantation involves transferring the microbiome from a healthy patient to a patient with a disease and is becoming a widespread practice for the treatment of diseases that do not respond to antibiotics. The microbiome also appears to be involved in several neuropsychiatric disorders such as depression, schizophrenia, autism, anxiety, and stress response[221]. This is likely due to the damage that inflammatory processes cause to myelin, the sheath surrounding the neurons, thus altering the normal transmission of nerve impulses. Recent results demonstrate that gut microbiome composition is shaped predominantly by environmental factors (diet and lifestyle) and that the microbiome is not significantly associated with the genetic ancestry.

DIETARY DIVERSITY

Dietary diversity is a good indicator of the relative health of a diet[222], and traditional diets tend to be more diverse than western diets. Traditional diets also tend to be supported by more agrobiodiverse and agroecological systems[223]. Additionally, traditional agriculturalists typically benefit from 'the hidden harvest,' so-called for the multiple wild foods harvested within cultivation zones, contributing to dietary diversity[224]. The rise in organic agriculture in regions such as Europe with a quadrupling of market value in the last 15 years[225] and a doubling in organic agricultural acreage since 2004[226], is just one marker signifying this trend. It also signifies a growing health consciousness, as consumers value organic produce as a healthier alternative to their conventional counterparts, particularly as regards reduced pesticide residues[227] and antibiotics[228]. On more grassroots levels, increasing interest and practice of permaculture, urban agriculture, agroecology, wild foraging and the growth of local farmers' markets with diverse heirloom and forgotten vegetables, all point towards a reclamation of our food systems to regain control of our food and therewith our cells, tissues, organs and bodies.

Historically, the world is rich in nourishing traditions ranging from Ayurveda in India to the Mediterranean diet in Europe, amongst many others. Meanwhile, Ayurvedic diets can help treat brain and neurologic disorders[229]. Vegetarian diets, based on a high intake of fruit and vegetables, are also recommended for their health-promoting characteristics[230].

The Mediterranean diet, composed of high intake of olive oil, olives, fruits, vegetables, mostly unrefined cereals, legumes, nuts, fish, meat, dairy and wine in moderation, is perhaps one of the most well-studied diets in the world. This diet represents a significant model of "nutrition for health", being based on concrete data and therefore integrated into the university programs of the faculties of medicine[231], thanks to its benefits on longevity, quality of life and prevention of a wide range of chronic-degenerative diseases.

Since Keys' seminal Seven Countries Study (1970), a wide range of papers have been published on the health benefits of this traditional diet[232], including its protective effects against cardiovascular disease[233], metabolic syndrome[234], obesity[235] [236], chronic diseases and cancer.

The Mediterranean Diet is increasingly being adopted for its diversity and nutritious qualities. It is rooted in local food cultures and diversity. It is also a lifestyle based on community, sharing and comeradeship[237] [238]. However this nutritional model is increasingly threatened by the globalisation and industrialisation of food, standardised lifestyles, eating fast, junk food, and through the loss of identity and appreciation of one's own food culture including the erosion of local food heritage and a progressive loss of food sovereignty. The Mediterranean food culture means protecting people's lifestyle in which food is in harmony with nature and creates a space of health and wellbeing for communities[239].

Diversity and uniformity: seeds, food and health

The opinions of the nutritionists looking at the effects of various diets do not always agree, but what all nutritionists seem to agree on is that diet diversity is of paramount importance for having a healthy microbiome[240]. And here the problems begin. How can we have a diet based on diversity, if 60% of our calories come from just three plant species, i.e. wheat, rice and corn[241]? And how can we have a diet based on diversity, if almost all the food we eat is produced from seed varieties that, in order to be legally traded (i.e. in order to be legally sold in supermarkets), must be registered in a catalogue that is called register of varieties, and that, in order to be recorded in this register, must be uniform, stable and recognisable?

Food and seed regulations run contrary to the imperative of a diet based on biodiversity, organic and local food for a healthy microbiome and nutritious food. Between the need to eat "diverse" foods discussed so far, and the uniformity in food products required by laws on crops, there is a clear contradiction. So too there is an obvious contradiction between uniformity and stability on the one hand and the need for crop adaptation to climate change and local environments on the other. **If our health depends on the diversity and composition of the microbiome, which in turn depends on the diversity of the diet, how can we have a diversified diet if the agriculture that produces our food is based on uniformity[242]?**

A diet based on diversity needs an agriculture based on diversity. Diversity on farms needs small farms and local food systems. Monocultures, large-scale farms, and globalised, long distribution require monocultures of a handful of commodities. Diversity and decentralisation go hand in hand. Monocultures and globalisation go hand in hand. The situation gets even worse when we consider that alongside a food oligopoly, there is also a seed oligopoly (from which all the food comes directly or indirectly) as the world seed market, a market worth billions of dollars, is for about 55% (2016 data) in the hands of five large multinational corporations, up from only 10% in 1985. Some of the same corporations simultaneously control another multi-billion dollar market, that of pesticides (i.e. herbicides, insecticides and fungicides)[243].

Because of the industrial production system, crops have lost 25-70% of their nutrients since the end of the 2nd world war[244]. Today's food produces 10 to 25 percent less iron, zinc, protein, calcium, vitamin C, and other nutrients, as the World Watch studies show.

Washington State University researchers found an 11 percent decline in iron content, a 16 percent decline in copper, a 25 percent decline in zinc, and a 50 percent decline in selenium in spring wheat cultivars grown between 1842 and 2003[245].

Table 1: Showing effect of continuous farming on soil under organic and chemical mode[247]

Nutrient	Change under Chemical Farming	Change under Organic Farming
Organic Matter	-14%	+29-99%
Total Nitrogen (N2)	-7-22%	+21-100%
Available Phosphorous (P)	0%	+63%
Available Potassium (K)	-22%	+14-84%
Zinc (Z)	-15.9-37.8%	+1.3-14.3%
Copper (Cu)	-4.2-21.3%	+9.4%
Manganese (Mn)	-4.2-17.6%	+14.5%
Iron (Fe)	-4.3-12%	+1%

On Navdanya farm, organic matter has increased by up to 99%, zinc and magnesium have increased by 14%, thanks to the billions of microorganisms present in living soils. Healthy plants feed human beings in a healthy and adequate way. On the contrary, chemical agriculture has led to a decrease in soil nutrients, which translates into a decrease in the nutritional content of our foods. Desertification is linked to the fact that organic matter is not returned to the soil. Humus-rich soils can retain 90% of their weight in water. Living soils are the largest reservoir of water and nutrients.

The benefits of organic nutrition

The association between organic versus conventional food consumption and health outcome needs to be carefully adjusted for differences in dietary quality and lifestyle factors, and clinical studies are difficult and not yet conclusive[248].

One of the main advantages of organic farming is that it allows no use of agrochemicals (artificial pesticides, growth regulators, and synthetic soluble fertilisers), thus reducing the pesticide exposure for consumers[249]. For the general population, pesticide residues in food constitute the main source of exposure: in particular a high intake of fruit and vegetables is positively correlated with pesticide excretion and frequent consumption of organic produce is associated with lower urinary pesticide concentration. Studies have found that children and adults who eat conventionally produced foods have significantly higher levels of organophosphate pesticide metabolites in their urine than those who eat organically produced foods[250]. This has been illustrated in intervention studies where the urinary excretion of pesticides was markedly reduced after 1 week of limiting consumption to organic food[251]. This is of great importance during pregnancy: in fact a healthy diet based on vegetable and fruit consumption can expose the pregnant to pesticides that can easily cross the placenta, reaching the fetus[252]. Diets high in fruits and vegetables are widely recommended for their well-documented health-promoting

properties. However, as recently indicated for effects on semen quality, these benefits might be compromised by the adverse effects of pesticide residues[253 254].

The association between preconception intake of fruit and vegetables (FVs), considering their pesticide residue status, and Artificial Reproductive Technology (ART) outcomes among women undergoing infertility treatment was investigated in a recent study[255]. The main finding was that greater intake of high pesticide residue FVs was associated with lower probabilities of clinical pregnancy and live birth per initiated cycle. The observed association with live births was driven by a higher risk of early and clinical pregnancy loss. Conversely, low pesticide residue FVs intake was associated with a lower risk of early pregnancy loss, and more interestingly, replacing high pesticide residue FVs with low pesticide residue FVs was estimated to provide the greatest benefit for achieving clinical pregnancy and live birth. The potential negative effects of dietary pesticide residues on consumer health should, of course, not be used as an argument for reducing fruit and vegetable consumption. In this context, organic farming is an opportunity to increase the sustainability of food systems, to positively affect human health as well as animal wellbeing, increasing food security and environmental sustainability.

The only cumulative chronic risk assessment comparing organic and conventional products known to us has been performed in Sweden[256]. According to the study, there is at least a 70 times lower exposure weighted by toxicity for a diet based on organic foods. A small number of human cohort studies and animal dietary intervention studies have identified associations between organic food consumption and specific health, and health-related physiological parameters. Most human cohort studies were mother-and-child dyad cohorts and reported positive associations between organic vegetable and/or dairy consumption and risks of pre-eclampsia in mothers[257], hypospadias in baby boys[258 259], and/or eczema in infants[260].

The association between organic food consumption and reduced risk of overweight/obesity was also found when data were adjusted for age, physical activity, education, smoking status, energy intake, restrictive diet, and adherence to public nutritional guidelines. Also, a subgroup of a large UK cohort study focused on cancer incidence in middle-aged women, showed that there is a weak association between organic food consumption and a reduced incidence of non- Hodgkin's lymphoma, although the study was based on an observation period of only seven years[261].

A series of recent systematic reviews and meta-analyses of published data have shown that there are significant differences in the concentrations of nutritionally relevant compounds between organically and conventionally produced foods[262]:

- organic crops have higher antioxidant activity and between 18 and 69% higher concentrations of a range of individual antioxidants; increased intake of polyphenolics and antioxidants has been linked to a reduced risk of certain chronic diseases such as cardiovascular and neurodegenerative diseases and certain cancers

- conventional crops have higher levels of the toxic metal cadmium, and are four times more likely to contain detectable pesticide residues; there are general recommendations to minimise the intake of pesticides and cadmium to avoid potential negative health impacts
- organic meat, milk, and dairy products have approximately higher concentrations of nutritionally desirable omega-3 fatty acids
- organic milk was reported to contain higher levels of total conjugated linoleic acid (CLA), higher iron and α-tocopherol concentrations, which are all considered to be nutritionally desirable
- conventional meat has significantly higher concentrations of the saturated fatty acids myristic and palmitic acid, which were linked to an increased risk of cardiovascular disease.

Recently, extensive studies have also demonstrated not only lower presence of pesticide residues in organic food, but also better nutritional profiles than conventional ones and GMOs. A recent extensive review of 343 studies comparing organic and conventional foods concluded that higher levels of polyphenols (from 19% to 51%) and antioxidants, lower pesticide residues and lower levels of heavy metals are present in organic foods, in particular cadmium[263] [264].

The European Parliament on 20th December 2016[265] published an important document on the relationship between human health, organic farming and organic food consumption, recognising that the consumption of organic food:

- reduces the risk of allergic diseases and obesity
- protects brain development, especially during pregnancy
- provides a minor presence of cadmium
- guarantees higher omega 3 levels in milk and meat from organic farms, offers less risk of antibiotic resistance.

SOIL AND HEALTH: ORGANIC SOILS RICH IN BIODIVERSITY GENERATE HEALTHIER AND MORE NUTRITIOUS PLANTS

"Health is a continuum, from soil to plants to animals, including humans"[246]. There is an intimate connection between the biodiversity, soils, the plants, our gut and our brain. The results of a 20 year study comparing soils farmed organically and soils farmed chemically show the buildup of nutrition in organic soils, and decline in nutrition in chemically farmed soils. Healthy soils produce healthy plants. When the soil is healthy, with diversity of living organisms, it is able to produce all the nourishment it needs, and all the nourishment plants need.

SECTION 3

THE TRUE COSTS OF "CHEAP" INDUSTRIAL FOOD: EXTERNALITIES, SUBSIDIES, AND DISTORTED PRICES

It is often claimed that industrial food is cheap. However this 'cheapness' is artificially manufactured by externalising social, environmental and health costs, through subsidies which make industrial food produced and processed at very high costs appear "cheap", and by false prices through manipulation of the market.

3.1 ECONOMIC COSTS OF DAMAGE TO HEALTH AS A RESULT OF MALNUTRITION, CHEMICAL SUBSTANCES AND CHRONIC DISEASES

Modern day diets are largely based on supply-oriented industrial food systems. This priority is explained as a response to population growth and rising standards of living, as well as urbanisation, and economic globalisation. Nevertheless, the overall picture is not beneficial for human health, and also not ecologically sustainable from the perspective of planetary viability. Current food system, in order to produce massive amount of cheap, ultra-processed food, focuses on monoculture agriculture, excessive use of chemicals from farm to supermarket to ensure long shelf-life, and distributes foods through reliance on global supermarket chains.

There are multiple health externalities and hidden costs of the industrial food systems which are not taken into account. Particularly those relating to health are systematically externalised by the industry, which refuses to take responsibility for the damage caused by malnutrition, pesticides and chronic diseases.

The economic costs of malnutrition and its adverse impact on development are huge. Over the next 20 years, NCDs will cost more than $30 trillion, representing 48% of the global GDP, and pushing millions of people below the poverty line[266]. By contrast, mounting evidence highlights how millions of deaths can be averted and economic losses reduced by billions of dollars if added focus is put on prevention. A recent WHO report underlines that population-based measures for reducing tobacco and harmful alcohol use, as well as unhealthy diet and physical inactivity, are estimated to cost $2 billion per year for all low- and middle-income countries[267], which in fact translates to less than $0.40 per person. It is far cheaper to follow preventive measures, such as the good nutrition policies recommended by global institutions rather than spending huge sums on public health to cure or manage NCD.

The good news according to a WHO survey report is that "some countries are making remarkable progress" by dedicating funding for strong public health systems, as well as implementing economic and fiscal policies, such as trade and market restrictions, labeling requirements, and taxes on harmful products[268]. Efforts are underway to discourage unhealthy food consumption, especially if food producers are targeting children by offering sugary drinks, and ultra processed food that contain an excessive amount of sugar, salt, and saturated fat. Tobacco taxation is the most widespread fiscal intervention with 87% of all countries imposing some kind of tax. Alcohol comes second with taxes in 80% of the world's countries. Sugar-sweetened beverages (18% of countries) and foods high in fat, sugar or salt (8% of countries) ranked third and fourth from this perspective of fiscal intervention.

These figures show that unhealthy food is not yet controlled through fiscal remedies. Adopting preventive measures, such as effective nutritional policies, under the supervision of global institutions, rather than devoting large funds to the treatment and/or management of noncommunicable diseases, is undoubtedly a more cost-effective solution.[269] Many preventive measures have been taken in developed countries. Therefore, middle and low-income countries of the Global South have become the target of marketing strategies. While sales volumes remain higher in high-income countries, the rate of growth has been faster in lower income countries during the period 2000-2013[270].

Economic costs for pesticide health damage

Already in 2012, a study quantified the impact on health and costs related to the damage resulting from exposure to 133 pesticides applied in 24 European countries in 2003, equivalent to almost 50% of the total mass of pesticides applied in that year. Only 13 substances, applied to 3 classes of crops (grapes / vines, fruit trees, vegetables) contributed, according to this survey, to 90% of the overall health impacts due to a loss of about 2000 years of life (corrected for disability) in Europe every year, corresponding to an annual economic cost of 78 million euros[271]. In 2012, a survey was published that assessed the costs of acute pesticide poisoning in the state of Parana, Brazil, concluding that the total cost of acute pesticide poisoning amounts to $ 149 million each year. That is to say for every dollar spent on the purchase of pesticides in this state, about $ 1.28 is spent due to the costs externalised by poisoning[272].

It has been calculated that in the 1990s in the United States the environmental and public health costs resulting from the use of pesticides amounted to 8.1 billion dollars each year. Therefore, 4 billion dollars are being spent every year for pesticide consumption in this country, it means that for 1 dollar spent on the purchase of these substances they spend 2 for outsourced costs[273]. Another study published in 2005 estimated that in the USA the costs for chronic diseases through pesticide poisonings amounted to 1.1 billion dollars, of which about 80% for cancer[274]. It has been calculated that in the Philippines the transition from one to two treatments for rice cultivation resulted in a further profit of 492 pesos, but additional health costs of 765 pesos, with a net loss of

273 pesos[275]. In Thailand it has been estimated that externalised costs of pesticides can vary annually from 18 to 241 million dollars[276]. In Brazil the only costs for damage to the health of workers employed in bean and maize crops amount to 25% of the profits[277].

To come up with more recent data and closer to the European reality, we can recall a recent work conducted to assess the burden of diseases and costs related to exposure to endocrine disruptors in Europe: a panel of experts evaluated with "strong probability" that every year in Europe 13 million points of IQ (IQ) are lost for prenatal exposure to organophosphates and that there are an additional 59,300 cases of intellectual disability[278]. Since it has been estimated that each point of IQ lost for prenatal exposure to mercury is worth about 17,000 euros, the accounts can be similarly soon made also for exposure to organophosphorus[279].

The health consequences of maladapted modernity, driven by commercial food systems are currently being experienced in epidemic proportions across the world. Apart from premature death and prolonged disability, diseases resulting from nutritionally poor diets are forcing people to seek expensive health care, which is often financially unaffordable. Commercial health care systems are beneficiaries of these modern epidemics, by offering technology intensive and high cost tests and treatments for health disorders that could and should have been easily prevented through good nutrition and a healthy environment. The merger of Bayer and Monsanto, implies that the same corporations who sell the chemicals that are causing diseases also sell pharmaceuticals as cures for the diseases they have caused.

ESTIMATES OF GLOBAL COSTS OF HEALTHCARE DUE TO FOOD SYSTEM RELATED ILLNESS

- Obesity $ 1.2 trillion by 2025[280]
- The global cost of just diabetes in 2015 was estimated at US$ 1.31 trillion. In Italy, every patient suffering from diabetes today costs 2589 euros a year to the National Health System, and the diabetes-related therapies cost the Italian National Health System about 9% of the budget, or about 8.26 billion euros[281]. In Africa, 35 million people – twice the number at present – will be affected by diabetes in the next 20 years. By 2030 diabetes will cost $ 1.5 trillion [282]
- AMR infections $ 1 trillion by 2050[283]
- Cancer $ 2.5 trillion[284]
- Costs of exposure to endocrine disruptors in Europe alone are $ 209 billion annually; the costs of exposure to endocrine disruptors in the US are $ 340 billion[285]
- New research finds annual cost of autism has more than tripled to $126 billion in the U.S. Autism reached £34 billion in the UK and is the most costly health problem[286]
- Rising infertility has led to a new fertility industry which will cost US $ 21 billion by 2020[287]

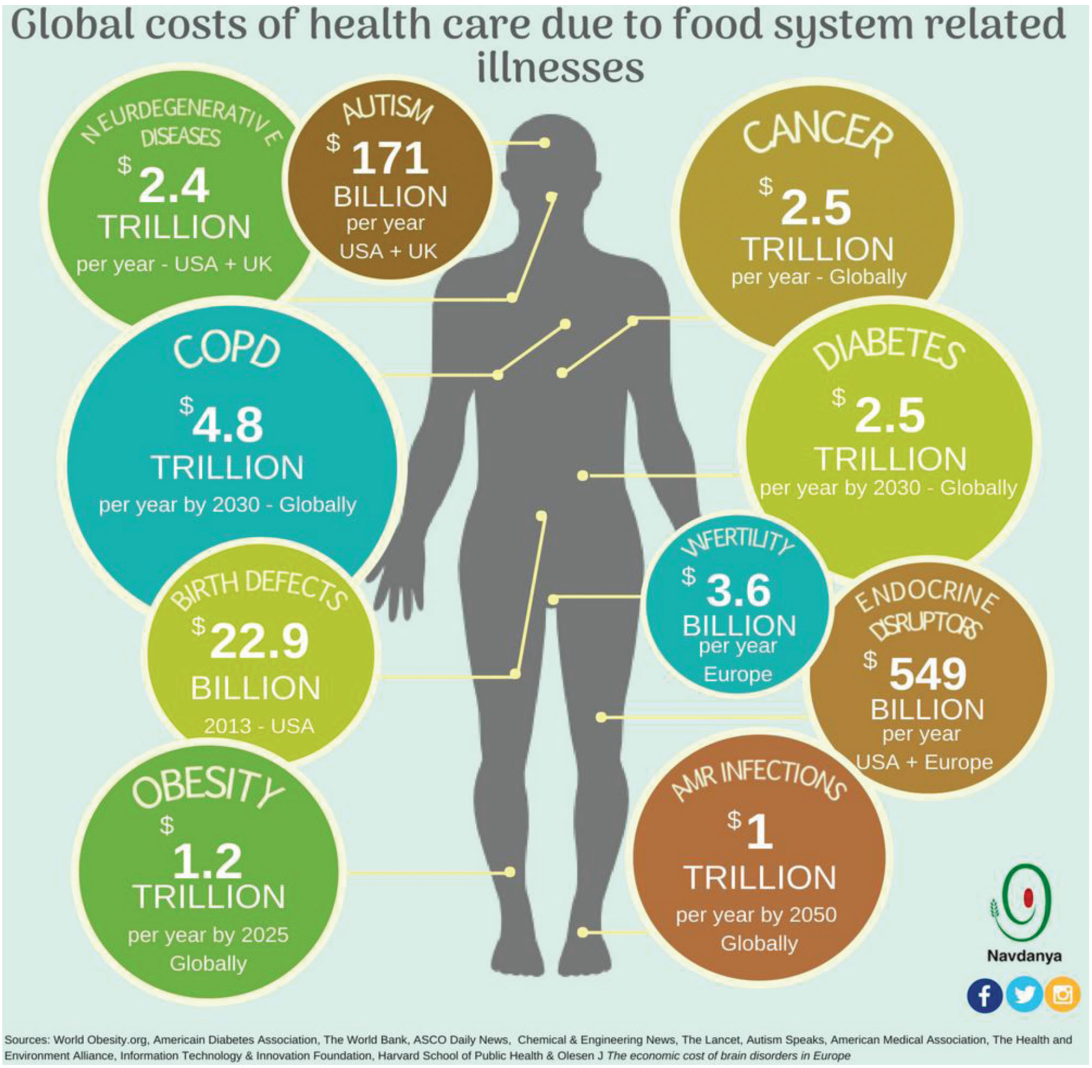

FIGURE 7: GLOBAL COSTS OF HEALTH CARE DUE TO FOOD SYSTEM RELATED ILLNESSES- DESIGN: CHLOÉ GENIN

3.2 THE HIGH COSTS OF "CHEAP" FAKE FOOD: HOW REDUCTIONIST ECONOMICS WORKS WITH REDUCTIONIST SCIENCE TO HIDE THE TRUE COST OF FOOD

The challenge of sustainable development in the 21st century is to reorient our agriculture and food systems to become better aligned to the nutrition and health needs of a growing global population, while being environmentally sustainable and financially viable. Local agriculture can be a concrete alternative also in terms of productivity.

Small farmers are more productive than large industrial farms. Using 25% of the land they provide 70% of the food[288] [289].

A false logic is often established according to which industrial agriculture produces more food, and increased production leads to lower prices. When viewed in terms of total food output, industrial agriculture does not produce more nutrition and low prices are connected to monopoly control, not to productivity.

The lowering of agricultural prices is not due to increase in productivity or efficiency or competition. It is due to anti-competitive practices of agribusiness giants.

Contrary to the false claim of higher productivity, industrial agriculture requires ten times higher inputs as energy than it produces as food[290]. Therefore, the industrial agriculture system has negative productivity, and would not exist without the huge subsidy directed to industrial agriculture.

The costs to health, environment and society are not counted and left as externalities. Negative externalities are one of the classic causes of market failure[291].

FAO has estimated that the value of plant based economy in terms of "natural capital" amounts to of $1.150 billion, which is more than 170% of the production value, while animal production produces natural capital costs of more than $1.180 billion, which is 134% of its production value[292].

Out of the total calories produced by the global industrial food system in a year, it has been calculated that 50% is used for animal feeding. Only 12% of this percentage, (or 6% of the total) is used for human nutrition, which implies that there is a waste of 44% of the total calories. 9% of what remains is destined for biofuel production and other non-food products[293], at least 15% is wasted between transport, storage and processing[294], while 8% is thrown into household waste by consumers[295]. As for environmental damage, it has been estimated that 80% of the synthetic fertilisers used worldwide are used for the cultivation of crops destined for livestock animals feeding[296]. The resulting soil and environmental damage costs more than 4[297]. The industrial food system dominates more than 75% of the world's arable land[298], using synthetic fertilisers, with an estimated environmental cost of $375 billion[299]. It is also responsible for the loss of 75 billion tonnes of fertile soil each year, representing an estimated damage of $400 billion[300] [301].

Further, when we discuss global agricultural production we forget about the enormous quantities of food that end up in waste, as much as 1.3 billion, equal to 30% of agricultural production[302].

The total cost of food wasted annually includes economic costs of $1055 billion (market value and subsidies), environmental costs of $696 billion (for air, soil and water pollution and loss of biodiversity) and social costs of $882 billion (in terms of loss of livelihoods and conflicts due to environmental degradation and pesticide poisoning)[303].

About 1/3 of the food we produce is wasted, while over 800 million people are still malnourished[304]. In 2017 a United Nations (UN) report defined as a "false myth" the mantra that was being repeated over and over by the agro-chemical companies, according to which the use of pesticides is necessary to guarantee crop productivity

and as such, to pursue the objective of a sustainable development. **Rather, the UN advocates that the problem of malnutrition is caused by inequalities and therefore it is fundamentally a problem of distribution and not of quantity[305].**

The trillions of dollars citizens are paying are profits for the same corporations that are spreading disease through nutritionally empty toxic food. With this system, the incomes of small and medium-sized farms collapse, the profits of the industry increase and the quality of food collapses. The purpose of the current system is not to ensure adequate nutrition and human wellbeing, but to maximise profits of the 'Big Food' players[306].

Key questions to ask are: who controls our food system? Through aggressive mergers and acquisitions big agri-chemical corporations are expanding their markets, and, by directly targeting decision-makers, increasing their influence and pressure on governments and institutions. By expanding their monopolies on seed and food, chemicals and medicines, they deepen their control over our food and health. The Big 6 chemical and GMO corporations that own the world's seed, pesticides and biotechnology industries are now enlarging their empire with mega buyouts. Syngenta is merging with ChemChina ($43 billion deal). Dow Chemical, which bought up Union Carbide, responsible for the Bhopal disaster killing over 20,000 people, is merging with Dupont ($122 billion deal) while Bayer is now merging with Monsanto ($57 billion deal), so that just 3 companies are left in control of 60% of the world's seeds and 70% of the chemicals and pesticides[307]. The consolidation of dominant positions prevents the emerging of sustainable agricultural models and different systems of seed supply, production and trade.

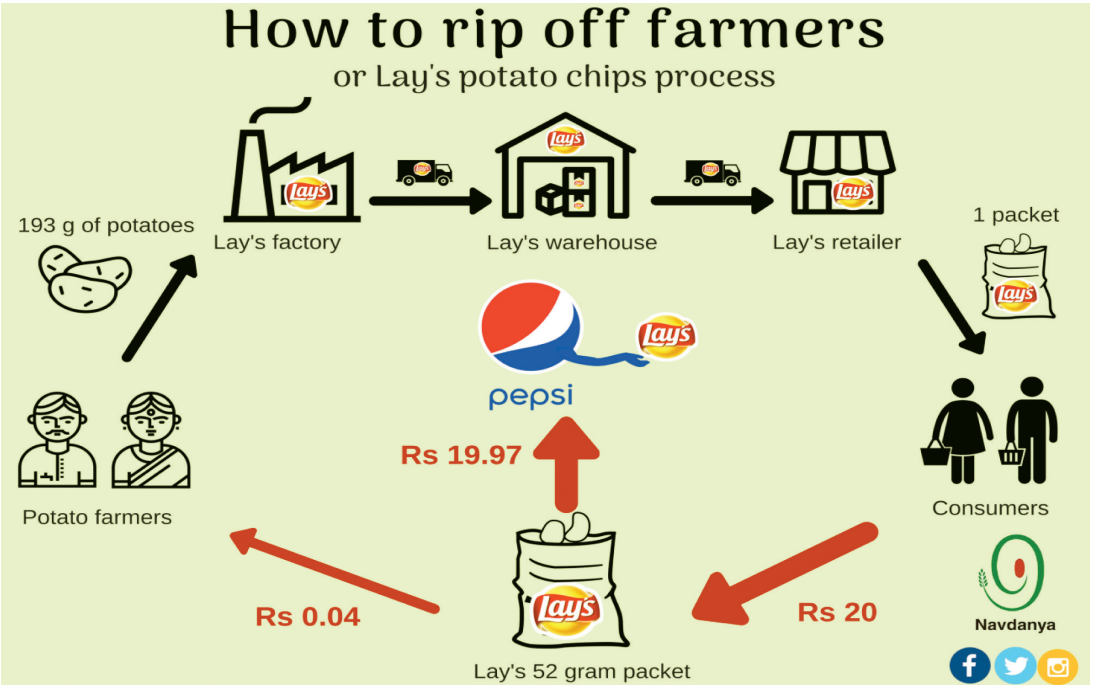

FIGURE 8: HOW TO RIP OFF FARMERS - DESIGN: CHLOÉ GENIN

Margaret Chan, former director of the WHO, publicly recognized and admonished the role of Big Food, Big Soda and Big Alcohol and their powerful reconstruction of public policies through aggressive tactics[308]. Moreover, most of Big Food's growth in sales are occurring in the developing world, instigating radical shifts in global dietary patterns[309]. It is developing countries that pay the highest price in terms of public health burdens[310].

TRUE COST ACCOUNTING

An integral aspect of just and equitable food system reform is the creation of transparent and fair markets. Currently, globalised food markets' primary motive is cost reduction and increased profit margins. In conjunction with regulatory oversights and monitoring difficulties, this translates into devastating negative externalities, that is, environmental and health costs that burden citizens' health and public budgets. But how can we make citizens and professionals aware of the profound injustice of a system dominated by the interests of powerful multinational agribusinesses?

True cost accounting is an economic approach to internalise negative externalities along the value chain and offers a promising method to increase transparency and equity in food systems. Moreover, it offers one avenue to reduce the gap between producer and consumer prices and balance unequal distribution of market power among economic actors, with farmers in the weakest position. In this regard, consumers' and supermarket chains may use their purchasing power to promote food products incorporating true cost accounting in their pricing schemes.

Methodologies to quantify full cost accounting are still being developed[311]. For instance, within the context of food systems, The Economics of Ecosystems and Biodiversity (TEEB) is developing a standardised true cost accounting framework and methodology to assess the impacts of the food system on both environmental and human health and wellbeing[312]. Within this framework, valuation of ecosystem services and natural, social and human capital lies at the heart of true cost accounting. Another approach to quantifying human health and wellbeing is Quality-Adjusted Life Years (QALYs), which are not quantified in monetary form, but on a scale of 0 – 1, representing mortality and perfect health respectively[313].

More specific to the organic sector, Eosta, one of the leading wholesale distributors of fresh organic produce in the EU, and the accountancy firm Ernst & Young produced a pilot project for true cost accounting for organic, as compared to conventional, produce. They found a 0,19 € per kg difference in health impacts between organic and conventional apples, favouring organic[314]. An informal investigative journalism foray into true cost accounting by the New York Times concluded that fast food burgers in the United States amount to US$4 billion per year in health costs alone, translating to 48 cents per burger, at a conservative estimate, whilst other estimates are five or six times as high[315]. Only once these more representative metrics are incorporated into mainstream accounting and valuation systems, will the true price of food be known to consumers, thereby forming the foundation of equitable, transparent, sustainable and wholesome food systems.

3.3 UNFAIR RULES OF "FREE TRADE" IMPOSE THE CONSUMPTION OF UNHEALTHY FOOD PRODUCTS FUELING DUMPING AND DAMAGING LOCAL ECONOMIES

Industrial food is produced and processed at high costs with high subsidies and traded globally through unfair rules of "free trade' which force degraded bad food on communities and countries that do not want it and want to protect their healthy indigenous diets. Farmers are not paid a fair price and give up farming. Local, diverse, healthy food systems are destroyed. Consumers are not told the true cost, and artificially cheap bad food and "fake food" produced at high cost is dumped on markets.

Unfair rules of "free trade" combined with unscientific "food safety" standards have spread degraded contaminated food throughout the world through coercive measures and forced imports. Unscientific "food safety " standards are used to ban local, artisanal processing which is good for health, and imposing chemical, industrial, unhealthy industrial diets on entire countries.

The primary objective of these rules appears to be to facilitate trade by eliminating differences in food, animal and plant regulations across countries, but in actual fact they allow even higher levels of pesticide residues (including DDT) in food than allowed by many national food safety and public health laws[316].

Free trade treaties are supported by corporations seeking to sell to the world their industrial agricultural system based on the use of GMOs, intensive monocultures, herbicides and pesticides. The controversial mechanism of supranational courts such as the ICS (Investment Court System) or ISDS (Investor - State Dispute Settlement) also poses a real threat to the democratic system. These are private courts that allow large companies to sue national governments with the aim of claiming compensation in the event of regulations that are unfavourable to their interests. This mechanism favours an intimidating process, as multinationals are accustomed to using supranational courts in an aggressive manner. This leads to the inhibition of the activity of legislators who, precisely for fear of being sued, are often led not to introduce regulations that are not appreciated by powerful and wealthy corporations.

From an economic point of view, it is important to assess the effects of these treaties on our agricultural and food system, as the invasion of large industrial and food farming enterprises on the markets threatens local production patterns. These threats are based on the fundamental legislative diversity between Europe and countries such as the United States and Canada. The adoption of these treaties leads to a process of downstream harmonisation of standards, including those relating to pesticides, further undermining our food, health and environmental security.

The most recent case involving Europe is the Comprehensive Economic and Trade Agreement (CETA), the free trade agreement between the European Union and Canada that could open the door to some 42,000 US companies with affiliates in Canada. In overseas legislation the criteria are substantially different: the presence of GMOs in food

is intense, the levels of antibiotics allowed in meat are high and the use of pesticides in agriculture is massive. The absence of proper food certification and labelling in the United States and Canada is a potential health risk for consumers and affects the right to information about what we consume.

GLYPHOSATE SEASONED PASTA AND PIZZA

The case of Canadian wheat, which is produced using large doses of pesticides, poses a serious threat to our health. The Italian case is, in this perspective, emblematic. In the Italian production plants, food products such as pizza, bread and pasta are produced using, in many cases, Canadian wheat because of its low price and high protein level, considered useful to speed up production processes and increase thermal stress resistance. However, this result is achieved through a specific non-natural drying procedure, which is necessary due to adverse climatic conditions and is carried out through the use of large quantities of glyphosate-based herbicide. Glyphosate spraying in the "preharvest" phase, facilitates the opening of the wheat ears and speeds up drying. Glyphosate is sprayed directly on the developed seed. The degree of absorption is therefore very high.

This technique is used in countries where wheat is grown in spring and harvested in September, just before the rains arrive. These areas are characterised by cold climates, thus the ears do not have enough time to ripen. A common practice especially in the North American cultivation areas, as in the Midwest of the United States, and in the Canadian provinces of Saskatchewan and Manitoba. In Europe, the practice of preharvest is prohibited precisely because it involves greater exposure of the plant to the pesticide and higher levels of residue on the crop.

In Italy, wheat is sown in autumn and harvested in June, leaving the time for the ears to ripen naturally, thanks to the dry climate. The wheat is then left to ripen naturally until it reaches the humidity of less than 13% required for harvesting. Italy, the leading European durum wheat producer, produces 4.8 million tonnes annually and imports 2.3 million tonnes. More than half of this quantity (about 1.2 million tonnes) is imported from Canada[317] [318] [319].

SECTION 4

A TRANSITION TO HEALTHY FOOD SYSTEMS IS A SOCIAL, ECOLOGICAL, ECONOMIC & DEMOCRATIC IMPERATIVE

4.1 A HEALTHY DIET IS A UNIVERSAL RIGHT AND NOT JUST A MATTER OF 'PERSONAL CHOICE'

Chronic diseases, as for example cardiovascular problems, are often described as 'lifestyle diseases'. In this context, food choices are often considered as personal choices. But choice is instead determined by many factors and can be conscious, conditioned or constrained. Conscious decisions too may be based on correct or incorrect information and understanding of the relationship between diet, nutrition and health. Choice is also conditioned by aggressive marketing and promotion by commercial interests, cultural influences and peer pressure. Choice is very often constrained by the availability and affordability of healthy foods. Even if one has high nutrition literacy, the lack of local availability or the high price of healthy foods may prevent an individual from adopting healthy dietary habits. This is especially so, when unhealthy alternatives are mass produced, aggressively marketed and low priced.

This absolute lack of concrete alternatives is then presented as "free choice". The right of the population to adequate and safe food is a universal human right and should be respected, protected and fulfilled by governments. It is, therefore, essential that governments and all other stakeholders in society commit to and earnestly endeavour for creating an environment that is conducive to helping people make and maintain healthy dietary choices all through life. What we need is the emergence of a supportive political will from world leaders and dedicated government policies, backed up by secure funding and strong accountability mechanisms for all the actors, from government bodies to the food industry. Tackling noncommunicable diseases at the national level means tackling unhealthy diets. Coordinated national efforts coming from agriculture, health and education sectors would ensure a healthy diet for people, making consumers part of an adaptation process.

First, consumers should be guided to the right choices. Therefore, nutritional education is the first essential step, and it is essential to start with children. A healthy diet is vital during the first two years of human life in order for the future generations to be physically and mentally healthy. The importance of fully relying on breastfeeding from

day one to six months and beyond is the best way to reduce disease, as breastfeeding builds a healthy immune system for infants and mothers. All these policies are based on scientifically proven research and various UN institutions are promoting these findings worldwide. However, as baby food is one of the world's leading market products, competition with business interests is a problem.

Secondly, food markets should be organised in a way that the people are granted access to healthy food, such as fruit and vegetables, and consume less red meat (scientific evidence has now proven that processed meat is one of the main causes of NCDs). This is linked to healthy food availability and accessibility (prices affordability and geographical availability), thus to a lower inclination to rely on cheaper or more available alternatives. This approach requires aggressive governmental policies to adequately regulate supermarkets chains and introduce commercial policies that are profoundly different from the current global economic order. It will be necessary to regulate unhealthy food imports and encourage direct foreign investments that stimulate the companies that produce and trade junk food to move to healthier food products. It will not be easy, since many of the big food firms are dominated by transnational oligopolistic enterprises, whose focus is on short-term profits only.

Thirdly, governments should coordinate with the various sectors to promote a national diet that entails good nutritional standards, closely cooperate with local producers and encourage environmentally sustainable production practices. **Agricultural production systems' transformation requires a structural change rather than short-term policies. This political view would contribute to increasing healthy food availability, granting sustainable incomes and better life conditions to local producers and to the conservation of natural resources and biodiversity**[320].

4.2 PRINCIPLES FOR A TRANSITION TO FOOD AND AGRICULTURE SYSTEMS FOR HEALTH

How can farmers, who are the main victims of this system, be mobilised for the good cause? How can new generations be convinced that this food production system is harmful to nature and their own future? How can the vested interests of the agroindustry be countered? How can it be made clear that the right to healthy food is not viable unless a new idea of economy, sustainable development and a new sense of civic ethics are established?

A transition to a healthy food system needs a paradigm shift from reductionist to systems science. It needs a shift from chemical intensive industrial agriculture to ecologically intensive organic farming. It needs a shift from extractive economies to circular and solidarity economies. It needs a shift from unfair "free trade" rules based on unscientific claims to safety, to fair trade based on economic democracy and systems science.

It is now necessary to stop and regulate the agroindustry multinational corporations' power machine, which gets its extraordinary profits by speculating on the essential need for food. We need to claim the right to food for all the earth inhabitants, from human beings to nature. We are facing a modern social issue, behind which lies a modern class conflict: a minority is enjoying the privilege of eating good quality food and is multiplying its patrimonies and profits by manipulating and exploiting a primary need.

Due to the complexity of the multiple interactions among living systems, as for the dominion of the linear causality of the Cartesian paradigm, which resulted in a gap in the comprehension of systemic transformations, the precautionary principle becomes an imperative to protect the right to health for the future generations.

A shift towards health promoting agri-food systems requires:

- A transition from a reductionist paradigm that separates health from agriculture, food and nutrition to a systems paradigm based on agroecology and health which connects us to nature, soil, biodiversity, farmers and our health
- A transition from an industrial agricultural model to an ecological regenerative model
- From monocultures and uniformity to biodiversity in our fields, in our plates, in our gut and in our cultures
- A transition from commodification of our seed, our food, our health, our knowledge and our democracy to the recovery of the commons and putting the common good at the centre
- A transition from the manipulation of knowledge and science by commercial interests who control agriculture, food, nutrition and health, to participatory knowledge and diversity of knowledges
- A transition from competition to cooperation. Competition between countries (through free trade) between people, leading to conflicts and precarious work, between humans and other species, to cooperation across countries for a new planetary citizenship between people to create community and cultivate the commons, between humans and other species to create Earth community and an indivisible health from the planet to people
- A transition from predatory globalisation to local, diverse, cooperative, circular, solidarity economies for the common good and the planet. The movement for a transition to short chains for life is based on fresh, local, seasonal, diverse food weaving biodiversity, the farmers and eaters into one community of health and wellbeing
- A transition from degradation of the land, water, air, climate, our food, our societies, our democracies to the regeneration of life and freedom

- A transition from corporate free trade that is killing the planet, our democracies, and our local economies, to living democracies and living economies based on people's cooperation, and sovereignties.

4.3 FROM CHEMICAL MONOCULTURES TO ORGANIC FOOD SYSTEMS

Agroecological practices are the only alternative to combine food quality, environmental protection of soil fertility and response to climate change, water quality, biodiversity and human health. Organic food has not only proven to contain lower levels of contaminants and pesticide residues, but also has better nutritional profiles and should not be a privilege for the few, but a right for all.

The growing attention towards aspects of health connected with food consumption places organic products in a privileged position. An increasing interest in organic agriculture for food production is seen throughout the world and one key reason for this interest is the assumption that organic food consumption is beneficial to public health[321].

The number of organic producers worldwide in 2016 is/was estimated at 2.7 million, an increase of 12.8% from 2015 data. Agricultural areas dedicated to organic farming have reached 50.9 million hectares in 178 countries around the world with an increase of 15% from 2015 on a percentage of 1.2% of agricultural areas globally. The global market for organic products and consumer demand are growing, with a turnover of about 75 billion euros having been reached in 2016[322].

Data on the increase in the sector and the reasons for this growth show that consumption of organic products has evolved from the original model, which saw only a particular group of consumers buying organic products excluding everything else. Organic products have left their niche status and now contribute significantly to both domestic consumption and food exports.

Aside from organic agriculture, there are a range of related agricultural practices that offer benefits for human and environmental health, such as holistic managements[323], an alternative to intensive conventional livestock production, agroforestry and home gardens, urban and community supported agriculture and foraging for wild foods as an alternative to conventional monoculture.

Diet choices and the associated food production methods also have important impacts on environmental sustainability[324]. Consumption patterns of consumers preferring organic food seem to align well with sustainable diets[325].

GREEN ECONOMY AND QUALITY

A Nomisma panel test[326] revealed that, in Italy, the purchase of organic products is ever more motivated by a search for products considered to be safer and healthier, due to their lack of synthetic chemicals and pesticides. Another fundamental aspect is that of perceived quality: 70% believe that organic products are of higher quality than conventional products.

As outlined in Fondazione Symbola Italia's publications[327], investing in green technologies and products encompasses not only sustainable production, but also innovation. Of the company's investment in the green economy, 37.9% introduced product or service innovations, in comparison with 18.3% of businesses without green investments. Among the green businesses, 37.4% of them have a market presence abroad, as compared to 22.2% of other companies. This confirms that business strategies based on mid or long term sustainability is not only the right thing to do, but also the most economic. The optimal way to compete is to implement a quality based growth model. Companies that fail to understand the current trends will be left behind. The net result is that the sector's future entrepreneurial backbone will consist of modern, flexible businesses with a strong interconnection between agrarian traditions and culture, knowledge and innovation, leading to enhanced quality (Unioncamere). Selective economic growth manifests in a context in which consumers carefully select the products they buy. In this scenario, quality becomes an essential strategic element to remain competitive, and the limits of a growth model based on quantity alone becomes anachronistic.

For instance, the Made in Italy brand is a key element for Italian production and exports in terms of quality products based on knowledge and skills of traditions and occupational specialisations in Italy[328]. High quality agriculture is also linked to the dissemination of new development and consumption models based on some key principles, such as defence of the land, promotion and protection of biodiversity, local traditions and culture and public health[329].

4.4 FROM A LINEAR, EXTRACTIVE SYSTEM TO A CIRCULAR AND SOLIDARITY ECONOMY

Good food for health costs more because it does not hide and externalise costs, it is not subsidised, it is not based on exploitation of farmers by oligopolies, it includes benefits for the people and the planet as positive externalities.

A good food and true cost economy is based on cooperation with all members of the Earth Family, animals and plants and microbes that create the conditions for healthy ecosystems and healthy communities. Respect for all life is the basis of a good food economy for health.

Food for health represents a new paradigm, not only concerning products but a system of partnership in production, distribution, relations among all actors.

Current conventional food systems are based on wasteful, linear models, whilst natural systems tend to be built on closed loop models. **Linear systems concentrate power and profits in the hands of few operators and lead to the degradation of our food and our health. Circular systems, instead, can rejuvenate life.** Natural systems are based on primary production by photosynthesis from sunlight as the energy source into the system. Eventually, biomass undergoes decomposition, facilitating nutrient cycling in the system. The requirements for the development of circular economies in food systems include efficient and reduced resource use, reduction of food waste and residues reuse.

A further guiding principle of circular economies is the concept of cradle to cradle, referring to a design approach in which products may ultimately biodegrade back to their original state, connecting sources and sinks in a closed loop system. For instance, packaging from plant based plastic substitutes may biodegrade into organic matter that can regrow the plants used to make such packaging. **Cradle to cradle is now a certification scheme, which assesses the life cycle of products based on five elements, namely material health, material reutilisation, renewable energy, water stewardship and social fairness.**

Food systems may bio-mimic these natural systems in five key ways:

- Circular economies are zero waste economies. They do not waste food, nor do they build up waste of plastic and aluminum packaging
- Circular economies work with and within the nutrient cycle. They are based on closed loop nutrient cycles, i.e. composting, inclusion of nitrogen fixing plants, using animal manure from animals fed on food waste to fertilise fields, etc.
- Added value from by-products – by-products that would normally exit the food system as waste or pollution may be reclaimed or upcycled to reduce waste and add value in the closed loop value chain
- Circular economies build on food communities and solidarity between people in every aspect of the food system, from farmers as producers to consumers as co-producers
- Local and closer production and the improvement of a direct market are the basis of a new model of cooperation: a cooperation that connects people, citizens and farmers, university and researchers, institutions and different territory end countries.

MAKING FOOD SYSTEMS "NUTRITION SENSITIVE"[330]

1. To promote meaningful change, actions must also be directed at the food system level to make it more "nutrition sensitive." It is imperative that global food systems move away from agro-industrial production methods which are responsible for dietary monotony and reliance on ultra-processed food and beverages, towards a system that supports food sovereignty, small-scale producers, and local markets based on ecological balance, agro-biodiversity and traditional practices. Food sovereignty allows peoples to define their own policies and strategies for sustainable production, distribution and consumption of food. Globally, the majority of food is supplied by local farmers. Therefore efforts to combat malnutrition must support smallholder farmers and promote nutrition sensitive production. Agro-ecology ensures food and nutrition security without compromising the economic, social, and environmental needs of future generations[331]. It focuses on maintaining productive agriculture that sustains, yields and optimizes the use of local resources while minimizing the negative environmental and socioeconomic impacts of modern technologies[332]. It is imperative to support comprehensive research initiatives to lay the scientific basis for the claim that agro-ecology satisfies nutrition sensitive production while promoting local livelihoods and the environment.
2. While certain States have taken encouraging steps, most national systems to combat malnutrition are fragmented, and lack effective action, evaluation and accountability mechanisms. It is imperative that responses move away from isolated interventions and "medicalised" approaches to fighting malnutrition. In line with their obligations under the international human rights system, States must acknowledge the underlying causes of malnutrition and develop multi-sectorial approaches to coordinate nutrition policies with health, housing, water and sanitation, social protection, poverty and inequality reduction initiatives. Moreover, it must be recognised that to effectively combat malnutrition, women's rights should be at the forefront.
3. Recognising that industry self-regulation is ineffective, Governments should impose strong regulatory systems to ensure that the food industry does not violate citizen's human rights to adequate food and nutrition. It is however recognised that such efforts may face formidable resistance from the food industry seeking to protect its economic interests.
4. A holistic approach to nutrition requires national policymakers to create an environment conducive to nutritious, healthy diets, including through education, and dietary guidelines. Finally, a comprehensive approach should encourage adjustments in food supply and changes in food systems to increase availability and accessibility of healthier food that is both sustainable and nutrition sensitive.

4.5 FROM GLOBALISATION TO LOCALISATION : "SHORT CHAINS FOR LONG LIFE"

All over the world small farmers and gardeners are already implementing biodiverse ecological agriculture, while rejuvenating the soil and saving and breeding their seeds. They are providing healthy and nutritious food to their communities and bringing back food in the hands of farmers and consumers, making big agribusiness irrelevant and useless, along with their poisons and toxic food.

Diversity and decentralisation go hand in hand. Since diversity of crops and foods is vital to health, localisation and decentralisation of food systems is a health imperative.

Short supply chains address the issues of inefficiencies in the value chain as/since food waste, carbon emissions, ecological footprints and wealth disparities tend to accrue the longer the value chain becomes. One of the shortest supply chains, aside from direct consumption, is direct trade and the zero km diet. Throughout the world, whether it be buying points in villages or chic cafes in major metropolises, direct trade is growing in popularity and demand, as consumers seek more personal connections with their food sources.

Another form of direct trade is community supported agriculture. Within this model, consumers pay farmers in advance for the growing season, and in return obtain a weekly box filled with produce from the farm. In other models, such as self-harvest farms, consumers themselves go to the farm and harvest their produce directly for a monthly fee paid to the farmer.

According to estimates relating to 2015[333], there are over 2,770 Community Supported Agriculture (CSAs) in Europe. A 2017 USDA report[334] estimates that there are over 4,700 CSAs registered on the largest US online portal in the sector[335], to the over 6,000 surveyed by the Biodynamics Association.

Another popular and widespread means of shortening supply chains and supporting direct trade of foodstuffs is farmers markets. Most major cities now host farmers markets, where farmers themselves or their distributors may sell their produce to consumers. In addition to providing high quality produce, farmers markets often double as venues where local communities may mingle, fostering social bonds and community cohesion, another crucial aspect of human health and wellbeing.

Based on the idea of a short supply chain, biodistricts represent, according to FAO's definition, an innovative approach to sustainable, integrated and participatory territorial development based on the environmental, social and economic dimensions of sustainability[336]. The model of biodistricts is being tested for some years now in Europe. It is a project that has the territory at its heart, of which the farmers and agricultural production are the backbone. The success of biodistricts depends on the active mobilisation of citizens and on the conscious participation of municipalities and local institutions. It is a sustainable development project that has made quality its field of experimentation: from the reduction of the environmental impact of industries to the

collection and recycling of waste; from alternative energies to ecological tourism; from the rational use of water to zero soil consumption; from education in schools and in households on the value of food to the active participation of citizens and producers; from the social value of culture to social agriculture; from the challenge of pesticides and the use of synthetic chemicals to clean and organic agriculture. Biodistricts are based on a pact between the productive world, local governments and civil society to achieve together a sustainable governance of the territory. The territory then becomes the fundamental place to overcome fragmentation and to challenge the content of social discrimination that is intrinsic to the methods of industrial food.

Biodistricts, rather than an immobile paradigm, are therefore a field of experimentation that breaks with classical schemes and reflects diversity, knowledge centres and the small and large contradictions of territories, opens up new perspectives and feeds on direct democracy. Biodistricts intend to change reality and its deep dynamics by dialoguing and cooperating with local authorities, trying to influence political and institutional choices at regional, national and international level.

4.6 ROAD MAP: THE ROOT TOWARDS TRANSFORMATION

Civic actions

- Save, grow and reproduce traditional seed varieties to safeguard biodiversity. They need to be saved not as museum pieces in germplasm banks, but in living Seed Banks as the basis of a health care system
- Grow Gardens of Health, also at urban level, which favour the diffusion of nourishing varieties
- Create and support local food economies, farmers markets, CSAs, biodistricts
- Create links between schools, hospitals, health care centres and local organic fresh, diverse food systems
- Create poison free zones, communities, farms and food systems
- Demand labelling of chemicals and GMOs on the basis of fundamental right to know
- Organise to demand that public money and taxes stop subsidising unhealthy food systems that create a burden of disease for us and shift all public support including policy to health promoting agriculture and food
- Do not cooperate with laws that force unhealthy agriculture and food system

Government actions - local, regional, national, international

- Local governments should take back their right to protect public health on the principle of subsidiarity and promote healthy local food economies
- Regional governments should promote biodiverse local agriculture and bioregional food and health policies

- National governments should be guided in all policies and laws to give primacy to the health of their citizens and future generations
- Governments should support appropriate policies to promote access to quality fruit and vegetables, the cost of which is often prohibitive despite recommendations for consumption, for the more vulnerable members of the population
- Public subsidies should be redirected from health damaging systems to systems based on agroecology and biodiversity conservation, which provide health benefits and protect common goods
- Governments should ban the use of contaminating chemicals and instead defend biodiversity and promote agroecology
- National and regional governments should put in place policies to assess the damage caused by chemicals and apply the polluter pays principle and the precautionary principle in respect of pesticides and food additives[337]. Moreover, Public Research should shift from promoting chemicals and contaminants to promoting biodiversity and agroecology, and assessing the harm of chemicals and putting in place polluter pays principle
- All policies related to agriculture, food, nutrition and health need to be integrated on the basis of interconnectedness between what are seen as separate sectors
- Rules of trade and free trade agreements should be revisited on the basis of environment and health impact of agriculture and food systems, and reclaim food nutrition and health sovereignty of their citizens
- Institutions at all levels should lead the transition to healthy agriculture and food systems by declaring organic, pesticide and poison free regions
- Citizen participation to create food democracy and healthy agriculture food systems should be considered essential at all levels.

Changes in the International Trade Rules and Systems: responsibility of the United Nations and its relevant bodies

(a) The UN is a global declaratory, regulatory, and articulator of global policy. The UN should give a high priority to work on a comprehensive, global treaty to minimise the adverse impacts of the use of chemicals, and other practices that are dangerous to health and environmental protection, with great sensitivity to biological diversity, offering a framework that is grounded in applicable human rights principles.

(b) The goals of this treaty are as follows:

- identify and remove relevant double standards among countries, especially those that are detrimental to countries which are most food insecure and possess weaker knowledge and regulatory systems

- generate policies to reduce pesticide use worldwide and develop a framework for the banning and phasing out of highly hazardous and toxic pesticides as a matter of urgency
- promote agroecology and related approaches as an alternative production method to the current reliance on monoculture based industrial agriculture with its major use of chemical inputs
- impose strict liability on pesticide producers that refuse to follow voluntary guidelines.

(c) To reach these ambitious goals, awareness and encouragement of various non-binding documents are an essential step toward transforming agriculture for the benefit of human health: use of various existing tools established by the UN, such as the UN Decade of Action on Nutrition, as well as NGOs and academic networks to create a "master plan for nutrition" with a time frame and budgetary targets specifically tailored to meet national needs. The UN can make great contributions to the attainment of ambitious nutrition targets and ensuring the right of every person to adequate food and nutrition by using its convening and coordinating position at a global level.

(d) The UN should encourage States to adopt an initiative similar to the WHO Framework Convention on Tobacco Control to regulate the food and beverage industry and protect individuals from the negative health and nutrition effects of highly processed foods.

(e) UN agencies and programs must establish coordinated transparency and accountability mechanisms, with sensitivity to relevant stakeholder perspectives, to ensure that the multitude of existing nutrition targets are implemented in a way that is coherent, harmonised, mutually reinforcing, and avoiding gaps, with clear timelines and indicators to assess progress, and responsive to democratic values of participation and interaction.

(f) International regulations need to be articulated and implemented to curb the unchecked actions of powerful transnational economic actors that have led to the flooding of global markets with "junk food" and many kinds of processed foods not consistent with international nutrition standards. In this regard, negotiations within the Human Rights Council to establish a legally binding instrument to regulate the activities of transnational corporations are very much welcomed, and consistent with the spirit and realisation of the Manifesto.

(g) Implementation of the UN Guiding Principles on Business and Human Rights, to ensure corporate responsibility of the food and nutrition industry, as well as developing and enforcing the rights of victims of human rights violations, with full respect to extra-territorial obligations of States and other relevant actors are required.

(h) International trade and investment agreements should be re-evaluated to ensure they do not undermine health and nutrition policies. For example, food taxes, tariffs and other market restrictions or incentives that justifiably form part of national nutrition policies should be exempted from WTO rules and should not lead to penalties for violating trade agreements.

(i) Recognising the particular vulnerability of women, and especially girls, to malnutrition, the Universal Human Rights framework must protect a woman's general right to adequate food and nutrition. The empowerment of women should firmly be embedded within nutrition strategies[338].

THE WORKING GROUP

On 15 and 16 May 2018, a group of eminent experts in the fields of health, food and agriculture convened in the city of Florence to draw up a Manifesto on Food and Health, as part of the Food for Health campaign, continuing the work of the International Commission on the Future of Food and Agriculture. This document is the result of these discussions and includes contributions and elaborations by the participants, subsequently coordinated and integrated by the editorial board of Navdanya International.

The group of experts on Food and Health:

Vandana Shiva – *Meeting convenor and President of Navdanya International.*

Renata Alleva – *Specialist in the Science of Nutrition, Department of Biomedical and Neuromotor Science, University of Bologna.*

Sergio Bernasconi – *Full Professor of Paediatrics, former Head of Paediatric Clinic, University of Parma.*

Piero Bevilacqua – *Author, Sociologist, Historian, Sapienza University of Rome.*

Lucio Cavazzoni – *former president of Alce Nero.*

Salvatore Ceccarelli – *International expert in Agronomy and Plant Genetics.*

Guy D'hallewin – *Coordinator at the National Research Council, CNR – ISPA UOS Sassari.*

Nadia El-Hage Scialabba – *International Food Ecology Expert.*

Hilal Elver – *UN Special Rapporteur on the Right to Food.*

Richard Falk – *Professor of International Law Emeritus, Princeton; Director Climate Change.*

Patrizia Gentilini – *Oncologist and Haematologist, ISDE – International Society of Doctors for the Environment, Scientific Committee.*

Jacopo Gabriele Orlando – *Public Affairs & Project Development Manager, Aboca Group (research and innovation in medicinal herb-based products).*

Srinath Reddy – *President, Public Health Foundation of India and the World Heart Federation, All India Institute of Medical Science (AIIMS).*

Mira Shiva – *Director, Initiative for Health and Equity in Society, former Chairperson, Health Action International Asia –Pacific.*

With contributions of:

Sebastiano Andò, Full Professor of General Pathology, Director of the Department of Pharmacy and Health and Nutrition Sciences, University of Calabria.

Dario Bevilacqua, official of the Ministry of Agriculture, professor of administrative law, La Sapienza University of Rome.

Famiano Crucianelli, Biodistretti, Surgeon, Under-secretary for Foreign Affairs (2006 -2008)

Valentino Mercati, Chairman of Aboca Group

International Commission on the Future Of Food and Agriculture

The International Commission on the Future of Food and Agriculture was created in 2003 in Tuscany, Italy, as a result of an international meeting of leaders in the food and agriculture movement brought together by Claudio Martini, then President of the Regional Government of Tuscany and Dr. Vandana Shiva, President of Navdanya International.

The Commission brings together leading activists, academics, scientists, politicians and farmers from North and South, committed to building more socially and ecologically sustainable food and agriculture systems and active in creative movements for the protection of biodiversity, local food production and consumption, food security, food safety and health, and the rights of consumers and small farmers.

It has published four far-reaching Manifestos on issues of critical importance to the future of the planet: the future of food, the future of the seed, climate change and the future of food security, and the need for new knowledge systems. The Manifestos have been widely distributed at major international United Nations and Civil Society Conferences and Summits on food security, agriculture, and climate change.

Navdanya International

Navdanya International was founded in Italy in 2011 to support the mission of Navdanya, an organization created by Dr. Vandana Shiva 30 years ago in India, on an international level. Navdanya promotes a new agricultural and economic paradigm, a culture of food for health, where ecological responsibility and economic justice replace the present greed, consumerism and competition which have become dominant in society. Navdanya's research on Biodiversity based Agro-ecological farming has shown how Agroecology can increase nutrition and health, as well as farmers' incomes while rejuvenating soil, water and biodiversity and enhancing climate resilience.

Navdanya International contributes to strengthen Navdanya's global outreach through publications, campaigns, advocacy actions, communication, capacity building and movement building - both on a local level with communities and a national/ international level - in cooperation with communities from all over the world. In October

2012, Navdanya International launched its Global Seed Freedom Campaign to bring to citizens' attention the crucial role of seed in the battle to defend food sovereignty and food safety and help strengthen the movement to save and exchange seeds in response to the growing corporate hijacking of our seeds and our food.

Navdanya International has been at the forefront of showing connections between multiple crises in the global debate in a holistic perspective,focused on the agri-food systems analysis and their close link to soils, biodiversity, climate resilience and social justice.

Starting from the Commission's work, the organization's commitment is to encourage the convergence and the action of movements defending agroecology, food sovereignty, seed conservation, social justice and public health, with the aim of creating a common vision of a sustainable, fair and inclusive development and elaborating global strategies to overcome the industrial agriculture model dominated by giant agrichemical corporations.

Biographical notes of the Working group members

Vandana Shiva – *Coordinator of the "Food for Health" campaign and Navdanya International founder.*
Physicist, ecologist, activist, and the founder and director of Navdanya International. In 1982 she founded the Research Foundation for Science, Technology and Ecology (RFSTE). For many years, she has been committed to promoting a paradigm shift in agriculture and food, denouncing issues related to intellectual property, biodiversity, biotechnology, bioethics, genetic engineering, and the globalization of food systems. Author of numerous books, she serves on the board of the International Forum on Globalization, and is member of the executive committee of the World Future Council.

Renata Alleva – *Specialist in the Science of Nutrition, Department of Biomedical and Neuromotor Science, University of Bologna*
Senior Researcher at the Department of Biomedical and Neuromotor Sciences of the University of Bologna. She is the author of about 50 peer-reviewed publications and book chapters on Nutrigenomics, Oxidative Stress, DNA damage and repair, pesticides and tumors. Speaker at national and international conferences, she collaborates with various periodicals and scientific journals, and is member of the scientific committee of the International Association of Doctors for the Environment (ISDE - Italy).

Sergio Bernasconi – *Full Professor of Paediatrics, former Head of Paediatric Clinic, University of Parma*
He directed the Department of Pediatrics at the University of Modena and Reggio Emilia and University of Parma. Former President of the Italian Society of Pediatric Endocrinology and Diabetology (SIEDP) and Member of the Council of the European

Society for Pediatric Endocrinology (ESPE), from which he received the Outstanding Clinician Award in 2013. He's the author of over 300 international publications, mainly on issues of endocrinology and clinical genetics.

Piero Bevilacqua – *Author, Sociologist, Historian, Sapienza University of Rome.*

Professor of contemporary history at "La Sapienza" University in Rome until 2016. He is a scholar of multiple interests, and is actively engaged in issues of agriculture, food and the health and rights of people and of the planet. He founded in 1986 the Southern Institute of History and Social Sciences (IMES), which he still presides.

Lucio Cavazzoni – *Former president of Alce Nero*

Sociologist, co-founder of Valle dell'Idice beekeeping cooperative and later of CONAPI, the National Beekeepers Consortium, which he led until 2008. Since 2004 he has been president of Alce Nero, Italian organic product leading company.

Salvatore Ceccarelli – *International expert in Agronomy and Plant Genetics*

Expert in participatory and evolutionary genetic improvement, climate change crop adaptation and the connection between biodiversity, food and health. He's been full professor of Agricultural Genetics at the Institute of Genetic Improvement, University of Perugia He also conducted research at ICARDA (the International Center for Agricultural Research in Dry Environments,) based in Aleppo, Syria until 2006, and continued as a consultant until 2014.

Guy D'hallewin – *Coordinator, National Research Council, CNR - ISPA UOS Sassari*

Agricultural engineer, since 2015 he is coordinator of the Research Unit of the Institute of Science of Food Production of the Italian National Research Council in Sassari, Sardinia. His scientific activity focuses on developing sustainable approaches to contain food heritage losses. The diffusion of old sustainable fruit crops, along with innovative handling systems to avoid crop spoilage after harvest, are presently his main concerns.

Nadia El-Hage Scialabba – *International food ecology expert*
Specialized in environmental sciences at the University of Charleston, USA, during her 33 years of service at the Food and Agriculture Organization of the United Nations (FAO) in Rome, she created and coordinated the interdisciplinary program for organic farming, in addition to her primary responsibility to integrate sustainability considerations into agriculture, forestry and fisheries, from guidelines for integrated management of natural resources, to sustainability protocols and full cost accounting methodologies. She is currently an international consultant on sustainability issues, including transformative approaches to food ecology-especially mitigating the impact of the food system on human health.

Hilal Elver – *UN Special Rapporteur on the Right to Food*
She is an international law professor and Global Distinguished Fellow at the UCLA Law School Resnick Food Law and Policy Center; as well as the Co-director of the Climate Change, Human Security and Democracy project at the Orfalea Center, UC Santa Barbara. She served also to Turkish government as the founding legal advisor of the Ministry of Environment, and General Director of the Women Status at office of the Prime Minister (1989- 1994).

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Director of the Climate Change Project, he has been associated as Research Fellow with the Orfalea Center of Global and International Studies at the University of California, Santa Barbara. He is consultant at the Pomeas Project, Instanbul Policy Center, Sabanci University and member of the consultative editorial committee of "The Nation". Between 2008 and 2014 he served as UN Special Rapporteur on Israeli Violations of Human Rights in Occupied Palestine.

Patrizia Gentilini – *Oncologist and Haematologist*

She worked as Medical Director 1st level Oncology and responsible for Onco-Hematology Module, at the Oncology Unit of AUS, Forli until 2007, now retired. For about 20 years she has had Primary Prevention and Health Protection as a priority interest through the reduction of exposure to environmental risks, author and co-author of over 80 scientific publications and numerous popular articles.She is a member of the Executive Committee and the Scientific Committee of the Association of Doctors for the Environment (ISDE Italy).

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Srinath Reddy – *President, Public Health Foundation of India and the World Heart Federation, All India Institute of Medical Science (AIIMS)*

He is presently an Adjunct Professor at Harvard and Emory & Honorary Professor of Medicine at the University of Sydney. He has served on many WHO expert panels & has been the President of the World Heart Federation (2013-14). He is a member of the Leadership Council of the Sustainable Development Solutions Network, established to assist the United Nations in developing the post-2015 goals and chairs the Thematic Group on Health in the SDSN.

Mira Shiva – *Director, Initiative for Health and Equity in Society, former Chairperson, Health Action International Asia –Pacific*

Medical doctor and public health activist, she is well known both in India and abroad for her contribution in areas of social justice in health care, rational drug use, women's health and the survival of the poor in Third World countries. She was member of the Working Group on Regulations for Food & Drugs, and founding member of Doctors for Food Safety & Biosafety, and the Indian Initiative for Management of Antibiotic Resistance. She was head of the Public Policy Division at Voluntary Health Association of India and coordinator of the All India Drug Action Network.

She is the founding member of Antibiotic Resistance Coalition and People's Health Movement. A member of the Right to Food movement. She is part of the National Coordination Committee of Infant and Young Child Feeding, Ministry of Health and Family Welfare. Dr Mira Shiva was the chairperson of the Task Force on Safety of Food and Medicine, Ministry of Health and Family Welfare

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