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Environmental education from positive consequences of **food waste** reduction

Educar ambientalmente a partir de las **consecuencias positivas** de la **disminución** de residuos alimenticios

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Abstract

This study focused on data of ecological, economic, and social consequences of food waste reduction of the most frequent and abundant fresh components (including tortilla) of the Mexican diet. Some of the major outcomes were significant money and energy savings and water and ecological footprint decreases. Ecological and socioeconomic benefits -as calculated for a city of 20 million people- were discussed to show how a minimum cultural change of avoiding throwing away even small quantities of food can amazingly improve human-environment relationship. This study makes three contributions (1) Retaking the learner as the center of education; (2) Presenting a holistic vision of the environment; (3) Dealing with multiple consequences; and proposing a positive vision of the consequences. The information discussed can be used in any part of the world. Nonetheless, for better results all local information should be considered on food cost and waste per person and cost of final waste disposal.

Keywords: Environmental education; Sustainable development; Ecological footprint; Socioeconomic benefits; Holistic vision

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Resumen

Este estudio se basa en consecuencias ecológicas, económicas y sociales de la reducción del desperdicio de alimentos de los componentes frescos más frecuentes (además de la tortilla) y abundantes de la dieta mexicana. Algunos de los principales resultados son importantes ahorros de dinero y energía y una disminución de la huella ecológica y del agua. Se discutieron los beneficios ecológicos y socioeconómicos calculados para una ciudad de 20 millones de personas para mostrar cómo un cambio cultural mínimo de evitar tirar, aunque fueran pequeñas cantidades de alimentos, puede mejorar asombrosamente la relación entre el ser humano y el medio ambiente. Este estudio realizó tres contribuciones (1) Retomar al alumno como el centro de la educación; (2) Presentar una visión holística del medio ambiente y (3) ocuparse de múltiples consecuencias; desde una visión positiva de las mismas. Esta información puede usarse en cualquier parte del mundo; no obstante, para obtener mejores resultados, se debe considerar toda la información local sobre el costo y desperdicio de los alimentos per cápita y el costo de la eliminación final de los desechos.

Palabras clave: Educación ambiental; Desarrollo sustentable; Huella ecológica; Beneficios socioeconómicos; Visión holística.

Introduction

One of the most important sustainability challenges is food waste reduction (Everitt et al., 2021). According to the Food and Agriculture Organization (FAO) (2019) a third of global food production is wasted each year. Gutiérrez-Barba and Ortega-Rubio (2013) found that participating housewives in a food waste minimization workshop were able to reduce food waste to a minimum of 0.0158 g/person/d and a maximum of 120 g/person/d. In 2017 at global level, 47 kg/capita/year (128.76 g/capita/day) of avoidable food waste (AFW) were discarded; AFW is never used for human consumption as their main purpose (Coudard et al., 2021), and an unnecessary environmental impact is produced (Williams et al., 2012). Therefore, urgent strategies are essential for food waste reduction, and environmental education (EE) is one of the most powerful.

In the topic of waste, EE has been mainly driven toward its correct segregation (Mosquera et al., 2014), storage, and final disposal (Ikeda, 2014). From this proposal, the purpose of education is detracted as a process centered in the learner placing the focal point on the result in benefit of the environment (*sensu stricto*) instead of on the learner.

Tilbury (1997) proposed education about the environment (EAE), education for the environment (EFE) and

education in the environment (EIE). Twenty years later, Gutiérrez-Barba et al., (2017) made a specific exercise with respect to these three types of environmental education taking solid waste into account.

The authors highlighted that in the first type (EAE) the information is the center of the proposal and refers to waste and segregation types. The second one (EFE) is directed to improving the environment and related to solid urban waste

Education practices underline recycling to emulate nature, as preparing compost – one of the best known and handy practices.

Thus, these two types of environmental education are not totally effective since they are based only on information. Chen and Martin (2014) and Aka and Buyukdag (2021) educational models emphasize that information is not effective by itself and sideline consubstantial human processes to education, such as reflection (Colomer et al., 2013) relating it inextricably with practice and action research (Rolfe, 2014).

Therefore, the third type, EIE takes waste as an opportunity of rethinking culturally and reflecting on our relationships with this learning objective – waste and put it into action. Gutiérrez-Barba et al. (2017) showed that such relationships are defined by their own mental processes specified from ethos, as rational and symbolic thought that should lead to raise awareness critically and consciously through questions, contextualization, and reflection. Neither Tilbury (1997) nor Gutiérrez-Barba et al. (2017) explicitly mentioned the hedonistic factor (positive psychology) in their proposal.

With respect to environmental behavior, Sharpe et al. (2021) found that stronger personal motivations are the more inclined people are to show such behavior. These authors consider biospheric values as motivation, which are only one of those possible to take action, since Thommen et al. (2021) mentioned that motivation is multidimensional and includes the pleasure of acting, self-efficacy to act and knowledge to do it. At the end of the day, to recognize the factors influencing behavior toward food waste will lead a person to its prevention (Flanagan and Priyadarshini, 2021). Respecting those factors, some studies are focused on lack of information or misinformation on labelling, storing, packaging but to our knowledge no information on positive consequences of avoiding food wasting is produced.

The first contribution of this work shows a holistic vision of the environment. It not only reflects toward environmental, *sensu lato*, but also includes social and economic consequences of food beyond its nutritional aspects, directing reflection toward a highly serious environmental aspect, which is food waste generation.

The second contribution deals with multiple consequences in the wide sense of environment since its dominant focus is limited to affecting the natural environment. It generally refers to producing and consuming organic and local food production,

making compost and leaving a gap related to food waste reduction. Only recently the Food and Agriculture Organization (FAO) and the Commission for Environmental Cooperation (CEC) of North America mentioned programs specifically to encourage decreasing food waste. Nonetheless, to our knowledge social and economic dimensions have not been considered yet. The third contribution is based on positive consequences as a substantial part dealt very little in environmental education.

Fatalism – frequently used when speaking about such consequences – is a perspective that provokes negative emotions as guilt, despair, anxiety, eventually subverting subjective well-being and frequently leading to negating the situation that caused it. On the contrary, embodying the consequences positively generates good spirits, satisfaction, provides the possibility of taking part and adds well-being (hedonism). Thus, it is less likely for the learner to retreat psychologically and materially from the situation and rather turn it to strengthening oneself.

Consequentialism

The logic of consequentiality is one[2] the logics of decision-making of administrators (Dewulf et al, 2019), regarding citizenship, most people are consequentialists (Johansson-Stenman, 2012). Despite the importance of multiple outcomes, "mono-consequentialism… reigns across the social sciences with relatively few challenges to its hegemony"; mono-causality also reigns across the social science (Agrawal and Chhatre, 2011:1), and education is not the exception. Most studies on food education have focused mainly on health (FAO programs, mass media messages, food labeling) although food consumption has multiple consequences.

Positive consequences

Punitive or fatalism didactics is not the only way to provide meaningful education. Nevertheless, didactic resources as "An Inconvenient Truth" or "The Age of Stupid" are frequently discussed in educational interventions (Howell, 2011), provoking negative thoughts and feelings. In fact, some studies (Flanagan and Priyadarshini, 2021) show environmental caring and environmental uncaring persons both feel negative emotions when wasting food so negative emotions do not make any difference. Conversely, positive emotions promote the increase of emotional intelligence and reflection (Lambrechts et al., 2011). Our perspective is focused on positive consequences (impacts) of food waste reduction, therefore, to calculate such

[2] The other is the logic of appropriateness

positive impacts, data of the reduction achieved was organized by ecological, economic, and social consequences of 100 g of food waste avoidance, considering world data taken from literature and/or official sources.

Respecting wasted food groups, Coudard et al., (2021) found that the four most wasted food groups were cereals, vegetables, fruits and finally dairy products, but for this study, the six most frequent and abundant fresh components of Mexican's diet (dry beans, potatoes, rice, egg, poultry, and beef) were included. Corn tortilla is a processed meal, but it was included because it is a very frequent and abundant meal eaten by Mexicans with an intake of 236g/capita/day (FAO, 2013 cited by Sánchez-Villa et al, 2020).

The equations set out were used for calculating average waste reported by Vázquez del Mercado and Lambarri (2017) in tons per year; for chicken 1 095 132; beef 628 752; beans 310 712, rice 82 697; and tortilla 2 139 412. In this manner, average waste / person/day measured in kilograms is 0.026 for chicken; 0.012 for beef; 0.0075 for beans; 0.002 for rice; and 0.21 for tortilla. In the case of corn and potato, they were calculated with 100 g/waste/ day/person because no official data was available.

Ecological Consequences: water footprint

Information on virtual water is diverse but dispersed and incomplete as well. Some sources have reported the use of 2070 L to produce 100 g of beef (Hoekstra, 2003); others have reported 1600 L for the same production (UNESCO 2011). The same situation occurs for rice; for example, to produce 1 t of husked rice, 3000 m3 of virtual water are necessary (world average); data varies from 1600 m3/t in Japan and in the U.S.A to 4000 m3/t in Brazil (Berittella et al., 2007). To produce 100 g of poultry, it requires 282.8 L of water; 100 g of potatoes 16 L; 100 g of maize 190 L (Hoekstra, 2003), 90 L (FAO 2004), 71 L, or 45 L (UNESCO 2011). One egg requires 135 L of virtual water and dry beans 562.7 L/100 g in Mexico (Berittella et al., 2007).

For each food, it is possible to calculate water footprint decrease (WFPd) if the following information is known the reduction of waste generation per person (WG) (grams), the amount of virtual water of that food (VW) (water content in 100g of food in liters), and the waste generation described per person/day.

Those data are calculated for one person or the entire population[3] (Pp), for one or many days (t).

Water footprint decreased calculation for each food group and for the whole population in Mexico City; its boundaries are shown in Table 1 where the greatest water saving corresponded to not wasting meat and the least to potato.

When the liters that would be saved were multiplied by the population living in Mexico City and boundaries, the numbers were amazing (Table 1)

[3] Pp = population (8 918 653 people in Mexico City; 20 116 842 people in Mexico City and boundaries)

Table 1. Water Footprint decrease

Food	wasted food by Mexicans (kg/ person/ day)	Virtual water saving (L/kg)	Annual water saving (L)	Annual water saving at Mexico City (L/person/ year) (1*)	Annual water saving at Mexico City and boundaries (L/person/ year) (2*)
Maize *	0.1	450	16 425	1.46E+11	3.30E+11
	0.1	710	25 915	2.31E+11	5.21E+11
	0.1	1900	69 350	6.19E+11	1.40E+12
Rice	0.002	3000	2 190	1.95E+10	4.41E+10
Potato *	0.1	160	5 840	5.21E+10	1.17E+11
Poultry	0.026	282.8	2 684	2.39E+10	5.40E+10
Beef	0.012	16,000	70 080	6.25E+11	1.41E+12
	0.012	20,700	90,666	8.09E+11	1.82E+12
Beans	0.0075	562.7	1 540	1.37E+10	3.10E+10
Egg **	1	135	49 275	4.39E+11	9.91E+11
Tortilla	0.021				

*calculated on 100 g waste

**calculated on 1 piece of waste*: bgutierrezb@ipn.mx: bgutierrezb@ipn.mx: bgutierrezb@ipn.mx*

(1*) 8 918 653

(2*) 20 116 842

Ecological Consequences: Ecological Footprint

Mexicans have an ecological footprint (EF) from 2.56 to 3.25 ha (White, 2007; Ewing et al., 2009). To reduce EF some savings can be done but not food. In this case, waste reduction is a good option. If 100 g of food waste came from corn, rice, potatoes or dry beans, land area for cultivating them would be reduced, depending on harvest conditions.

For each and every food, it is possible to calculate the Ecological footprint decrease (EFd) if the reduction of waste food per person (WF) (grams) is known and the amount of food production (t/ha) in case of potato, maize, rice, beans. Those data are calculated for one person or the entire population (Pp), for one day or many (t):

Table 2 shows how much EF land area would be reduced to stop harvesting 100 g of food (just vegetables). One hectare produced 34 t of potato (Flores Gutiérrez, 2011); maize from 1.995 t/ha (López-Lozano, 2003) to 3.26 t/ha (SAGARPA 2010); and rice yielded from 3.5 to 6.2 t/ha (Berittella et al., 2007). In 2010, each hectare planted with beans in Mexico produced 0.7 t (López-Lozano, 2003).

Environmental costs of transport were not considered, so the EF reduction would have been even greater. Lower benefits corresponded to a higher yield. Higher benefits were related to dry beans (786 712.21 ha), and the lowest one was related to potato (2 159 602.2 ha).

Table 2. Ecological footprint decrease

Food	wasted food by Mexicans (kg/per person/ day)	wasted food by Mexicans (kg/per person/ year)	Production kg/ha/ year	Personal ecol footprint decrease (ha)	Ecol. footprint decrease in Mexico City (ha) (1*)	Ecol. Footprint decrease Mexico city & boundaries (ha) (2*)
Maize *	0.1	36.5	199.5	0.18295739	1631733.5	3680525
	0.1	36.5	326	0.11196319	998560.84	2252345.8
Rice	0.002	0.73	350	0.00208571	18601.762	41957.985
	0.002	0.73	620	0.00117742	10500.995	23685.959
Potato *	0.1	36.5	340	0.10735294	957443.63	2159602.2
Beans	0.0075	2.7375	70	0.03910714	348783.04	786712.21

*calculated on 100 g waste

** calculated on 1 piece of waste

(1*) 8 918 653

(2*) 20 116 842

Ecological Consequences: Space in landfills

For the aims of this study, organic wastes would have been disposed in landfills. In Mexico City, landfill received 13 401 t/day in 2011. Household waste had a density of 226 kg/ m3 according to Mexico City Government (Balderas et al., 2007).

For any food, it is possible to calculate the Space in landfills (LSd), if it is known the amount of waste generation per person (WG) (grams), and the density described above (226 kg/m3).

Those data are calculated for one person or the entire population (Pp)[4], for one day or many (t) With respect to space in landfills, the maximum decrease in landfill space would be 844 729 m3/year, and the minimum decrease would be 64 979 m3 per year taking into account the values of food waste by Mexicans.

Economic Consequences

In Mexico, 50% of urban solid waste has been disposed in landfills to date (INE 2011b), and in Mexico City (CDMX), the government spent $12.03 USD/t. If food is not thrown away, then an economic saving is reached.

For any food, economic saving can be calculated for not disposing food waste (ESnD) multiplying the amount of spending money for disposing waste in landfills (12.03 USD/t) by the reduction of waste generation (WG) in grams. These data could be extrapolated for the entire of population (Pp)[5]

Taking these data as basis, a reduction of 100 g of daily waste per person living in CDMX would save a total of USD 10 729.13. If this 100 g of

[4]Pp = population: 8 918 653 people in Mexico City; 20 116 842 people in Mexico City and

[5]Pp = population (8 918 653 people in Mexico City; 20 116 842 people in Mexico City and boundaries)

food is not newly acquired, then an additional saving is reached. All data shown were calculated taking retail prices published by BANXICO (Banco de México, 2021) and INEGI (Instituto Nacional de Geografía e Informática, 2021) (if no other source is cited).

Tortilla retailed at $0.89 USD; maize at $0.399 USD/kg; rice at $1.74 USD/kg; Alpha potato variety at $0.99 USD/kg in average; poultry retailed at $3.24 USD/kg; beefsteak at $8..24 USD/kg. One kilo of eggs corresponded to 17 pieces and it retailed at $1.68 USD/kg; Beans cost $2.19 USD/kg.

For each food, direct saving (Ds) in USD, can be calculated if the market price of 100g of food is known (Pr) in USD multiplied by daily reduction of waste generation (WG). This saving can be calculated for one day or more (t) and extrapolated for the entire population (Pp)[6]:

With respect to direct economic savings, Table 3 summarizes data for each food. Certainly, these savings are underestimated; food market value was not the real cost because of the grant supporting agriculture in most countries (Hodges, 2005).

Beans were the cheapest food whereas beef was the most expensive. The maximum annual saving was USD 248 054 49 and the minimum 2 415 438.

According to the European Union, the United Kingdom households threw away from £250 to £400 of potentially edible food each year (FOE, 2007). Mexicans generate 0.32 kg food waste on average equivalent to $0.69 USD/day, which is lower than that reported for the UK.

Low-income families in Mexico allocate up to 56% of their income to buy food and beverages while high-income families allocate up to 20% (Martínez and Villezca-Becerra 2003), so any savings in food-buying had a positive impact in family expense; unfortunately, benefits are not equally proportioned.

[6]Pp = population (8 918 653 people in Mexico City; 20 116 842 people in Mexico City and boundaries)

Table 3. Economic savings

Food	Wasted food by Mexicans (kg/per person/ day)	cost kg (USD)	Savings/day	Annual economic saving/ person (USD)	Annual economic saving Mexico City (1*) (USD)	Annual economic saving Mexico City and Boundaries (2*) (USD)
Maize*	0.1	0.399758146	0.039975815	14.59	130,133,602.97	293,528,308.57
Rice	0.002	1.74894189	0.003497884	1.28	11,386,690.26	25,683,727.00
Potato*	0.1	0.999395366	0.099939537	36.48	325,334,007.43	733,820,771.43
Poultry	0.027	3.248034939	0.087696943	32.01	285,480,591.52	643,927,726.93
Beef	0.015	8.245011768	0.123675177	45.14	402,600,834.19	908,103,204.65
Beans	0.007	2.198669805	0.015390689	5.62	50,101,437.14	113,008,398.80
Egg**	1	0.099112831	0.099112831	36.18	322,642,825.38	727,750,562.85
Tortilla	0.021	0.899455829	0.018888572	6.89	61,488,127.40	138,692,125.80

Social Consequences: Hunger

At global level, 9.1 million people dye from hunger (FAO, 2011), In Mexico, in 2019, the 7.2% of the national population in undernourished (World Bank, 2021). To solve this condition, it is necessary to know the average food consumption. The FAO (1997) has recommended a daily diet for adults, composed of 900 g of the following main food: 500 g of tortilla; 50 g of meat; 100 g of beans; 100 g of tomatoes; 100 g of orange; 50 g of onion; plus 25 g of oil and 10 g of salt. In other words, it would be possible to provide all the food needed to one person in Mexico for every nine of them reducing food waste in 100 g/day. Considering CDMX population (8 918 653), maximum feeding would be available for 985 891 more people.

If all the population of CDMX and boundaries (20 116 842) were considered in the calculation, available food would benefit 2 237 461 people. Some precisions are needed: for five persons not wasting tortilla (100 g/day), one person would be fed; for each one not wasting 100 g of dry beans, another one would be fed; and 100 g of beef would feed two persons more.

Social Consequences: Food energy

Dietary energy supply is defined as the minimum necessary energy amount to maintain corporal weight and perform moderate physical activity; not only is knowing the number of hungry people needed but also the degree of hunger they suffer.

No precise data were available on the undernourished level due to consumption deficit in Mexico, but the FAO (2000) mentioned that daily consumption deficits of kilocalories were ~200 kcal for Central America, so these

Table 4. Food energy (FE) and food beneficiaries (FB) per day calculating 100 g of food waste reduction.

Food	wasted food by Mexicans (kg/per person/ day)	food energy (kcal/kg)	FB/per person	Total FB Mexico City (1*)	Total FB Mexico City & boundaries (*2)
Maize *	0.1	35500	1.775	15830609.1	35707394.55
Rice	0.002	36400	0.364	3246389.69	7322530.488
Potato *	0.1	8000	4	35674612	80467368
Poultry	0.026	13900	1.807	16116006	36351133.49
Beef	0.013	11500	0.7475	6666693.12	15037339.4
Beans	0.0075	33200	1.245	11103723	25045468.29
Egg **	1	158	0.79	7045735.87	15892305.18
Tortilla	0.21				

*calculated on100 g waste

** calculated on1 piece of waste

(1*)8 918 653

(*2) 20 116 842

data were taken for calculations. Usually, 1 g of carbohydrates or proteins provides 4 kcal whereas 1 g of fat provides 9 kcal (Nelson and Cox, 2000).

The amount of food beneficiaries (FB) can be calculated if the calorie content of each food is known (FE) and the food energy required (Fer) (200 kcal/person/day). For one person or for the entire population (Pp)[7]

Table 4 shows the amount of available food energy and total beneficiaries. Every person reducing 100 g of food waste contributes with the food energy required (200 kcal/person/day) from 0.4 people as minimum to 1.82 people as maximum. In consequence, considering all the people living in CDMX and their boundaries, then 7 322 530 people as minimum and 36 351 133 people as maximum would be benefitted.

Discussion

Certainly, an environmental crisis has arisen, but catastrophic expectations must be changed to positive ones in which beneficial consequences of people's acts will make the difference. This article was based on positive consequences because most research done has been related to the attitude and intention of buying food -mainly organic-. Previous research has been driven by ethical factors (Sharpe et al, 2021), shifting to plant-based diets (Coudard et al., 2021) health, religion, and so on, but none concerns attitude toward food waste reduction even as Coudard et al (2021: 6) point out "vegetables and fruits are responsible for more than a third of total cumulative energy use of AFW and their waste incidence is very high". To summarize, most ethical studies have focused only on showing values or setting behavior to follow, but ethical-philosophical currents as consequentialism have not been dealt with in environmental education. Finally, it is important to bear in mind that if citizens feel they have made a genuine impact, their support for waste management increases (Garnett and Cooper, 2014).

Few studies have established a clear relationship between reflection variants and instrumental learning outcomes (Roessger, 2014). However, Gutiérrez-Barba (2014) has shown that a quantitative assessment by weighing food waste pre- and post-testing was feasible to assess behavioral change offering advantages over other ways of measuring, as diaries used by other authors (Williams et al., 2012). This study turns to measuring waste by the persons themselves, solving the difficulties of quantifying household solid waste (Everitt et al., 2021), which agrees with the proposal of Aka and Buyukdag (2021) promoting awareness. However, it differs in terms of mediating reflection on habits and not habits per se as done by the authors.

[7]Pp = population (8 918 653 people in Mexico City; 20 116 842 people in Mexico City and boundaries)

Using a consequentialism approach could help reach the important changes in food culture in a more flexible educational environment. The proposal was based on the beneficial impacts of food waste reduction as a reflective and positive point of view.

In this sense, this study is similar to previous ones (Sharpe, 2021) but goes beyond by considering more aspects than only values.

If ecological impact self-motivates people to change their lifestyle, information related to space in landfills, ecological footprint, and virtual water should be presented by environmental or food educators to invite reflection and action.

An interesting point of view for reflection and undoubtedly related to environmental and social issues is the fact that a "... meat-intensive diet leads to a greater degree of inequality in the use of environmental services..." (White, 2000).

Economic reasons are valid and kept in mind by many people; if a person in environmental education has one of these reasons, data of money savings for not buying food and/or avoiding food waste, then landfilling is an excellent teaching tool. On the contrary, if hunger motives are the main positive contributors to change the person's life style, data for food energy and undernourishment could be taught.

Although the goal of education is the learner, in environmental education more actions and proposals have been done to benefit the environment (EFE) with respect to structure and function (EAE) and few proposals for actions for people (EIE), that is, their reflexive processes, well-being and acting. Education in the environment (EIE) is an authentic education proposal. This study is framed in this type and agrees with Tilbury (1997) and Gutiérrez-Barba et al., (2017) approach.

Final reflections

Even though this study is similar to previous ones, its originality lies on positive insights for such reflection, which is in respect to multiple consequences (not mono-consequentialism). Many studies have been published related to environmental ethics, but to our knowledge none concerns attitude toward food waste reduction as this one.

Information about virtual water and ecological footprint was the most difficult to get and the most variable. Virtual water savings on agriculture was the main ecological impact. Beef waste reduction showed the highest virtual water benefits and maize the lowest.

The highest benefits of food energy were related to rice waste reduction whereas the lowest were related to potato. Among all consequences of food waste reduction, money savings was the

highest; not buying beef was the biggest saving, whereas not buying maize was the lowest.

This information can be used as basis for educational projects in any part of the world. Nonetheless, for better results all local information should be considered on food cost, food waste per person, and cost of final waste disposal. This information per se is based on Education about and for the environment; however, Education in the environment entails further considerations since Consequentialism is a rational approach, and some others as refection and meaningfulness based on sense making (Dewulf et al., 2019) must fulfill the educational strategies. As mentioned by Reid et al., (2011), the heart of behavior change lies on the reflection and questioning process rather than on information.

Actions should be anchored in conviction that people can change their behavior by analyzing the context, starting from their motivations, ethos and possibilities for decision making and future plans in pro environmental actions.

Further studies on global consequences as green gas emissions avoidance, species extinction, soil depletion and more studies dealing with other types of food are necessary to allow environmental and food educators to have quantitative information to use it directed to motivate people and take them to reflect on the positive consequences of their actions.

Self-motivation determines personal involvement, so it is important to explore it deeply considering the differences of social sub-groups in function of gender, socio-economic, educational or cultural, geographical or demographic levels, such as daily activities, civil status, family members or others.

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Cited Literature

Agrawal, A. y A. Chhatre. 2011. *Against mono-consequentialism: Multiple outcomes and their drivers in social–ecological systems*. Global Environmental Change (11): 1-3. Doi: 10.1016/j.gloenvcha.2010.12.007.

Aka, S. y N. Buyukdag. 2021. *How to prevent food waste behaviour? A deep empirical research*. Journal of Retailing and Consumer Services (61):102560. Doi: 10.1016/j.retconser.2021.102560.

Balderas Luna, R., C.A., Soto Barrera, J. Medina Valtierra y M.G. Lira Padilla. 2007. *Caracterización de los residuos sólidos municipales*. Conciencia Tecnológica, (3): 47-48.

Banco Mundial. 2021. Prevalencia de desnutrición (% de la población)- México. En: https://datos.bancomundial.org/indicator/SN.ITK.DEFC.ZS?locations=MX (Consultado el 29/10/2021).

BANXICO Banco de México. 2021. Tipo de cambio promedio del periodo En: https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=6&accion=consultarCuadro&idCuadro=CF86&locale=es (Consultado el 22/10/2021).

Bennett-Levy, J. y C.A. Padesky. 2014. *Use It or Lose It: Post-workshop Reflection Enhances Learning and Utilization of CBT Skills.* Cognitive and Behavioral Practice, (21): 12–19. Doi: 10.1016/j.cbpra.2013.05.001.

Berittella, M., Y. Arjen, A. Hoekstra, K. Rehdanz, R. Rosond, S. Richard, y J. Tolf. 2007. *The economic impact of restricted water supply: a computable general equilibrium analysis*. Water Research, (41): 1799-1813. Doi: 10.1016./j.watres.2007.01.010.

Chen, J. y A.R. Martin. 2014. *Role-Play Simulations as a Transformative Methodology in Environmental Education***.** Journal of Transformative Education 13 (1)*:* 85-102. https://doi.org/10.1177/1541344614560196.

Colomer, J., M. Pallisera, J. Fullana, M. Pérez Burriel, and R. Fernández. 2013. *Reflective learning in higher education: A comparative analysis.* Procedia - Social and Behavioral Sciences, 93: 364 – 370. Doi: 10.1016/j.sbspro.2013.09.204.

Coudard, A., E. Corbin., J. de Koning., A. Tukker, and J. M. Mogollón. 2021. *Global water energy losses from consumer avoidable food waste.* Journal of Cleaner Production 326: 129342. https://doi.org/10.1016/j.jclepro.2021.129342

COVECA Comisión Veracruzana de Comercialización Agropecuaria. s/f. *Monografía de la papa (Potato Monograph) En:* http://portal.veracruz.gob.mx/pls/portal/docs/PAGE/COVECAINICIO/IMAGENES/ARCHIVOSPDF/ARCHIVOSDIFUSION/MONOGRAFIA%20PAPA2010.PDF. (Consultado el 15/03/2011).

Dávila-Inga, I., P. Díaz-Vela, J. Llacsa-Tacuri, T. Medina-Hinostroza, P. Ramírez-Huamán, A. Roldán-Chavez, and R. Estrada Jiménez. 2006. *Recetario de Platos Típicos del Frijol.* PNUD, FMAM, Cooperatione Italiana. En: http://www.inia.gob.pe/genetica/INSITU/recetas/frijol.pdf. (Consultado el 12/12/2011).

Dewulf, A., N. Klenk, C. Wyborn and M.C. Lemos. 2019. *Usable environmental Knowledge from the perspective of decision-making: the logics of consequentiaty, appropriateness, and meaningfulness*. Current opinion in Environmental Sustainability 42: 1-16. https://doi.org/10.1016/j.cosust.2019.10.003.

Everitt, H., P. van der Werf, J.A. Seabrook, A. Wray y J.A. Gilliland. 2021.*The quantity and composition of household food waste during the COVID-19 pandemic: A direct measurement study in*

Canada. Socio-Economic Planning Sciences, 101110. https://doi.org/https://doi.org/10.1016/j.seps.2021.101110.

Ewing B., S. Goldfinger, A. Oursler, A. Reed, D. Moore y M. Wackernagel. 2009. *The Ecological Footprint Atlas 2009.* Oakland: Global Footprint Network. En: https://www.footprintnetwork.org/content/images/uploads/Ecological_Footprint_Atlas_2009.pdf (Consultado el 26/09/2021).

FAO. 1997. *Human nutrition in the developing world*. Food and Nutrition Series - No. 29. En: http://www.fao.org/DOCREP/006/W0073S/w0073s18.htm#TopOfPage. (Consultado el 7/3/2012).

FAO. 2000. *Magnitud del hambre. ¿Cuánta hambre tienen los que la padecen?* En: http://www.fao.org/FOCUS/S/SOFI00/sofi002-s.htm. (Consultado el 20/11/2011).

FAO. 2004. *Año internacional del arroz*. En: http://www.fao.org/rice2004/es/f-sheet/hoja6.pdf. (Consultado el 20/11/ 2011).

FAO. 2006. México. *Tendencias en la reducción del hambre para el monitoreo de las metas de la cumbre mundial de la alimentación (CMA) y de la declaración del milenio (DM)*.

FAO, 2011. Food Wastage Footprint Impacts on Natural Resources. En: http://www.fao.org/3/i3347e/i3347e.pdf. (Consultado el 20/10/2021).

FAO, 2019. The State of Food and Agriculture 2019. Moving Forward on Food Loss and

Waste Reduction. FAO, Rome. En: https://www.fao.org/policy-support/tools-and-publications/resources-details/es/c/1242090/ (Consultado el 20/10/2021).

Flanagan, A., and A. Priyadarshini. 2021. *A study of consumer behaviour toward food waste in Ireland: Attitudes, quantities and global warming potentials*. Journal of Environmental Management 284:112046. https://doi.org/10.1016/j.jenvman.2021.112046

Flores Gutiérrez, F.X. 2011. *Avances logros y perspectivas del programa regional cooperativo de papa. (PRECODEPA).* En: http://www.fao.org/docs/eims/upload/206549/1_2_1_cases.PDF. (Consultado el 10/11/2011).

FOE. Friends of the earth 2007. *Briefing. Food Waste Collections*. UK.

Garnett, K. y T. Cooper. 2014. *Effective dialogue: Enhanced public engagement as a legitimizing tool for municipal waste management decision-making*. Waste Management, (34): 2709-2226. https://doi.org/10.1016/j.wasman.2014.08.011

Gutiérrez-Barba, B.E. y A. Ortega-Rubio. 2013. *Household food-waste production and a proposal for its minimization in Mexico.* Life Science Journal, 10(3): 1772-1783.

Gutiérrez-Barba, B.E. 2014. *Food habits and environmental education*. Ph. D. Thesis. Instituto Politécnico Nacional. México. 126 pp.

Gutiérrez-Barba, B. E., B. Suárez-Alvarez y L.M. Rodríguez-Salazar. 2017. Educación sobre el ambiente, para el ambiente y en el ambiente. Una mirada desde los residuos sólidos urbanos. 70-81. En: Reyes Ruiz y Castro Rosas (Eds.) *Travesías y dilemas de la pedagogía ambiental en México* 340 pp. U de G, UPN, ANEA, CEGIA.

Hodges, J. 2005. *Cheap food and feeding the world sustainably*. Livestock Production Science (92): 1-16. Doi: 10.1016/j.livprodsci.2005.01.001.

Hoekstra, A. (Ed.). 2003. *Virtual water trade proceedings of the international expert meeting on virtual water trade. Value of water.* Research Report Series No. 1, IHE-DELFT. The Netherlands 248. En: https://www.waterfootprint.org/media/downloads/Report12.pdf (Consultado el 26/11/2021).

Howell, R.A. 2011. *Lights, camera . . . action? Altered attitudes and behaviour in response to the climate change film The Age of Stupid.* Global Environmental Change, (21), 77-187. DOI: 10.1016/J.gloenvcha.2010.09.004.

Ikeda, Y. 2014. *Importance of patient education on home medical care waste disposal in Japan*. Waste Management, 34: 1330-1334. DOI: 10.1016/j.wasman.2014.04.017.

INE Instituto Nacional de Ecología. (2011b). *Los sistemas de aseo urbano en México.* En: http://www2.ine.gob.mx/publicaciones/libros/345/sistemas.html. (Consultado el 12/11/2011).

INEGI. 2021. Consulta de precios promedio. En: https://www.inegi.org.mx/app/preciospromedio/?bs=18promediOpara septiembre de 2021 (Consultado el 12/10/2021).

Johansson-Stenman, O. 2012. *Are most people consequentialists?* Economics Letters, (15): 225-228. DOI: 10.1016/j.econlet.2011.12.050.

Lambrechts, W., I. Mulà, K. Ceulemans, I. Molderez y V. Gaeremynck. 2011. *The integration of competences for sustainable development in higher education: an analysis of bachelor programs on management.* Journal of Cleaner Production, (45): 65-73. Doi: 10.1016/j.jclepro.2011.12.034.

López Lozano, M. 2003. *El cultivo del maíz en México y la contribución del fitomejorador para favorecer la autosuficiencia*. Rev. Mexicana de Agronegocios. Enero-junio, VII (12) http://redalyc.uaemex.mx/redalyc/pdf/141/14101208.pdf. (Consultado el 10/11/2011).

Martínez J. y J. Villezca- Becerra. 2003. *La alimentación en México: un estudio a partir de la encuesta nacional de ingresos y gastos de los hogares.* Notas. Revista de Información y Análisis (21): 26-37.

Mosquera, M., M.J. Andrés-Prado, G. Rodríguez-Caravaca y P. Latasa. 2014. *Evaluation of an education and training intervention to reduce health care waste in a tertiary hospital in Spain*. American

Journal of Infection Control 42(8): 894-897. Doi: 10.1016/j.ajic.2014.04.013.

Nelson, D. L. y M.M. Cox. 2000. *Lehninger Principles of Biochemistry (3rd ed.)*. New York: Worth Publishing. 1200 pp.

Reid, L., C. Hunter y P.W. Sutton. 2011. *Rising to the challenge of environmental behavior change: Developing a reflexive diary approach*. Geoforum 42(6): 720-730. Doi: 10.1016/j.geoforum.2011.04.011.

Roessger, K.M. 2014. *The effect of reflective activities on instrumental learning in adult work-related education: A critical review of the empirical research*. Educational Research Review (13): 17-34. https://doi.org/10.1016/j.edurev.2014.06.002

Rolfe, G. 2014. *Rethinking reflective education: What would Dewey have done?* Nurse Education Today, 34(8): 1179-1183. Doi: 10.1016/j.nedt.2014.03.006.

SAGARPA Secretaría de Agricultura, Ganadería y Pesca. 2010. *Producción Agrícola, ciclo otoño-invierno y primavera verano*. En: http://www.siap.gob.mx/index.php?option=com_wrapperandview=wrapperandItemid=350 . (Consultado el 15/3/2012).

Sánchez-Villa, C.E., R. Zepeda-Bautista, M.E. Ramírez Ortíz, and L. J. Corzo Ríos. 2020. *Nixtamalized tortillas supplemented with proteins isolated from Phaseolus coccineus and huauzontle (Chenopodium berlandieri subsp. nuttalliae) flour : rheological, textural, and sensorial properties*. Gastronomy and food science https://doi.org/10.1016/j.ijgfs.2020.100274

SEMADF Secretaría de Medio Ambiente del Distrito Federal 2004. *La ley de residuos en el D.F. en el sector reciclaje*. En: http://www.sma.df.gob.mx/rsolidos/11/02clave.pdf. (Consultado el 28/4/2011).

Sharpe, E.J., G. Perlaviciute y L. Stege. 2021. *Pro-environmental behaviour and support for environmental policy as expressions of pro-environmental motivation*. Journal of Environmental Psychology (76):101650. Doi: 10.1016/j.jenvp.2021.101650.

Tashiro, J., Y. Shimpuku, K. Naruse, M. Maftuhah y M. Matsutani. 2013. *Concept analysis of reflection in nursing professional development*. Japan Journal of Nursing Science 10 (2): 170–179. Doi: 10.1111/j.1742-7924.2012.00222.x.

Thommen, D., V. Sieber, U. Grob y A. K. Praetorius. 2021.*Teachers' motivational profiles and their longitudinal association with teaching quality*. Learning and Instruction. https://doi.org/10.1016/j.learninstruc.2021.101514

Tilbury, D. 1997. Environmental education: a head, heart and hand approach to learning about environmental problems. In: http://www.hkta1934.org.hk/NewHorizon/abstract/1997/page1.pdf. (Consultado el 26/9/2021).

United Nations Education, Scientific, and Cultural Organization (UNESCO) 2011. *La huella hídrica*. Boletín de noticias semanal del portal del agua de la Unesco # 145. En: http://www.unesco.org/water/news/newsletter/145_es.shtml#know. (Consultado el 14/8/2011).

Vazquez del Mercado, R. y J. Lambarri. (Eds.) 2017. Huella hídrica en México: análisis y perspectivas. *Instituto Mexicano de Tecnología del Agua*. 572pp En: http://repositorio.imta.mx/handle/20.500.12013/1714?locale-attribute=en (Consultado el 14/8/2011).

White, T. J. 2007. *Sharing resources: The global distribution of the Ecological Footprint*. Ecological Economics 64(2): 402-410. https://doi.org/10.1016/j.ecolecon.2007.07.024

White, T. 2000. *Diet and the distribution of environmental impact*. Ecological Economics 34(1): 145-153. Doi: 10.1016/S0921-8009(00)00175-0.

Wood, B., C. Nelson y L. Nogueira. 2009. *Food price crisis: welfare impact on Mexican households*. International Agricultural Trade Research Consortium Analytic Symposium, Seattle, Washington.

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