HUNGER AND OBESITY AS SYMPTOMS OF NON-SUSTAINABLE FOOD SYSTEMS: STAKEHOLDER-DRIVEN INNOVATION POLICIES AS COUNTERMEASURES

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Abstract: In this analytical paper we seek to explore the role of health status and food quality within the context of global food security and related innovation policies towards a more sustainable food system. Current regulations and literature on food security primarily focus on food quantity (i.e. serving sizes), daily calories intake, and means to increase food production. Yet from a systems perspective, food security is not an independent condition. Rather, it is characterized by the interplay of a vast net of economic, financial, sociocultural, political, legal, institutional, technological, infrastructural, and ecological effects, which all need to be considered as parts of a comprehensive global food system; here, we highlight a few aspects within this vast net which we consider particularly important. Our paper addresses the relative underrepresentation of food quality, the interplay of obesity and hunger, and their influence on health and wellbeing and we link the hunger and the obesity discussion including their implications on health and wellbeing by raising the question of society's and stakeholders' responsibilities. We first elaborate on the relationship between hunger and obesity as global phenomena, arguing for the necessity of a comprehensive systemic policy approach in order to capture all (i.e. direct and indirect) effects of hunger and obesity, and on all levels of society. Through the lens of health and wellbeing, we further discuss potential drivers of responsible behavior, either in relation to oneself or to others (e.g., increased creativity and innovativeness). With respect to the characteristics of a sustainable food system, we highlight how single policy means, e.g., supporting the expansion of biofuel production, can simultaneously be advantageous for obesogenic environments like the Western world and at the same time perilous for undernourished parts of the world. In the last section of this paper, we then discuss a few strategies and policies towards a more sustainable food system. This paper contributes to the social responsibility of humans and their influence on human health.

Keywords: *Food security; health; malnutrition; hunger; obesity; stakeholder-driven innovation policies; social responsibility.*

LAKOTA IN PREHUDA DEBELOST KOT ZUNANJA ZNAKA NE-TRAJNOSTNEGA PREHRANSKEGA SISTEMA; INOVACIJSKE POLITIKE Z IZHODIŠČEM V DELEŽNIKIH KOT PROTIUKREP

POVZETEK: V tem analitičnem prispevku poskušava raziskati vlogo zdravstvenega statusa in kakovosti hrane v kontekstu svetovne prehranske varnosti in s tem povezanih inovacijskih politik, ki stremijo k trajnostnemu prehranskemu sistemu. Sedanja pravila in literatura o prehranski varnosti se osredotočajo na količino hrane (i.e. velikost obrokov), dnevne užitje kalorij in sredstva za porast pridelave hrane. Toda s sistemskega vidika prehranska varnost ni neodvisno stanje. Značilno zanjo je prepletanje ogromnega omrežja ekonomskih, družbeno-kulturnih, političnih, pravnih, institucionalnih, infrastrukturnih in ekoloških vplivov; vse njih je treba šteti za delo celovitega svetovnega prehranskega sistema. Tukaj osvetljujeva nekaj vidikov iz tega omrežja, ki jih štejeva za posebno pomembne. Ukvarjava se z dokaj premajhno zastopanostjo kakovosti hrane, medsebojnim vplivom med prehudo debelostjo in lakoto ter z njunim vplivom na zdravje in dobro počutje; odpirava vprašanje o odgovornosti družbe in deležnikov. Najprej obravnavava odnos med lakoto in prehudo debelostjo kot globalnima pojavoma in trdiva, da je potreben celovit sistemski pristop k politiki, zato da bi zajeli vse (t.j. neposredne in posredne) vplive lakote in prehude debelosti in to na vseh ravneh družbe. Z vidika zdravja in dobrega počutja potem razpravljava o možnih dejavnikih za odgovorno obnašanje človeka do sebe in do drugih (n.pr. več ustvarjalnosti in inovativnosti). Glede na lastnosti trajnostnega prehranskega sistema izpostavljava, kako zmorejo posamična sredstva politike, ki npr. podpirajo porast proizvodnje bio-goriv, hkrati nuditi prednosti okoljem s preveč debelih, kot je zahodni svet, in spravljati v nevarnost premalo prehranjenim predelom sveta. V zadnjem delu prispevka potem razpravljava o nekaj strategijah in smernicah za bolj trajnosten prehranski sistem. Tako ta prispevek krepi družbeno odgovornost ljudi in njihov vpliv na človeško zdravje.

Ključne besede: družbena odgovornost; inovacijske politike z izhodiščem v deležnikih; prehranska varnost; preslaba prehranjenost; zdravje;

Introduction

Malnutrition induces underweight as well as overweight, and is considered the single most important threat to global public health (The Economist, 2008). WHO data suggest that malnutrition as the underlying contributing factor accounts for the largest proportion of childhood mortality worldwide (WHO, 2013). Undoubtedly, nutrition, health status, and wellbeing of citizens are strongly interrelated and have far reaching social, ecological, and economic effects. China' economic development since 1978, for example, which was based on market reforms, has been closely linked with large improvements in the country's *nutrition and health status* (e.g., FAO, 2006). Put differently, appropriate nutrition affects not only people's health status, but – on a larger scale – also the sustainability of evolving societal systems. Moreover, malnutrition not only leads to undernourishment but also to overweight and obesity. Paradoxically, hunger, if understood as a form of discomfort from not eating, affects the undernourished and overweight alike.

We discuss the role and precise responsibilities of single stakeholders in current food and health policies in this paper, as well as several other thematically relevant questions, including: At what societal level are decisions towards a healthy and satisfying life made? How can societal stakeholders be encouraged to play a more active and responsible role within the food and health systems? We argue that – as the basis for a healthy society – an improved systemic understanding of the inter-dependencies of food, health, and wellbeing is needed at all levels of society to develop food and health policies which take the full potential of society (including their creativity and innovativeness) into account.

The paper starts out with some clarifications of concepts and underlying definitions regarding the interrelatedness of the food and health systems (Section 1), then explores hunger as a global phenomenon (Section 2) followed by an outline of the obesity epidemic in the Western world (Section 3), and a discussion of the hunger-obesity paradox (Section 4). Health effects of malnutrition related to over- and under-supply in calories intake, food quality, and behavioral patterns are also discussed in these three sections. Section 5 reviews economic, technological, and social

dimensions of food security, based on the characterization of global food security as a complex adaptive system along a timeline, which encompasses past developments, the status quo, and future developments with 2050 as time horizon. Potential strategies and policies towards a sustainable food system as well as responsibilities of various societal agents, lastly, are outlined in Section 6.

1 Definitions

Several commonly used definitions in the context of our paper require clarification. *Food security*, for example, "… exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). This implies that food security depends on food availability, food access, appropriate utilization of food, and stability of access to adequate food, as stated in the Rom Declaration of the Food and Agricultural Organization (FAO) of the United Nations (FAO, 2006). The Rom Declaration also points out the importance of the relationship between the quality of food and health; yet, the interrelatedness of undernourishment and overweight/obesity as well as their interplay with food quality, waste prevention, and food reuse or recycling strategies are, at best, of secondary interest.

The right to food, – another technical term – is universal (i.e. a human right) and, as such, has been put down in writing in UN charters (UN-OHCHR, 2008). Subsequently, the related concept of food entitlement was identified by 1998 Nobel Laureate Amartya Sen. The following definitions are mostly based on FAO, IFAD, and WFP (FAO et al., 2013) and outlined in Figure 1: *Malnutrition* includes under-nutrition and over-nutrition as well as micronutrient deficiencies and is understood as an abnormal physiological condition caused by inadequate, unbalanced or excessive consumption of macronutrients and/or micronutrients. *Under-nutrition* as the outcome of *under-nourishment* (i.e. a state, lasting for at least one year, of inability to acquire enough food, defined as a level of food intake insufficient to meet dietary energy requirements) is characterized by deficiencies of essential vitamins and minerals (collectively referred to as micronutrients) and includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient malnutrition). *Over-nutrition* is a result of excessive food intake relative to dietary nutrient requirements. *Hunger* has been described as a form of discomfort from not eating, and as such can affect both undernourished as well as overweight individuals; however, in this paper hunger is used synonymous with chronic undernourishment (as discomfort from not eating, also obese people can experience hunger). *Obesity*, finally, refers to the over-consumption of specific nutrients, which, as another form of malnutrition, by definition is characterized by a body-mass index (in kg/m2) of 30 or greater (whereas overweight refers to a BMI of 25-29.9).

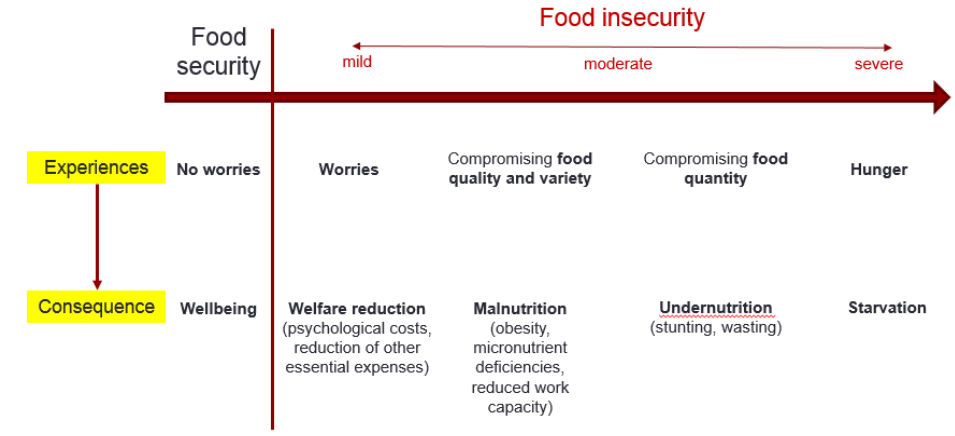

Figure 1: From food security to food insecurity (adapted from Cafiero/FAO, 2013)

In terms of undernourished energy supply, 12.5% of the global population has been undernourished in the period 2011-13, which equals a total of 842 million people worldwide (FAO et al., 2013).

2 The global phenomenon of hunger

Among adults, 1-2% of all deaths worldwide are attributable to nutritional deficiencies including malnutrition, and in children ages 1-4, over 7% annually die due to hunger, resulting in 140,000 deaths of 2 million deaths total attributable to hunger (Lozano et al., 2012). Besides an increased infant mortality, the numerous negative health consequences of hunger span from low birth weight to underweight and stunting, poorer overall health, higher rates of chronic illnesses and asthma, decreased or delayed cognitive ability to higher rates of mental illness, as well as increased rates of obesity. Though the latter may seem puzzling, it ties in with the fact that parental poverty is a risk factor for obesity, independent of the socioeconomic status (SES) attained by the offspring. Part of the explanation for this is that food insecurity during childhood may lead to compensatory overeating. Further, the fetal origin hypothesis poses that prenatal under-nutrition induces permanent changes in regulatory mechanisms of energy intake and expenditure, and that in-utero exposure to under-nutrition is a developmentally sensitive time period. Even though the number of undernourished individuals has declined over time, the decrease has been slow and has not equally affected all parts of the world, with the slowest progress having been made in Africa and Oceania (FAO et al., 2013: 11).

3 The obesity epidemic

America and the Western world overall, currently experience an unprecedented obesity epidemic, which, in the US, began in the 70ies – the time when the "energy balance flipping point" occurred (Swinburn et al., 2011). The flipping point essentially refers to an increase in food supply (probably due to increasing food access), which took place around that time. Since then, obesity rates have grown at a remarkable rate, initially in the US, and with some lag-time more recently also in Europe. For example, current obesity rates in the US were in 2013 on average 27%, and have risen in Europe from <5% in 1984 to a staggering 50% today. Immigrant data suggest that the chance of becoming obese increases within a relatively short time frame (i.e. 10-15 years) if a person moves into an "obesigenic" environment like the US (Goel et al., 2004). Obesity is a silent killer, which can be held accountable for countless – particularly chronic - illnesses, most notably diabetes mellitus, heart disease, and a variety of cancers. In sum, there is reason for concern, and an urgent need for action. Among the many risk factors for obesity, unhealthy nutrition is gaining increasing attention. In the US, a stepwise approach towards fighting the obesity epidemic has been implemented as early as 1999, initially targeting increased awareness, then later implementing state programs, and more recently involving the food industry. These measures are starting to show signs of success in the form of a modest decrease in childhood obesity rates, which, for the first time in decades, have recently been reported. Meanwhile the European Union, after several unsuccessful information campaigns, is discussing a ban on marketing targeted at children, and better nutrition labels, as newer and potentially more promising measures the EU is recently contemplating to fight this out of control epidemic.

4 Hunger-obesity paradox

Even though still on a modest scale, the paradoxical situation of a co-existence of both obesity and malnutrition exists. For example, one of the US prime examples of staggering obesity rates, the district South Bronx in the city of New York (obesity rates, since years, top the nations' obesity rates) also has the highest proportion (37%) of individuals who cannot afford food. This, as well as other data, strongly points towards food quality as one of the prime culprits for the paradoxical co-existence of two opposite states on the food security scale. And indeed, research suggests that the amount of weight gained is strongly related to the type of food people consume. A recent study using large US data bases (Mozaffarian et al., 2011) demonstrate that the biggest weight gain is achieved by those who consume larger amounts of potato chips, meat, sweets, or butter, for example; whereas those whose diet comprises more fruits, whole grains, and nuts, seem to lose weight most easily. In most countries of the world, underweight and overweight tend to inversely correlate with each other. However, besides the above discussed paradox in parts of the Western world, several low- to middle-income countries also show positive associations between under- and overweight, and this correlation appears to exist independent of SES (Corsi et al., 2011). Examples where high rates of underweight co-exist with high rates of overweight/obesity include Albania, Turkey, Morocco and Jordan, as well as Zambia, Mozambique, and Burkina Faso. Taken together, this suggests that, even though the coexistence of under- and overweight may not yet have occurred at a large scale, the development of this paradoxical situation ought to be carefully monitored.

5 Economic, technological, and social dimensions of food security

The global rise in demand for crop production is largely driven by 1) an increase in food demand, which, in turn, is strongly related to population growth and changes in dietary patterns as a result of growing affluence; and 2) by an increase in biofuel production. Estimates put the increase in crop production needed by 2050 between 60% and 110%, depending on whether they consider food demand alone, or in conjunction with biofuel consumption. FAO's production estimates, for example, do not consider the increase of agricultural production for biofuels; consequently, their estimates project a 60% increase in crop production required by 2050 (FAO, 2012).

When taking the expected increase in biofuel consumption into account, and focusing on four key crops that account for approximately 75% of global agricultural calories – maize, rice, wheat, and soybean – big discrepancies between projected and needed yields are anticipated to exist by 2050 (Ray et al., 2013). With the need to roughly double agricultural production by 2050, annual expected growth rates of maize (1.6%), rice (1.0%), wheat (0.9%), and soybean (1.3%) lag far behind the needed growth rate of approximately 2.4%. The currently expected growth rates translate into a global growth of 67% in maize, 42% in rice, 38% in wheat, and 55% in soybean; hence, business as usual will definitely lead to worsened food insecurity worldwide. Furthermore, large regional differences in crop productivity exist, globally. As an example, in Africa, rates of maize yield are increasing in, e.g., the Nigerian states of Yobe and Adamawa, in Ethiopia, Angola, South Africa, and Madagascar, but maize yield rates are decreasing in Morocco, Chad, Somalia Kenya, Zambia, Zimbabwe, Rwanda, Burundi, and the Democratic Republic of Congo (Ray et al., 2013: 5).

The application of fertilizers is one measure to provide additional nutrients to the soil and to enhance its fertility, which helps to boost crop yields. Fertilizer, either organic or mineral-based, has the purpose to supply soils with nitrogen, phosphorus, and potash (potassium) as the three most important macronutrients for crop growth. According to the International Fertilizer Industry Association (IFA), global fertilizer demand is expected to grow; it was 176 mega tons in 2011-2013, and is expected to be around 179.5 mega tons in 2013/14, and 184.3 mega tons in 2014/15 (ICIS, 2013). The share of Nitrogen accounted for +/- 58 percent, phosphate for +/- 24 percent, and potash for the remaining +/- 18 percent. Of note, inequalities for different stakeholders and regions relate to the global fertilizer value chain. For example, China, the United States, and India are the top three fertilizer consumers, accounting for 58% of the world consumption in 2010, whereas Sub-Saharan Africa – as one of the three key developing regions besides Latin America and South Asia – imports only small amounts of fertilizers (Weber et al., 2014). Given their low crop productivity rates, Sub-Saharan Africa's fertilizer application rates are still far too low, averaging 10 kg of nutrients per hectare (Ha) arable land (with huge differences between Sub-Saharan countries and with South Africa as the only significant African importer), in comparison to 86 kg/Ha in South Asia, 118 kg/Ha in Latin America, 198 kg/Ha in an average middle-income country, and 288 kg/Ha in a high-income country (IFPRI, 2011). On the other hand, Morocco is the largest exporter of phosphate rock (PR) worldwide, with 2,575 kilo tons in 2010 (Weber et.al, 2014).

Another critical dimension of food security relates to food waste. A study by the Swedish Institute for Food and Biotechnology (SIK) and the FAO in 2011 confirmed that approximately "one-third of the edible parts of food produced for human consumption gets lost or wasted globally, which is about 1.3 billion ton per year" (SIK & FAO, 2011: 4). Although a global phenomenon, big regional differences exist with respect to food waste occurring along the food supply chain (FSC). Food losses occur at the beginning of the FSC in production post-harvest, and processing stages, whereas food waste occurs during retail and final consumption (Parfitt et al., 2010). This distinction is important in order to highlight regional peculiarities in consumption patterns. The study further outlines that the per capita food waste and losses of 170kg/year in Sub-Saharan Africa can mostly be attributed to losses in the early stages of the FSC, whereas only 6 kg/year can be attributed to food wasted by consumers. In comparison, per capita food wasted by consumers in Europe accounts for 95 kg/year in Europe and 95-115 kg/year in North-America, as part of a total of 280 kg/year in Europe and 300 kg/year in North America per capita food losses and waste. At a global level it shows that 222 mega tons of food waste at the consumer level in industrialized countries equal almost the total net food production of 230 mega tons of Sub-Saharan Africa. In addition, food losses and waste become a growing global problem with respect to their deposition at landfills, leading to pests, toxic liquids, odors, and methane gas as a tremendous risk for climate change.

6 Strategies & policies towards a sustainable food system & responsibilities

From a systems perspective and as outlined in the previous sections, food security is not an independent, self-contained affair. Any effort to achieve a sustainable food system has to go beyond merely boosting production in order to meet the crop yield targets for an expected world population of around 9 billion people in 2050. Rather, economic, financial, sociocultural, political, legal, institutional, technological, infrastructural, and ecological effects all need to be considered

as parts of a comprehensive global food system, which is, in addition, characterized by regional and stakeholder specific differences.

The following outlines several potential strategic options when aiming at food security and health as the two core dimensions of a sustainable food system: (1) measures for food production increase (either by boosting crop yields of today's agricultural land or by clearing further land for agriculture); (2) food losses and waste prevention, alternative uses, and recycling; (3) avoidance of food overconsumption and changed quality related consumption patterns; (4) hybrid solutions of (1), (2), and/or (3); (4) to development of health programs, which build on joint (pro)active and passive health related nutrition initiatives; and (5) the establishment of food and health policies, which build on the increased responsibility of all members of society. These strategies will also depend on technological and social innovation at various levels of society (including stakeholder-driven innovation), awareness building among, and educational measures to increase the competences of various stakeholders of society, more systemic policies, which integrate strategies related to overweight (and obesity) as well as those related to undernourishment, and cost reduction as potentially helpful promoters within a sustainable food system.

Technology-based strategies usually aim for food production increase, which can be achieved by (1) the use of more sophisticated fertilizers; (2) better and more efficient irrigation systems (e.g., the use of cheaper drip-irrigation systems for small holder farmers); (3) improved seed quality; and (4) better logistics and storage systems (to avoid food losses during production, storage, and transport). The provision of such technologies tends to be considered a "support service" by rich countries for the poor. However, rather than considering this as a Samaritan act, market-based strategies ought to be taken into consideration as well. As reminisced by Stanford's former president William Miller: when a technology provider on a 'Samaritan mission' went to India 'as a socialist' to provide irrigation systems to poor smallholder farmers, he returned to California as a 'capitalist'; the key to success was not to provide highly subsidized expensive irrigation systems to these farmers, but to be innovative in providing the same basic functionality at reduced product costs and simultaneously opening a huge new market of relatively poor farmers, who had become the customers of a new product which had not existed at such a price before. Consequently, although profit margins were relatively small per water pump, the incredible amount of new customers built the basis for a new business model based on cheap affordable technology.

If one wants to take the thinking paradigm focusing on maize, rice, wheat, and soybean as the cornerstone of global food production one step further, technology might go beyond strategies that focus on production improvement. The development of niche strategies, for example, may, over time, lead to a change of thinking paradigms. From this perspective, an approach may focus on alternative sources of protein and carbohydrates rather than merely striving to increase existing production patterns. AgriProtein Technologies, a South African eco-business case is based on a fly project which leads to paradigm changes along various dimensions (Drew & Joseph, 2012): (1) Recycling of waste nutrients (e.g., waste from supermarkets or abattoir waste from industrial slaughterhouses) by; (2) rearing fly larvae (which consist of around 55 % proteins) on these waste nutrients and; (3) producing larvae meal to replace fishmeal in industrial farming. The effects of this fly project are manifold: waste is reduced, less need for other primary resources of feed (e.g., soy), and waste as secondary resource is substituting primary resources, thereby closing a nutrient loop. Other successful examples of waste nutrient recycling are, e.g., known in Thailand where catfish are grown in raw human sewerage. Further research on the potential transmission of infectious pathogens and other health issues would be beneficial to gain broader public acceptance of projects of this kind.

Concluding Remarks

This paper explored the role of health status and food quality within the context of global food security and related innovation policies towards a more sustainable food system. Food and health policies are two sides of the same coin, as a sustainable food system depends on coupled food and health policies which are based on the increased responsibility of all members of society along the agriculture and food value chain (including industry, farmers, traders and retailers, consumers, citizens, policymakers, and others). Our discussion also showed that future studies need to put more emphasis on an in depth understanding of the interdependencies within the global food system.

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