



Identification and Prioritization of Food Insecurity and Vulnerability Indices in Iran

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Abstract

Background: Food security is a multi-dimensional phenomenon. The objective of this study was to identify and prioritize major indices for determining food insecurity in Iran.

Methods: Descriptive study using the Delphi method was conducted through an email-delivered questionnaire. Forty-three senior experts at national or provincial level were selected based on their work experience and educational background through study panel consultation and snowballing from Tehran and other cities of Iran. During two rounds of Delphi, participants were asked to identify priority indicators for food security at provincial level in Iran.

Results: Sixty five percent of Delphi panel participated in the first round and eighty-nine percent of them participated in the second round of Delphi. Initially, 243 indices were identified through review of literature; after excluding indicators, which was not available or measurable at provincial level in Iran, 103 indicators remained. The results of study showed that experts identified “percentage of individuals receiving less than 70% of daily energy requirement” with a median score of 90, as the most influential index for determining food insecurity. “Food expenses as a proportion of the overall expenses of the family”, “per capita of dietary energy supply”, and “provision of micro-nutrient supply requirement per capita” with median of 80 were in the second rank of food security priority indicators.

Conclusion: Out of 243 identified indicators for food security, 38 indicators were selected as the most priority indicators for food security at provincial level in Iran.

Keywords: Food security, Food vulnerability, Delphi technique

Introduction

In 1996, the World Food Summit defined food security as a condition “when all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life” (1, 2). This definition was later redefined as a state in which the entire society has perpetual, physical and economical access to nutritious foods, which

are culturally acceptable, sufficient to meet dietary needs and reflecting personal preferences, for a healthy and productive life (1, 2). Food vulnerability refers to the condition that places vulnerable people at risk of becoming food-insecure and may result from various factors such as an inability to overcome the risks of hunger (3).

Food insecurity results from a wide range of socioeconomic variables related to famine, periodic hunger and the instability of food supplies from poverty, unemployment, inflation, illiteracy, natural disasters such as droughts and other calamities including social problems, variables which may be both the causes and the consequence of food insecurity (4, 5).

A single indicator of food insecurity or food vulnerability cannot measure household food insecurity (6,7). Instead, a number of conditions, behaviors, and experiences must be examined to obtain a comprehensive view of severity and pervasiveness of food insecurity in households (8). One of the major challenges faced when monitoring the degree of food insecurity is developing reliable food security indices (9,10). Lack of clarity surrounding causes, specific signs, and consequences of food security can hinder development of the indicators to map the prevalence of food insecurity in any country or region (8).

Previous studies have shown the presence of food insecurity and vulnerability in various regions in Iran with different distributions of root causes (11). It has been well documented that the average food supply is adequate at the national level; however, poverty or gender inequality may have influenced the allocation of food at community and household levels (5). Currently, several organizations are monitoring and reporting indicators associated with food insecurity (11). However, there is no report on the prioritization of the food insecurity and vulnerability indices in Iran. We aimed to identify and prioritize dominant indices for determining food insecurity and food vulnerability at provincial level in Iran, using the Delphi method.

Materials and Methods

The study was a qualitative study that used Delphi technique to collect the data in 2013. Delphi technique is a widely used and accepted method for gathering data from a panel of experts to assess and develop consensus. This structured group communication process forecasts and assists decision-making process. Its main components are

repetition or iteration, questionnaires, expertise of a specific field, controlled feedbacks, anonymity, statistical aggregation, consensus, time, and a facilitating team (12, 13).

Participants

To select the subjects of the study, an expert committee from different fields of nutrition, agriculture, economic, management and health was formed. This expert group was responsible for defining criteria for selection of Delphi subjects, and following the study and analyzing the results. The expert group enlisted a group of senior level experts as provisional list of Delphi panel. The experts in this provisional list were contacted and were requested to introduce other experts in this field. Finally, 43 experts were selected by using purposive expert sampling method and snowballing technique as Delphi subjects were identified and invited for the study.

The selection criteria were as follow:

- Education level and expertise in the relevant field
- Field experience
- Commitment and devoting enough time to participate in the study
- Having publication in this field
- Skills for E-communication.

From 43 experts, 23 represented nutritional sciences, 15 economy/agriculture and five epidemiology/policy making. Twenty-eight (65%) of all the invited experts, participated in the first stage, whereas 89% of the participants of the first stage also, participated in the second stage. In total, 25 individuals (58%) of all the identified individuals participated in the both stages, 17 from nutritional sciences, four from epidemiology/health policy, and four from economy/agriculture. Each participant was contacted 3- 6 times via phone or in person to follow up the data collection and receiving response from each round of Delphi. Lack of time to participate in the study was the main reason for refusal of participation in the study.

Preliminary research through certified data from Statistical Centre of Iran, Ministry of Jihad-e-Keshavarzi, and Ministry of Health and Medical Education and subsequent consultation with sen-

ior members of the relevant organizations identified 243 food security/insecurity indices (variables or indices influencing food insecurity and food

vulnerability). After excluding indicators for which no data were available at the provincial level, 103 indicators remained (Table 1).

Table 1: Characteristics of participating experts in the Delphi study and their level of contribution

	Number of experts to participate in the first stage of Delphi (percent)		Number of experts to participate in the second stage of Delphi (percent)	
	n	%	n	%
The experts' field of expertise				
Nutrition sciences	19	82.60	17	89.47
Epidemiology	5	100	4	80
Economy/agriculture	4	26.66	4	100
Educational Level				
PhD and above	21	0.75	20	0.80
MPH, MSC	7	0.25	5	0.20
Total	28	65.11	25	89.28

Data collection procedure

An explanatory letter that contained a brief description of the Delphi method, objective of the study, and the 103 previously identified indicators and their definitions were sent out to all of the panel members, prior to the first round of the Delphi via email. In addition, the participants were offered for further clarification of the methods via telephone or in person, if the explanatory letter seemed unclear. The objective of the first round of Delphi was to identify the priority list of indicators out of list of 103 indicators that were sent to the participants. Participants chose, combined, or removed some of the indices, and added any other relevant indicators that might be missing on the original list.

After removing repetitive indices and reviewing the panel feedback, 38 indices were identified as the priority indicators for food security assessment at provincial level in Iran. The selection criteria for each indicator were agreement of minimum 50% of participants. Based on these indicators, a structured questionnaire was developed for the second round of Delphi. The objective of the second round of Delphi was to rank the list of selected 38 indicators based on their importance in assessment of food security at provincial level in Iran.

The questionnaire was validated by a panel of ten key experts and piloted to estimate the amount of time for completion. Seventy percent of agreement on validity of each question was considered as an acceptable level of validity. Internal consistency of the questionnaire was assessed using Cronbach's alpha Coefficient which showed a high level of reliability ($\alpha=0.97$). The participants scored each indicator for mapping food insecurity and vulnerability using a graphic five-point Likert scale ranging from "very insignificant (0-20)" to "very significant (80-100)". After the questionnaires were returned, each indicator was arranged in the order of significance. The median score for each indicator was used to rank all the indicators based on their priority.

Data analysis

Data were analyzed using the SPSS, version 19 (Chicago, IL, USA) software.

Ethics

This study was approved by the Institutional Review Boards from the Ethical Review Committee at the Tehran University of Medical Sciences. A written informed consent was obtained from all participants who were ensured that their responses would be confidential.

Results

Out of 243 identified indicators through review of literature, 103 indicators that were available from official sources in Iran were selected by the research team. Delphi panel identified 38 indicators, out of the 103 selected indicators, as priority indi-

cators for assessment of food security at provincial level in Iran. Mean age of participants was 50.5 ± 12.8 years. Areas of expertise of the team and their educational level are presented in Table 2. The results of the prioritization of the 38 indices (second stage of Delphi) are listed in Table 3.

Table 2:

103 originally identified indicators at the provincial level for determination of food insecurity and vulnerability

Indicator
1. Urban population to rural population ratio
2. Population growth rate
3. Population density (relative density of population)
4. Family size
5. Student to teacher ratio (2008-2010)
6. Percentage of population covered by funding agencies
7. Gini index
8. Imports capacity
9. Employment and unemployment rates
10. Percentage of families with employed 5 to 17 years old offspring
11. Income rate
12. Human Development Index (HDI)
13. Education index
14. Gross Domestic Product (GDP)
15. Life expectancy
16. Literacy rate
17. Total fertility rate
18. Household with catastrophic health expenditure
19. Per capita consumption of tobacco
20. Per capita of Dietary Energy Supply (DES)
21. Percentage of individuals with less than 70% of daily energy intake
22. Percentage of individuals receiving less than 70% of daily protein requirement
23. Average protein consumption
24. Per capita calcium requirement
25. Per capita iron requirement
26. Per capita vitamin A requirement
27. Per capita Thiamine requirement
28. Per capita Riboflavin requirement
29. Per capita Niacin requirement
30. Per capita Vitamin C requirement
31. Average bread and cereal consumption
32. Average vegetable consumption
33. Average fruit consumption
34. Average meat consumption
35. Average dairy consumption
36. Average oils consumption
37. Average sugars consumption
38. Per capita protein supply
39. Per capita oil supply
40. Per capita bread and cereals supply
41. Per capita meat protein production
42. Per capita milk protein production
43. Per capita chicken protein production
44. Per capita egg protein production
45. Per capita wheat production
46. Per capita barley production

Table 2: Continued...

47. Per capita rice production
48. Per capita grain production
49. Per capita potato production
50. Per capita vegetable production
51. Annual inflation of foodstuff and beverage
52. Average bread and cereal household expenditure
53. Average red meat household
54. Average milk, dairy and eggs household expenditure
55. Average oils household expenditure
56. Average fruit and vegetables household expenditure
57. Average various fruit household expenditure
58. Average various vegetables household expenditure
59. Average nuts household expenditure
60. Average sugars, coffee, and cacao household expenditure
61. Average sheep meat price in market
62. Average chicken meat price in market
63. Average beef price in market
64. Average egg price in market
65. Provincial rain fed cultivation
66. Growth in cereal yield
67. Ground water resources
68. Regional climate conditions
69. The 5 year average of rainfall
70. Agricultural land average area of state
71. Number of natural disasters in a year
72. Agricultural lands use change
73. Co2 emissions
74. Food production index
75. Percentage of food expenditures to total household expenditures
76. Average household health expenditures
77. Access to Primary Health Care (PHC)
78. Breast fed children percentage
79. Mortality rate in children under 5
80. Iron deficiency anemia
81. Maternal mortality rate
82. Micro-nutrients deficiency
83. Percentage of population undernourished
84. Prevalence of tuberculosis, measles and diphtheria
85. Percentage of pregnant receiving supplements (iron, folic acid and multivitamins)
86. Percentage of nutrition educated mothers
87. Single time child care (measuring of weight, height, and head circumference)
88. Prevalence of anemia in pregnancy
89. Percentage of high risk pregnancy
90. Health education to mothers
91. Vitamin A deficiency disorders prevalence
92. Prevalence of goiter
93. Percentage of child vaccination coverage
94. Average of Body Mass Index (BMI)
95. Percentage of underweight (BMI <18.5) in adults
96. Percentage of students with BMI less than 5th percentile
97. Percentage of students with BMI more than 95th percentile
98. Prevalence of stunting, wasting and underweight in children under 5
99. Prevalence of Low Birth Weight (under 2500 grams)
100. Percentage of people with at least 10 minutes exercise everyday
101. Percentage of access to safe drinking water
102. Percentage of access sanitary toilet
103. The number of hospital beds per 100,000 individuals

From the experts' point of view, the most influential index to determine food insecurity and vulnerability was the "percentage of individuals receiving less than 70% of daily energy requirement" with a median of 90. That score was followed by "foodstuff expenses percentage in overall expenses of the family", "per capita of diet energy supply (DES)", and provision of micronutrient (vitamins and minerals) supply requirement per capita with a median of 80. With a median of 20, in the experts' opinion, "per capita consumption of tobacco" was

considered the least influential index in food insecurity and vulnerability. It was followed by the "number of hospital beds per 100,000 people", "population density" (population per square kilometer), "percentage of people at least 10 minutes of daily exercise", "urban population to rural population ratio", "prevalence of goiter", "total fertility rate", "maternal mortality rate", and "child vaccination coverage percentage" with medians ranging from 25 to 40.

Table 3: Median and interquartile range (IQR) of scores for each indicators for determining food insecurity and vulnerability; results of the second round of Delphi

Indicator	Median	IQR
Percentage of individuals receiving less than 70% of daily energy requirement	90	80-100
Percentage of food expenditures to total household expenditures	80	60-85
Per capita of Diet Energy Supply (DES)	80	50-80
Provision of micronutrient requirement per capita	80	50-80
Average consumption of macronutrients	75	70-100
Employment and unemployment rates	75	70-80
Prevalence of stunting, wasting and underweight in children under 5	70	70-85
Annual inflation rate of foodstuff and beverage price	70	50-80
Human Development Index (HDI)	70	40-65
Percentage of individuals receiving less than 70% of daily protein requirement	70	30-70
Per capita supply of protein, bread, and cereal	70	60-90
Per capita production of protein, bread, and cereal	70	45-80
Education Index	70	40-80
Percentage of individuals with access to safe drinking water	65	30-65
Prevalence of anemia in pregnancy	65	30-70
Access to Primary Health Care (PHC)	60	50-75
Percentage of underweight among adults (BMI <18.5)	60	50-80
Prevalence of Low Birth Weight (LBW)(under 2500 grams)	60	30-60
Literacy rate	60	20-50
Average of 5 years rainfall	60	40-80
Gross Domestic Product (GDP) index	60	70-85
Percentage of families under catastrophic health expenditure	60	60-85
Under 5 mortality rate	60	40-80
Percentage of population under coverage of social welfare	60	45-85
Percentage of families with child labor among their children	60	25-80
Population growth rate	50	20-50
Percentage children breast fed	50	40-80
Rate of access to hygienic waste disposal system	50	40-80
Life expectancy	50	70-90
Percentage of child vaccination coverage	40	65-90
Maternal mortality rate	40	40-80
Total fertility rate	40	40-80
Prevalence of Goiter	40	10-55
Ratio of urban population to rural population	40	15-50
Percentage of people with daily exercise of at least 10 minutes	30	30-60
Population density (population in square kilometer)	30	40-80
Number of beds in health care services per 100,000 people	25	30-70
Per capita consumption of tobacco	20	50-80

BMI, Body Mass Index

Discussion

The present study was the first in Iran that attempted to identify and prioritize indices of food insecurity and food vulnerability at provincial level, through collecting expert' opinion and using Delphi technique. Continuing population and consumption growth along with climate change made concern over food security a re-emergence issue around the world (14).

The results of this study show that experts paid equal attention to all possible aspects of food insecurity and vulnerability; amongst the high priority indices (medians over 50), sectors such as food provision, food selection, economic purchasing power, and health provision were observed. One of the most significant indices identified by the experts in this study was the percentage of food expenses as a proportion of the overall expenses of the household, which revealed the level of economic vulnerability of the household. Literature showed that families that spend most of their income (more than 75%) to purchase food appeared to be more susceptible to food insecurity. Regardless of their present food consumption conditions, if they experienced an income reduction, they would face reduced nutritional quality and/or quantity (15). Former studies have shown that families living in some of the richest countries of the world such as the United States (16) and Canada (17) spend less than 15% of their income on food, while the underprivileged families of the world spent over 75% of their incomes for procurement of food (16, 18).

This study identified employment and unemployment rate indices (economic contribution rate), annual variations in foodstuff and beverage prices (inflation), Human Development Index (HDI), Gross Domestic Price (GDP) index, and families with working adolescents (15 -17 years old) among high priority indices for food insecurity in Iran. There is sufficient evidence to support that food insecurity problems can occur even under high food availability conditions (19). For instance, if poor employment conditions in the society, high food prices, and social insecurity conditions are

not managed, members of the society may experience food insecurity even with abundant food availability and easy access to food.

Currently, public knowledge and consciousness play a decisive and defining role, in access to food, food security, and reduction of poverty, health and wellbeing (5, 20). Therefore, food security and nutritional quality may be focused on the conscious food choices based on the nutrition knowledge and culture. Education index is also influential on nutrition knowledge and culture and identified as a priority indicators for food security in this study. Studies have shown that knowledge of nutrition can create opportunities to improve food conditions at the societal level (21) and offer the necessary skills for preparation of safe and appropriate foods for individuals.

Some families are neither food insecure nor experiencing hunger, but rather they are at risk of experiencing these conditions in catastrophic economic vulnerability. Therefore, mere availability or adequate consumption of food is not sufficient in sustaining food security. This study identified percentage of families under catastrophic health expenditure as a priority indicator for food security (22).

The ability to digest food must also be accounted for, as proper cellular functioning from the digestion of consumed food makes a healthy body. Factors such as lack of hygiene and subsequent food-related illnesses and parasitic diseases can influence food security as well, by hindering the consumption of safe food and consequently affecting adequate performance of the required metabolic functions. Studies indicated that food security is also affected by elements such as conditions of hygiene, health, and absence of maladies in the society, in addition to meeting nutritional requirements (23, 24). Therefore, in this study indicators such as rate of access to hygienic waste disposal system, prevalence of Goiter, percentage of population with access to safe drinking water and Primary Health Care (PHC) were considered as priority indicators for food security.

In this study, DES, percentage of individuals receiving less than 70% of daily energy requirement, provision of micronutrient supply requirement per

capita, and average consumption of macronutrients were identified as high priority indices. These indicators that represent the availability and access to food are among the most well-known indicators for food insecurity that were used to measure in many previous studies (25, 26).

Previous studies on food insecurity focused on food deprivation and its physiological effects on the body through an anthropometric perspective. Anthropometric indices are usually late manifestation of food crises (27, 28). Indices of stunting, wasting, being underweight among children younger than five years of age, and prevalence of low birth weight were priority identified anthropometric indices of food insecurity in this study.

In this study, the 5-year averages of rainfall, and protein, bread, and cereal provision and production per capita were identified as high priority indices. Access to grain products, which are generally a staple source of energy, can be used as an indicator of availability of food, especially for the underprivileged classes of the society. Food provision is heavily influenced by the volume of agricultural products, which are affected by climate. Therefore, inadequate rainfall may result in drought; reduce agricultural production, and subsequently famine. The access to protection from famine strongly affects food security among rural communities (29, 30). Furthermore, food security will be threatened by climate change in near future (31). Schmidhuber et al. in his study on global food security under climate change explained that how other dimensions of food security means stability, utilization and access, in addition to availability, is affected by ongoing climate change (32).

Study limitations

Limitations of this study arise from limitations of Delphi technique itself including biased participant selection, limited periods for conducting and completing the method, a possibility of low response rate, and feedback from participants, which may unintentionally influence the study results (12). In addition, this method requires extensive time and energy in selecting the participants and subsequently preparing the questionnaires. Delphi questionnaires may limit potential re-

sponses and prevent respondents' stating their true opinion. As a result, Delphi questionnaires can mislead the results and produce irrelevant conclusion. Therefore, the questionnaires should be designed with extreme caution. This study approached the questionnaire with extreme vigilance. The lengthiness of the Delphi process may result in some participants withdrawing during the process; as in this study, from the 43 participants who participated in the first stage, only 25 contributed in the second stage. Another shortcoming of this method is that experts tend to put more focus on their respective field, and may even be inclined to exaggerate in scoring the indices related to their specific field of expertise. Consequently, in this study, examination of the median scores given by the experts (nutrition sciences, epidemiology, and economy/agriculture) to their subject indices revealed that the experts' field and interest of expertise had influenced the scores of some indices, indicating that the experts had prioritized the indices influencing food insecurity and vulnerability based on their respective field of activity.

Measuring food security, for "monitoring an important aspect of the well-being of households and for the design, implementation, and evaluation of policies, programs and projects" (33) is necessary and creating a composite index for an ongoing food security monitoring and surveillance is recommended.

Conclusion

This study identified 38 priority indicators for assessing food security in Iran. The identified range of indicators selected as priority indicators by experts showed that anthropometric measure and nutritional benchmark are considered as the most appropriate indicators by Iranian experts, but other overall developmental indicators, health related indicators have, been noted as priority indicators of food insecurity and vulnerability in Iran.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or fal-

sification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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References

1. FAO (1996). Report of the World Food Summit. Rome Food And Agriculture Organization Of The United Nations. Available from: <http://www.fao.org/docrep/003/w3548e/w3548e00.htm>
2. Clay E (2002). *Food security: concepts and measurement. Trade reforms and food security: Conceptualising the linkages*, pp 25-34.
3. Anonymous (2012). The State of Food Insecurity in the World. Food And Agriculture Organization Of The United Nations. Available from: <http://www.fao.org/docrep/016/i3027e/i3027e00.htm>
4. Coates J, Frongillo EA, Rogers BL et al. (2006). Commonalities in the experience of household food insecurity across cultures: what are measures missing? *J Nutr*, 136: 1438S-1448S.
5. Anonymous (2005). The millennium development goals: report 2005. United Nations Publications. Available from: <http://unstats.un.org/unsd/mi/pdf/mdg%20book.pdf>
6. Aiga H, Dhur A (2006). Measuring household food insecurity in emergencies: WFP's Household Food Consumption Approach. *Humanitarian Exchange Magazine*, 36.
7. Webb P, Coates J, Houser R (2002). Allocative responses to scarcity: Self-reported assessments of hunger compared with conventional measures of poverty and malnutrition in Bangladesh. Food Policy and Applied Nutrition Programme, Tufts University, USA. Available from: http://www.nutrition.tufts.edu/documents/fpan/wp13-allocative_responses.pdf
8. Pangaribowo EH, Gerber N, Torero M (2013). Food and Nutrition Security Indicators: A.
9. Bickel G, Nord M, Price C et al. (2000). Guide to measuring household food security. Alexandria Department of Agriculture Food and Nutrition Service. Available from: <http://www.fns.usda.gov/guide-measuring-household-food-security-revised-2000>
10. Haddad L, Kennedy E, Sullivan J (1994). Choice of indicators for food security and nutrition monitoring. *Food Policy*, 19: 329-43.
11. Kolahdooz F, Najafi F (2012). *Report of a National Survey : Food Security Information and Mapping System in Iran*. Tehran,Iran: Ministry of Health and Medical Education.
12. Hsu C-C, Sandford BA (2007).The Delphi technique: making sense of consensus. *PARE*, 12: 1-8.
13. Powell C (2003). The Delphi technique: myths and realities. *J Adv Nurs*, 41: 376-82.
14. Evans A (2009). The feeding of the nine billion: global food security for the 21st century. A Chatham House Report. available from: <http://stopogm.net/files/feeding9billion.pdf>
15. Smith LC, Subandoro A (2007). *Measuring food security using household expenditure surveys*. International Food Policy Research Institute, Washington DC. USA. .
16. Coleman-Jensen A, Nord M, Andrews M et al. (2011). Household food security in the United States in 2010. USDA-ERS Economic Research Report.
17. Lawn J, Harvey D (2003). Nutrition and food security in Kugaaruk, Nunavut. Minister of Indian Affairs and Northern Development, Ottawa, Ont.
18. Nord M (2010). Food Spending Declined and Food Insecurity Increased for Middle-Income and Low-Income Households From 2000 to 2007: DIANE Publishing.
19. FAO, IFAD, WFP (2013). The State of Food Insecurity in the World, 2013. The Multiple Dimensions of Food Security. Food and Agriculture Organization of the United Nations Rome, IT.

20. Atkins P, Bowler I (2001). Food in society: economy, culture, geography: Arnold, Hodder Headline Group.
21. FAO (2008). Food and Agriculture Organization of the United Nations: Number of hungry people rises to 963 million; High food prices to blame—economic crisis could compound woes. Rome.
22. Maxwell S, and Smith M (1992). Household food security: a conceptual review. Household Food Security: concepts, indicators, measurements. Edited by S. Maxwell and T. Frankenberger. Rome and New York: IFAD and UNICEF.
23. Swaminathan M (2008). Report on the state of food insecurity in rural India. MS Swaminathan research foundation.
24. Swaminathan M (2010). Achieving food security in times of crisis. *N Biotechnol*, 27: 453-60.
25. Moltedo A, Troubat N, Lokshin M, Sajaia Z (Eds.). (2014). *Analyzing Food Security Using Household Survey Data: Streamlined Analysis with ADePT Software*. World Bank Publications.
26. Arimond M, Osman N, Osei AK et al. (2005). Towards sustainable nutrition improvement in rural Mozambique: Addressing macro-and micro-nutrient malnutrition through new cultivars and new behaviors: Key findings. MSU.
27. Von Grebmer K, Torero M, Olofinbiyi T et al. (2010). 2010 Global Hunger Index: The Challenge of Hunger: Focus on the Crisis of Child Undernutrition: Intl Food Policy Res Inst.
28. Chilton M, Chyatte M, Breaux J (2007). The negative effects of poverty & food insecurity on child development. *IJMR*, 126: 262.
29. Thornton PK, Ericksen PJ, Herrero M, et al. (2014). Climate variability and vulnerability to climate change: a review. *Glob Change Biol*, 20 (11): 3313–28.
30. Tirado M, Crahay P, Mahy L et al. (2013). Climate change and nutrition: Creating a climate for nutrition security. *Food Nutr Bull*, 34: 533-47.
31. Lobell DB, Burke MB, Tebaldi C, et al. (2008). Prioritizing climate change adaptation needs for food security in 2030. *Science*, 319 (5863): 607-10.
32. Schmidhuber J, Tubiello FN (2007). Global food security under climate change. Proceedings of the National Academy of Sciences, 104 (50): 19703-08.
33. Pinstrup-Andersen P (2009). Food security: definition and measurement. *Food Secur*, 1(1): 5-7.