

**UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL  
CENTRO DE ESTUDOS E PESQUISAS EM AGRONEGÓCIOS  
PROGRAMA DE PÓS-GRADUAÇÃO EM AGRONEGÓCIOS**

**EDUARDO BOTTI ABBADE**

**A INSEGURANÇA ALIMENTAR NO AMBIENTE OBESOGÊNICO GLOBAL  
(FOOD INSECURITY IN THE GLOBAL OBESOGENIC ENVIRONMENT)**

**Porto Alegre, RS, Brasil**

**2014**

**UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL  
CENTRO DE ESTUDOS E PESQUISAS EM AGRONEGÓCIOS  
PROGRAMA DE PÓS-GRADUAÇÃO EM AGRONEGÓCIOS**

**EDUARDO BOTTI ABBADE**

**A INSEGURANÇA ALIMENTAR NO AMBIENTE OBESOGÊNICO GLOBAL  
(FOOD INSECURITY IN THE GLOBAL OBESOGENIC ENVIRONMENT)**

Tese de Doutorado apresentado ao Programa de Pós-Graduação em Agronegócios do Centro de Estudos e Pesquisas em Agronegócios da Universidade Federal do Rio Grande do Sul, como requisito parcial para a obtenção do título de Doutor em Agronegócios.

**Orientador: Prof. Dr. Homero Dewes**

**Porto Alegre, RS, Brasil  
2014**

EDUARDO BOTTI ABBADE

**A INSEGURANÇA ALIMENTAR NO AMBIENTE OBESOGÊNICO GLOBAL  
(FOOD INSECURITY IN THE GLOBAL OBESOGENIC ENVIRONMENT)**

Tese de Doutorado apresentado ao Programa de Pós-Graduação em Agronegócios do Centro de Estudos e Pesquisas em Agronegócios da Universidade Federal do Rio Grande do Sul, como requisito parcial para a obtenção do título de Doutor em Agronegócios.

Data da Aprovação em: 15/12/2014

**COMISSÃO EXAMINADORA**

---

Prof. Dr. Homero Dewes  
UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL  
Programa de Pós-Graduação em Agronegócio  
(Orientador)

---

Prof. Dr. Dario de Oliveira Lima-Filho  
UNIVERSIDADE FEDERAL DE MATO GROSSO DO SUL

---

Prof. Dr. Edson Talamini  
UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

---

Prof. Dra. Angélica Magalhães  
UNIVERSIDADE FEDERAL DA GRANDE DOURADOS

***Para meu pai e minha irmã.***  
*“Se cheguei até aqui foi porque me apoiei nos ombros de gigantes” (Sir. Isaac Newton).*

## AGRADECIMENTOS

Agradeço primeiramente a toda a minha família por tudo o que me proporcionaram ao longo de toda a minha vida. Obrigado à minha mãe, Lina Maria Botti Abbade, primeiramente por me dar a vida, e por todo o apoio e incentivo dado ao longo de toda a minha trajetória. Obrigado mãe por acreditar em mim sempre e estar ao meu lado. Agradeço muito a minha segunda mãe, minha tia (minha “dinda”) Maria Regina Vianna Botti, pelo apoio, pelas conversas, e por compartilhar comigo a paixão pela vida acadêmica. Muito obrigado à minha terceira mãe, minha avó (minha dinda oficial) Maria de Lourdes Vianna Botti, por ser minha mãe com açúcar e por sempre ter estado ao meu lado, me apoiando e me incentivando.

Agradeço também a dois seres iluminados que me definiram como ser humano. Ao meu pai Joel Nunes Abbade (*in memoriam*) por ter me ensinado a ser uma pessoa com caráter, honesta e com valores considerados raros hoje em dia. Agradeço a ele por ter me ensinado, e continuar ensinando, a ser um ser humano melhor. Agradeço também a minha irmã Simone Botti Abbade (*in memoriam*) por ter sempre acreditado em mim e por todos os conselhos valiosíssimos ao longo de toda a minha trajetória. Obrigado por ser minha melhor amiga e meu ombro de desabafo, por ser minha conselheira e por ainda me ouvir, onde quer que esteja, quando tenho minhas inseguranças. Todas as minhas conquistas não teriam sido possíveis sem o apoio e ensinamentos dessas duas pessoas que tenho a honra de chamar de pai e mana.

Um especial agradecimento ao meu orientador, prof. Dr. Homero Dewes, que me ensinou o que é ser um verdadeiro cientista, que me mostrou como se faz a boa ciência “de verdade”. Obrigado por ter me aceitado como orientando em um momento de insegurança e turbulência. Obrigado por me mostrar as reais urgências que um cientista deve atentar e buscar aliviar. Obrigado por me mostrar que um cientista “de verdade” deve objetivar contribuir para um mundo um pouco melhor.

Agradeço também a todos os meus colegas do CEPAN pelos momentos de convivência, pelas horas de estudos e debates acadêmicos, pelas cervejinhas e momentos de descontração extremamente necessários, pelos chopinhos no final do dia com batatinhas-fritas de graça na praça de alimentação do Bourbon da Ipiranga, e por terem me dado a oportunidade e honra de ter feito parte da família do CEPAN.

Obrigado também ao Centro Universitário Franciscano pelo apoio dado em todo o período de afastamento para que esse momento de minha carreira pudesse ser concretizado.

Agradeço a todos os colegas do Centro Universitário Franciscano pela torcida, apoio, auxílio e incentivo ao longo de toda essa minha jornada.

Meu muito obrigado ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) e à Comissão de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) pela bolsa de estudos que tornou possível a execução deste estudo. À Universidade Federal do Rio Grande do Sul (UFRGS) e ao Centro de Estudos e Pesquisas em Agronegócios (CEPAN) e todos seus colaboradores que de alguma forma auxiliaram e apoiaram esta conquista.

Agradeço também os membros da comissão examinadora por terem prontamente atendido ao convite de participarem dessa tarefa de grande responsabilidade. Obrigado pelas palavras e considerações valiosíssimas e pela atenção dada em todos os aspectos cabíveis.

## CURRICULUM VITAE DE EDUARDO BOTTI ABBADE

**Eduardo Botti Abbade** é Graduado em Administração de Empresas pela UFSM, Especialista em Estatística e Modelagem Quantitativa pela UFSM, Mestre em Administração pela UFPR e Doutorando em Agronegócios UFRGS. Atua como Professor Assistente do Centro Universitário Franciscano e Analista Administrativo da Empresa Brasileira de Serviços Hospitalares (EBSERH-HUSM). Tem experiência na área de Marketing e Estratégias Organizacionais, com ênfase em pesquisa de marketing, análise estratégica e posicionamento de mercado. Áreas de interesse incluem teorias e estratégias organizacionais, marketing estratégico, tecnologias de informação e gestão, arranjos e configurações produtivas e sistemas agroindustriais. Também se dedica a estudar os sistemas alimentares e a segurança alimentar em âmbito mundial.

**Endereço residencial** Rua Amélia Rodrigues, 255, ap. 605  
Rosário - Santa Maria  
97010-020, RS - Brasil  
Telefone: 55 99786264

**Endereço profissional** Centro Universitário Franciscano  
Rua Silva Jardim, 1175  
Rosário - Santa Maria  
97010-491, RS - Brasil  
Telefone: 55 30251202

### Endereço eletrônico

E-mail para contato : eduardo@unifra.br  
e-mail alternativo : ed\_abbade2000@yahoo.com.br

**2011 - 2014** Doutorado em Agronegócios.  
Universidade Federal do Rio Grande do Sul, UFRGS, Porto Alegre, Brasil  
Título: A Insegurança Alimentar no Ambiente Obesogênico Global  
Orientador: Homero Dewes  
Bolsista do(a): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

**2003 - 2005** Mestrado em Administração.  
Universidade Federal do Paraná, UFPR, Curitiba, Brasil  
Título: Cooperação Interorganizacional na Associação Londrinense de Empresas Supermercadas / ALES e no APL Têxtil de Goioerê - Uma análise sob a ótica da Teoria dos Custos de Transação., Ano de obtenção: 2005  
Orientador: Sérgio Bulgacov  
Bolsista do(a): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

**2010 - 2011** Especialização em Estatística e Modelagem Quantitativa.  
Universidade Federal de Santa Maria, UFSM, Santa Maria, Brasil  
Título: OS EFEITOS DA ORIENTAÇÃO PARA A APRENDIZAGEM E DA ORIENTAÇÃO PARA O MERCADO NO DESEMPENHO ORGANIZACIONAL  
Orientador: Roselaine Ruviano Zanini

**1999 - 2003** Graduação em Administração de Empresas.  
Universidade Federal de Santa Maria, UFSM, Santa Maria, Brasil  
Título: Administração de Produção na Calçados Beira Rio S/A - Unidade 12 de Roca Sales-RS  
Orientador: Denise Medianeira Mariotto

### Atuação profissional

- 1. Empresa Brasileira de Serviços Hospitalares - EBSERH**  
**2014 - Atual** Vínculo: Celetista , Enquadramento funcional: Analista Administrativo - Administrador , Carga horária: 40, Regime: Integral

2. **Centro Universitário Franciscano - UNIFRA**  
2005 - Atual Vínculo: Colaborador , Enquadramento funcional: Professor Mestre Assistente , Carga horária: 20, Regime: Parcial
3. **Faculdade Palotina - FAPAS**  
2013 - 2014 Enquadramento funcional: Professor , Carga horária: 12, Regime: Parcial
5. **Universidade de Passo Fundo - UPF**  
2013 - 2013 Vínculo: Professor Visitante , Enquadramento funcional: Professor de Pós-Graduação , Carga horária: 15, Regime: Parcial
6. **Sistema Educacional Galileu - SEG**  
2010 - 2010 Vínculo: Professor visitante , Enquadramento funcional: Professor visitante de pós-graduação, Regime: Parcial

#### Revisor de periódico

1. **Revista Produção**
2. **Revista de Negócios (Online)**
3. **RAC. Revista de Administração Contemporânea (Online)**
4. **J MANAGE ORGAN**
5. **JISTEM Journal of Information Systems and Technology Management (1807-1705)**
6. **Revista de Administração da UFSM**

#### Produção bibliográfica

##### Artigos completos publicados em periódicos

1. ABBADE, Eduardo Botti ; DEWES, Homero . Food insecurity worldwide derived from food supply patterns. *Food Security*, v. -, p. --- (online first), 2014.
2. ABBADE, Eduardo Botti ; DEWES, Homero . Brazilian dry-beans and food security in developing countries. *Journal of Agribusiness in Developing and Emerging Economies*, v. 4, p. 115-132, 2014.
3. ABBADE, Eduardo Botti . Technological readiness and propensity of young people to online purchases. *Revista de Negócios (Online)*, v. 19, p. 27-43, 2014.
4. ABBADE, Eduardo Botti . The role of brazilian agribusiness in Brazil s economic development. *GEPROS. Gestão da Produção, Operações e Sistemas (Online)*, v. 9, p. 149-158, 2014.
5. ABBADE, Eduardo Botti . Relacionamentos intra-cadeia e inter-cadeia: integrando marketing de relacionamento e custos de transação. *FACEF Pesquisa*, v. 17, p. 219-240, 2014.
2. ABBADE, Eduardo Botti ; FLORA, A. D. ; NORO, Greice de Bem . A Influência Interpessoal em Redes Sociais Virtuais e as Decisões de Consumo. *Revista de Administração da UFSM*, v. 7, p. 265-278, 2014.
7. ABBADE, Eduardo Botti . Inovatividade e Performances Social, Ambiental e Econômica em MPMES: Uma Investigação Empírica. *Revista Iberoamericana de Estratégia*, v. 13, p. 35-47, 2014.
8. ABBADE, Eduardo Botti ; MORES, Giana de Vargas ; SPANHOL, Caroline Pauletto . The Impact of Entrepreneurial Orientation on Sustainable Performance: Evidence of MSMEs from Rio Grande do Sul. *RGSA: Revista de Gestão Social e Ambiental*, v. 8, p. 49-62, 2014.
9. MORES, Giana de Vargas ; ABBADE, Eduardo Botti ; ANTONI, Verner Luis . Orientações estratégicas e desempenho: evidências do setor varejista de ópticas. *RAI : Revista de Administração e Inovação*, v. 10, p. 65-88, 2013.



10. ABBADE, Eduardo Botti ; MORES, Giana de Vargas . Responsabilidade social e desenvolvimento sustentável: Um estudo de caso em uma companhia brasileira de alimentos processados. *Revista de Negócios (Online)*, v. 18, p. 27-43, 2013.
11. ABBADE, Eduardo Botti . Orientações para mercado e para aprendizagem: interdependência, complementaridade. *Revista Iberoamericana de Estratégia*, v. 12, p. 138-164, 2013.
12. ABBADE, Eduardo Botti ; MORES, Giana de Vargas ; SPANHOL, Caroline Pauletto ; PIVOTO, D. . Precificação no setor supermercadista: uma análise baseada no paradigma estrutura-conduta-desempenho. *Revista de Economia (Curitiba)*, v. 39, p. 72-92, 2013.
13. ABBADE, Eduardo Botti ; NORO, Greice de Bem . Conhecimento, Segurança, Resistência e Utilização de Tecnologias de Auto-Atendimento Bancário. *Revista de Administração da UFSM*, v. 5, p. 507-524, 2012.
14. ABBADE, Eduardo Botti ; VIZZOTTO, T. P. ; NORO, Greice de Bem . Avaliação da orientação para a aprendizagem: Um estudo de caso na empresa Supertex de Santa Maria/RS. *Revista de Negócios (Online)*, v. 17, p. 37-52, 2012.
15. ABBADE, Eduardo Botti ; ZANINI, Roselaine Ruviano ; SOUZA, Adriano Mendonça . Orientação para aprendizagem, orientação para mercado e desempenho organizacional: evidências empíricas. *RAC. Revista de Administração Contemporânea (Online)*, v. 16, p. 118-136, 2012.  
Citações:1
16. ABBADE, Eduardo Botti . O efeito orientação para a aprendizagem no desempenho organizacional das empresas da região central do Rio Grande do Sul. *REGE. Revista de Gestão USP*, v. 19, p. 241-262, 2012.
17. NORO, Greice de Bem ; ABBADE, Eduardo Botti ; OLIVEIRA, Jackson . O ALINHAMENTO ENTRE OS TIPOS DE PROJETOS E AS COMPETÊNCIAS GERENCIAIS NOS PROJETOS DA AES SUL DISTRIBUIDORA GAÚCHA DE ENERGIA SA<br><http://dx.doi.org/10.5585/gep.v2i1.30>. *Revista de Gestão e Projetos*, v. 2, p. 106-142, 2011.
18. ABBADE, Eduardo Botti . E - Marketing - Novas Tendências para o Gerenciamento do Relacionamento DOI: 10.5007/1984-8951.2010v11n98p365. *Cadernos de Pesquisa Interdisciplinar em Ciências Humanas (Online)*, v. 11, p. 365-390, 2010.
19. ABBADE, Eduardo Botti . Cooperação Interorganizacional: Fonte de Aprendizagem e Vantagem Competitiva ou Oportunismo?. *Revista de Administração da UNIMEP*, v. 8, p. 154-179, 2010.
20. NORO, Greice de Bem ; ABBADE, Eduardo Botti . OS TIPOS DE PROJETOS E AS COMPETÊNCIAS GERENCIAIS NOS PROJETOS DA AES SUL DISTRIBUIDORA GAÚCHA DE ENERGIA S.A.. *RGO. Revista de Gestão Organizacional (UNOCHAPECÓ. Impresso)*, v. 3, p. 141-162, 2010.
21. OLIVEIRA, Alexandre Silva de ; LOPES, Luis Felipe Dias ; ABBADE, Eduardo Botti . COASSIMETRIA E COCORTOSE NA ANÁLISE DOS PREÇOS DAS AÇÕES NO MERCADO FINANCEIRO NACIONAL. *Revista de Administração da UFSM*, v. 3, p. 326-345, 2010.
22. OLIVEIRA, Alexandre Silva de ; CERETTA, Paulo Sérgio ; ABBADE, Eduardo Botti . Análise da relação entre o retorno anormal e o volume anormal de negociações das ações do índice BOVESPA. *FACEF Pesquisa*, v. 13, p. 301-314, 2010.
23. ABBADE, Eduardo Botti . Aplicação da teoria dos jogos na análise de alianças estratégicas. *GEPROS. Gestão da Produção, Operações e Sistemas (Online)*, v. 5, p. 131-147, 2010.
24. ABBADE, Eduardo Botti ; BRENNER . Perfil de Liderança e Tomada de Decisão. *Faces (FACE/FUMEC)*, v. 8, p. 107-127, 2009.
25. OLIVEIRA, Alexandre Silva de ; LOPES, Luis Felipe Dias ; ABBADE, Eduardo Botti . Co-Assimetria e Co-Curtose na Análise dos Preços das Ações no Mercado Financeiro Nacional. *Análise (PUCRS)*, v. 20, p. 103-122, 2009.

26. ABBADE, Eduardo Botti . Aplicação da teoria dos jogos na análise de alianças estratégicas. Cadernos de Pesquisa Interdisciplinar em Ciências Humanas (Online), v. 10, p. 205-227, 2009.
27. ABBADE, Eduardo Botti . Análise de Alianças Estratégicas sob a Ótica da Teoria dos Jogos. Revista de Administração da UNIMEP, v. 7, p. 24-45, 2009.
28. ABBADE, Eduardo Botti . Competitividade, aprendizagem e custos de transação nas relações de cooperação interorganizacional. RGO. Revista de Gestão Organizacional (UNOCHAPECÓ. Impresso), v. 2, p. 152-166, 2009.
29. MARQUES, K. F. S. ; DENARDIN, Élio Sérgio ; ABBADE, Eduardo Botti . PRÁTICAS DE MERCHANDISING EM UM HIPERMERCADO REGIONAL- RS. Revista Disciplinarum Scientia, v. 5, p. 79-103, 2009.
30. ABBADE, Eduardo Botti ; RAMOS, M. S. . A Percepção dos Consumidores quanto às Cores de Embalagens de Bens de Consumo. RGO. Revista de Gestão Organizacional (UNOCHAPECÓ. Impresso), v. 1, p. 69-88, 2008.
31. PITTHAN, Marcelo de Oliveira ; ABBADE, Eduardo Botti ; NORO, Greice de Bem . FORÇAS DE VENDAS: UM ESTUDO NAS MICRO E PEQUENAS EMPRESAS DE VAREJO CALÇADISTA DE SANTA MARIA-RS. Revista Disciplinarum Scientia, v. 3, p. 42-63, 2007.
32. LASTA, V. L. ; ABBADE, Eduardo Botti ; NORO, Greice de Bem . CLIMA ORGANIZACIONAL E QUALIDADE DE VIDA NA FÁBRICA CYRILLA DE BEBIDAS. Revista Disciplinarum Scientia, v. 3, p. 64-87, 2007.

#### **Artigos aceitos para publicação**

1. ABBADE, Eduardo Botti, DEWES, Homero. Behavioral and Societal Drivers of an Obesogenic Environment Worldwide. *Nutrition & Food Science.* , 2015.
2. ABBADE, Eduardo Botti. A Percepção de Clientes Universitários quanto ao Relacionamento com suas Operadoras de Telefonia Móvel. *REGE Revista de Gestao.* , 2014.
3. SANTOS, Suélen Xavier, ABBADE, Eduardo Botti, MEDEIROS, Flaviani Souto Bolzan, SCHRIPE, P., WEISE, A. D. Avaliação da qualidade de produtos e serviços oriundos de licitações do tipo menor preço: um estudo em uma câmara de vereadores no Rio Grande do Sul. *REGE. Revista de Gestão USP.* , 2014.
4. CHIELLE, L. V., ABBADE, Eduardo Botti, LUFT, E. I. Identificação do valor do cliente em uma distribuidora de alimentos. *Disciplinarum Scientia.* , 2014.

#### **Capítulos de livros publicados**

1. ABBADE, Eduardo Botti. PREÇOS MUNDIAIS DO MILHO E DA SOJA: TENDÊNCIAS E SAZONALIDADES In: Ensaio sobre o Agronegócio Brasileiro. 1 ed. Santa Maria : Centro Universitário Franciscano, 2014, v.1, p. 163-178.
2. MORES, Giana de Vargas, SPANHOL, Caroline Pauletto, PIVOTO, D., ABBADE, Eduardo Botti Análise dos preços praticados no setor supermercadista: reflexões sobre o paradigma estrutura-conduta-desempenho In: Varejo Competitivo. 1 ed. São Paulo : Saint Paul Editora, 2012, v.17, p. 65-82.
3. MORES, Giana de Vargas, ABBADE, Eduardo Botti, ANTONI, Verner Luis. Orientações para mercado e aprendizagem associadas à inovação elevam o desempenho da organização? Evidências em ópticas Passos-Fundenses. In: Varejo Competitivo - Volume 16.1 ed. São Paulo : Saint Paul, 2011, v.16, p. 171-195.
4. ABBADE, Eduardo Botti, SULZBACH, Cláudia, NORO, Greice de Bem. Comunicação interna organizacional: um estudo de caso em uma agência bancária In: Gestão Estratégica para o Desenvolvimento Sustentável ed. Ponta Grossa : Editora UEPG, 2007

### Trabalhos publicados em anais de eventos (completo)

1. CHIELLE, L. V., ABBADE, Eduardo Botti, LUFT, E. I. Identificando o valor do cliente em uma distribuidora de alimentos In: XXXIV ENEGEP - Encontro Nacional de Engenharia de Produção, 2014, Curitiba/PR. Anais do XXXIV ENEGEP. , 2014.
2. ABBADE, Eduardo Botti. O Papel do Agronegócio Brasileiro no seu Desenvolvimento Econômico In: XXXIV ENEGEP - Encontro Nacional de Engenharia de Produção, 2014, Curitiba/PR. Anais do XXXIV ENEGEP. , 2014.
3. SILVA, S. F., ABBADE, Eduardo Botti, LUFT, E. I. Reciclagem de embalagens de defensivos agrícolas: um estudo com empresas e produtores rurais In: XXXIV ENEGEP - Encontro Nacional de Engenharia de Produção, 2014, Curitiba/PR. Anais do XXXIV ENEGEP. , 2014.
4. NORO, Greice de Bem, STEFANELLO, R., ABBADE, Eduardo Botti. Análise de práticas de gestão empresarial e ambiental do grupo CAMNPAL In: 2º Fórum Internacional Ecoinnovar, 2013, Santa Maria. Anais do II Ecoinnovar. , 2013.
5. MORES, Giana de Vargas, ABBADE, Eduardo Botti, KAWANO, B. R., SILVA, Roberto Fray, CUGNASCA, C. E. No-tillage Overview from a Bibliometric Study with Multiple Correspondence Analysis In: EFITA Conference, 2013, Torino - Italy. Proceedings of EFITA 2013. , 2013.
6. MORES, Giana de Vargas, ABBADE, Eduardo Botti, KAWANO, B. R. QUAL É O FUTURO DO CONSUMO DE ALIMENTOS NO BRASIL? Uma análise baseada na aquisição de alimentos e na segurança nutricional In: 51o. Congresso da SOBER, 2013, Belém / PA. Anais do 51o. Congresso da SOBER. , 2013.
7. ABBADE, Eduardo Botti, MICHELIN, Fernanda Piccinin, SCHRIFFE, P., MEDEIROS, Flaviani Souto Bolzan, WEISE, A. D. Relacionamento e Governança na Cadeia Produtiva do Grupo Marfrig In: XIII SEMANA DE ENGENHARIA DE PRODUÇÃO SUL-AMERICANA (SEPROSUL), 2013, Gramado-RS. Anais do XIII SEPROSUL. , 2013.
8. NORO, Greice de Bem, KÖHLER, Grasielle Dutra, ABBADE, Eduardo Botti. A ECOEFICIÊNCIA COMO FATOR DETERMINANTE À GESTÃO SUSTENTÁVEL: O CASO DA SANTAMATE DE SANTA MARIA/RS In: VIII CNEG, 2012, Rio de Janeiro. Anais do VIII CNEG. , 2012.
9. NORO, Greice de Bem, KÖHLER, G. D., LENGELER, L., ABBADE, Eduardo Botti. A Ecoeficiência e a Gestão Sustentável: Um Estudo de Caso In: IX SIMPÓSIO DE EXCELÊNCIA EM GESTÃO E TECNOLOGIA - SEGeT, 2012, Resende – Rio de Janeiro. Anais do IX SEGeT. , 2012.
10. NORO, Greice de Bem, PASE, J., LENGELER, L., ABBADE, Eduardo Botti. A Educação Socioambiental na Universidade: a Percepção dos Acadêmicos do Curso de Administração In: IX SIMPÓSIO DE EXCELÊNCIA EM GESTÃO E TECNOLOGIA - SEGeT, 2012, Resende – Rio de Janeiro. Anais do IX SEGeT. , 2012.
11. NORO, Greice de Bem, AMARILHO, A., LENGELER, L., ABBADE, Eduardo Botti. A Gestão de Projetos Sustentáveis: o Caso América Latina Logística In: IX SIMPÓSIO DE EXCELÊNCIA EM GESTÃO E TECNOLOGIA - SEGeT, 2012, Resende – Rio de Janeiro. Anais do IX SEGeT. , 2012.
12. ABBADE, Eduardo Botti, NORO, Greice de Bem. A Percepção de Clientes Universitários quanto ao Relacionamento com suas Operadoras de Telefonia Móvel In: XXXVI Encontro da Associação Nacional de Pós-Graduação e Pesquisa em Administração - ENANPAD 2012, 2012, Rio de Janeiro - RJ. Anais do XXXVI ENANPAD. , 2012.
13. NORO, Greice de Bem, SIMÕES, E. P., LENGELER, L., ABBADE, Eduardo Botti, MATTANA, L. O Comportamento dos Consumidores Formigueirenses e Relação Ao Elemento do Composto de Varejo Adotado Pelos Supermercados de Formigueiro-RS In: IX SIMPÓSIO DE EXCELÊNCIA EM GESTÃO E TECNOLOGIA - SEGeT, 2012, Resende – Rio de Janeiro. Anais do IX SEGeT. , 2012.

14. ABBADE, Eduardo Botti, MORES, Giana de Vargas, SPANHOL, Caroline Pauletto, FARIA, Jessica Mota. ORIENTAÇÃO PARA O EMPREENDEDORISMO, INOVAÇÃO E DESEMPENHO SUSTENTÁVEL NAS INDÚSTRIAS GAÚCHAS DE ALIMENTOS E DE BEBIDAS In: 50º Congresso da SOBER, 2012, Vitória. Anais do 50º Congresso da SOBER. , 2012.
15. ABBADE, Eduardo Botti, ZANINI, Roselaine Ruviano, SOUZA, Adriano Mendonça. A Relação entre a Orientação para o Mercado e o Desempenho Organizacional: um Estudo em Empresas da Região Central do RS. In: V Encontro de Estudos em Estratégia - 3Es, 2011, Porto Alegre. Anais do V Encontro de Estudos em Estratégia - 3Es. , 2011.
16. JAGER, M. E., PAULA, T. M., ABBADE, Eduardo Botti. ADOLESCÊNCIA E INTERNET: ASPECTOS POSITIVOS E NEGATIVOS In: XV SEPE - Simpósio de Ensino, Pesquisa e Extensão - UNIFRA, 2011, Santa Maria. Anais do XV SEPE 2011. , 2011.
17. NORO, Greice de Bem, ABBADE, Eduardo Botti, DIEFENTHÄLER, Graciele. Desenvolvendo a Empregabilidade no Âmbito Acadêmico In: VIII SEGET - Simpósio de Excelência em Gestão e Tecnologia, 2011 Anais do VIII SEGET. , 2011.
18. NORO, Greice de Bem, CAPELARI, Nicole, ABBADE, Eduardo Botti. Incubadoras Tecnológicas e o Apoio ao Empreendedorismo In: VIII SEGET - Simpósio de Excelência em Gestão e Tecnologia, 2011. Anais do VIII SEGET. , 2011.
19. MEDEIROS, Flaviani Souto Bolzan, DENARDIN, Élio Sérgio, ABBADE, Eduardo Botti, SANTOS, Suélen Xavier. LICITAÇÕES DO TIPO MENOR PREÇO E QUALIDADE DOS PRODUTOS E SERVIÇOS EM UMA CÂMARA DE VEREADORES In: XXII ENANGRAD - Encontro Nacional dos Cursos de Graduação em Administração, 2011, São Paulo. Anais do XXII ENANGRAD. , 2011.
20. NORO, Greice de Bem, BECKER, D., BIANCHI, Renata Coradini, SUPTITZ, Carmen Cristina, ABBADE, Eduardo Botti. A Gestão da Rede Brasil Esportes do Rio Grande do Sul In: VI Congresso Nacional de Excelência em Gestão, 2010, Niteroi / RJ. Anais do VI CNEG 2010. , 2010.
21. NORO, Greice de Bem, OLIVEIRA, Jackson, ABBADE, Eduardo Botti. ALINHAMENTO ESTRATÉGICO ENTRE TIPOS DE PROJETOS E COMPETÊNCIA DE LÍDERES DE PROJETOS In: XXX Encontro Nacional de Engenharia de Produção - ENEGEP 2010, 2010, São Paulo - SP. Anais do XXX Encontro Nacional de Engenharia de Produção 2010. , 2010.
22. ABBADE, Eduardo Botti, NORO, Greice de Bem. Avaliação, utilização e resistência na adoção de serviços de auto-atendimento bancário In: XXXIV Encontro da Associação Nacional de Pós-Graduação e Pesquisa em Administração - ENANPAD 2010, 2010, Rio de Janeiro - RJ. Anais do XXXIV ENANPAD 2010. , 2010.
23. NORO, Greice de Bem, SUPTITZ, Carmen Cristina, ABBADE, Eduardo Botti, BOLZAN, A. G., BIANCHI, Renata Coradini. Desafios da gestão sustentável: um estudo de caso In: Congresso Internacional de Administração - ADM 2010, 2010, Ponta Grossa - PR. Anais do Congresso Internacional de Administração - ADM 2010. , 2010.
24. NORO, Greice de Bem, ABBADE, Eduardo Botti, MELLO, E., BOLZAN, A. G., BIANCHI, Renata Coradini. Gestão de Projetos: O Caso Global Village Telecom S/A In: Congresso Internacional de Administração - ADM 2010, 2010, Ponta Grossa - PR. Anais do Congresso Internacional de Administração - ADM 2010. , 2010.
25. NORO, Greice de Bem, ABBADE, Eduardo Botti, PITTHAN, Marcelo de Oliveira, BOLZAN, A. G., BIANCHI, Renata Coradini. Gestão de Projetos Sociais da Prefeitura de Santa Maria - RS In: Congresso Internacional de Administração - ADM 2010, 2010, Ponta Grossa - PR. Anais do Congresso Internacional de Administração - ADM 2010. , 2010.
26. NORO, Greice de Bem, ABBADE, Eduardo Botti, OLIVEIRA, Jackson. METODOLOGIA DE GESTÃO DE PROJETOS E SEUS RESULTADOS: UM ESTUDO DE CASO In: XXX Encontro Nacional de Engenharia de Produção - ENEGEP 2010, 2010, São Paulo - SP. Anais do XXX Encontro Nacional de Engenharia de Produção 2010. , 2010.

27. NORO, Greice de Bem, BECKER; D., BIANCHI, Renata Coradini, SUPTITZ, Carmen Cristina, ABBADE, Eduardo Botti. Sustentabilidade: uma visão baseada em stakeholders In: VI Congresso Nacional de Excelência em Gestão, 2010, Niteroi / RJ. Anais do VI CNEG 2010. , 2010.
28. NORO, Greice de Bem, ABBADE, Eduardo Botti, DENARDIN, Élio Sérgio, SILVEIRA, Cledir Marcia, BIANCHI, Renata Coradini. A Sustentabilidade com Base na Gestão de Stakeholders: O Caso Wal Mart In: VI Simpósio de Excelência em Gestão e Tecnologia (SEGeT), 2009, Resende-RJ. Anais do VI Simpósio de Excelência em Gestão e Tecnologia (SEGeT) 2009. , 2009.
29. NORO, Greice de Bem, OLIVEIRA, Verônica, ABBADE, Eduardo Botti, MATTANA, L. Alinhamento das estratégias de vendas em empresas do setor varejista da cidade de Santa Maria/RS In: Congresso Internacional de Administração - ADM 2009, 2009, Ponta Grossa - PR. Anais do Congresso Internacional de Administração - ADM 2009. , 2009.
30. NORO, Greice de Bem, ABBADE, Eduardo Botti, JOSENDE, A. C. C. Aprendizagem Organizacional - Um estudo de caso em uma Rede de Imobiliárias In: XXII SLADE - Congresso Latinoamericano de Estrategia, 2009, Córdoba. Anais do XXII SLADE. , 2009.
31. NORO, Greice de Bem, CARDOSO, M., ABBADE, Eduardo Botti. DESAFIOS PARA O DESENVOLVIMENTO SUSTENTÁVEL NO CONTEXTO COMPETITIVO In: IV Simpósio Internacional de Administração e Marketing - VI Congresso de Administração da ESPM, 2009, São Paulo - SP. Anais do IV Simpósio Internacional de Administração e Marketing e VI Congresso de Administração da ESPM. , 2009.
32. NORO, Greice de Bem, ABBADE, Eduardo Botti, CARDOSO, M. Desafios para o Desenvolvimento Sustentável no Contexto Competitivo In: XXII SLADE - Congreso Latinoamericano de Estrategia, 2009, Córdoba. Anais do XXII SLADE. , 2009.
33. NORO, Greice de Bem, ABBADE, Eduardo Botti, BIANCHI, Renata Coradini, CARDOSO, M. Desafios para o Desenvolvimento Sustentável no Contexto Competitivo: O caso Vonpar In: XXIX ENEGEP - Encontro Nacional de Engenharia de Produção - 2009, 2009, Salvador. Anais do XXIX ENEGEP 2009. , 2009.
34. NORO, Greice de Bem, CARDOSO, M., ABBADE, Eduardo Botti, BIANCHI, Renata Coradini, DENARDIN, Élio Sérgio. Desafios para o Desenvolvimento Sustentável: um estudo de caso In: Congresso Internacional de Administração - ADM 2009, 2009, Ponta Grossa - PR. Anais do Congresso Internacional de Administração - ADM 2009. , 2009.
35. NORO, Greice de Bem, CANTO, Rossana Viegas do, ABBADE, Eduardo Botti, BIANCHI, Renata Coradini. Mercado de Desenvolvimento Limpo (MDL): o Mercado de Carbono como alternativa sustentável In: Congresso Internacional de Administração - ADM 2009, 2009, Ponta Grossa-PR. Anais do Congresso Internacional de Administração - ADM 2009. , 2009.
36. NORO, Greice de Bem, CARDOSO, M., ABBADE, Eduardo Botti, BIANCHI, Renata Coradini. O Desenvolvimento Sustentável no Contexto Competitivo: O caso Vonpar In: XVI SIMPEP – Simpósio de Engenharia de Produção, 2009, Bauri - SP. Anais do XVI SIMPEP – Simpósio de Engenharia de Produção 2009. , 2009.
37. NORO, Greice de Bem, MELLO, E., ABBADE, Eduardo Botti, BIANCHI, Renata Coradini. Os Critérios de Tomada de Decisão em Gestão de Projetos nas Empresas de Construção Civil de Santa Maria – RS In: XVI SIMPEP – Simpósio de Engenharia de Produção, 2009, Bauri - SP. Anais do XVI SIMPEP – Simpósio de Engenharia de Produção 2009. , 2009.
38. ABBADE, Eduardo Botti, NORO, Greice de Bem. PERFIL DE LIDERANÇA E TOMADA DE DECISÃO DOS GESTORES In: SEMEAD - XII Seminários em Administração 2009, 2009, São Paulo - SP. Anais do XII SEMEAD 2009. , 2009.
39. ABBADE, Eduardo Botti, NORO, Greice de Bem, BRENNER; Fábio Goulart. Perfil de liderança e tomada de decisão dos gestores de empresas do Distrito Industrial de Santa Maria/RS In: XXII SLADE - Congresso Latinoamericano de Estrategia, 2009, Córdoba. Anais do XXII SLADE. , 2009.

40. NORO, Greice de Bem, ABBADE, Eduardo Botti, DENARDIN, Élio Sérgio, BENTO, Marcia Helena, BECKER; D. PERFIL DE LIDERANÇA: UM ESTUDO REALIZADO NAS EMPRESAS PARTICIPANTES DO SISTEMA DE AUTO-AVALIAÇÃO 2007 DO PGQP DA REGIÃO DE SANTA MARIA, RS. In: VI Simpósio de Excelência em Gestão e Tecnologia (SEGeT), 2009, Resende-RJ. Anais do VI Simpósio de Excelência em Gestão e Tecnologia (SEGeT) 2009. , 2009.
41. ABBADE, Eduardo Botti, MATTANA, L. Teoria dos Jogos como ferramental para Avaliação da Formação de Alianças Estratégicas In: XXIX ENEGEP - Encontro Nacional de Engenharia de Produção 2009, 2009, Salvador. Anais do XXIX ENEGEP 2009. , 2009.
42. DENARDIN, Élio Sérgio, NORO, Greice de Bem, ABBADE, Eduardo Botti, KIST, C. A ESPIRITUALIDADE:UM CAMINHO DE HUMANIZAÇÃO NAS ORGANIZAÇÕES In: ENEPO - 4º ENCONTRO DE ESTUDOS E PESQUISAS EM ORGANIZAÇÕES, 2008, JOAÇABA - SC. ANAIS DO 4º ENEPO - 2008. , 2008.
43. NORO, Greice de Bem, SOARES, C. L., DENARDIN, Élio Sérgio, ABBADE, Eduardo Botti, MATTANA, L. A influência do consumidor infantil na decisão de compra familiar In: Congresso Internacional de Administração - ADM 2008, 2008, Ponta Grossa - PR. Anais do ADM 2008. , 2008.
44. NORO, Greice de Bem, ABBADE, Eduardo Botti, SILUK, Júlio César Mairesse, BIANCHI, Renata Coradini. A MATUREZADE EM GESTÃO DE PROJETOS DAS EMPRESAS DE CONSTRUÇÃO CIVIL DE SANTA MARIA - RS In: XXVIII ENEGEP - ENCONTRO NACIONAL DE ENGENHARIA DE PRODUÇÃO, 2008, Rio de Janeiro - RJ. Anais do XXVIII ENEGEP. , 2008.
45. NORO, Greice de Bem, ABBADE, Eduardo Botti, DENARDIN, Élio Sérgio, BECKER; D. Análise do clima para inovação: um estudo de caso In: V EGEPE - Encontro de Estudos sobre Empreendedorismo e Gestão de Pequenas Empresas, 2008, São Paulo - SP. Anais do V EGEPE. , 2008.
46. NORO, Greice de Bem, ABBADE, Eduardo Botti, MATTANA, L., BECKER; D. COMPETÊNCIAS GERENCIAIS: UM ESTUDO REALIZADO NO BANCO DO BRASIL In: XIX ENANGRAD - ENCONTRO NACIONAL DOS CURSOS DE GRADUAÇÃO EM ADMINISTRAÇÃO, 2008, Curitiba. Anais do XIX ENANGRAD 2008. , 2008.
47. ABBADE, Eduardo Botti, NORO, Greice de Bem, MATTANA, L., BIANCHI, Renata Coradini. COMUNICAÇÃO INTERNA E CLIMA ORGANIZACIONAL - UM ESTUDO DE CASO NO JORNAL A RAZÃO In: XIX ENANGRAD - ENCONTRO NACIONAL DOS CURSOS DE GRADUAÇÃO EM ADMINISTRAÇÃO, 2008, Curitiba - PR. Anais do XIX Enangrad. , 2008.
48. ABBADE, Eduardo Botti, NORO, Greice de Bem, MATTANA, L. COMUNICAÇÃO INTERNA E CLIMA ORGANIZACIONAL – UM ESTUDO DE CASO NO JORNAL A RAZÃO In: XI Semead - Seminários em Administração, 2008, São Paulo - SP. Anais do XI Semead - São Paulo-SP. , 2008.
49. ABBADE, Eduardo Botti, GRANDI, R. S., NORO, Greice de Bem. Comunicação Interna e Clima Organizacional - um estudo de caso no Jornal A Razão In: XXI Congresso Internacional de la Sociedad Latinoamericana de estrategia (SLADE), 2008, Santiago de Chile. Anais do XXI SLADE 2008. , 2008.
50. CAVALHEIRO, Daniele Garcia, PASA, Marinês Cirolini, ABBADE, Eduardo Botti. Conflito Organizacional e Gestão da Mudança - um estudo de caso na Móveis Gaudencio Ltda. - RS In: XII Simpósio de Ensino, Pesquisa e Extensão - SEPE 2008, 2008, Santa Maria-RS. Anais do XII Simpósio de Ensino, Pesquisa e Extensão - SEPE 2008. , 2008. p.1765 - 1788
51. MATTANA, L., NORO, Greice de Bem, ABBADE, Eduardo Botti, ESTRADA, R. J. S. Da Caracterização à Sustentação de Alianças Estratégicas In: XXI Congresso Internacional de la Sociedad Latinoamericana de estrategia (SLADE), 2008, Santiago de Chile. Anais do XXI SLADE 2008. , 2008.
52. NORO, Greice de Bem, ABBADE, Eduardo Botti, DENARDIN, Élio Sérgio, BIANCHI, Renata Coradini. DA LIDERANÇA AO ESTILO COACH In: ENEPO 2008 - 4º ENCONTRO DE ESTUDOS E PESQUISAS EM ORGANIZAÇÕES, 2008, JOAÇABA - SC. ANAIS DO 4º ENEPO 2008. , 2008.

53. ABBADE, Eduardo Botti, NORO, Greice de Bem, MATTANA, L. MERCHANDISING DE PRODUTOS MARCA-PRÓPRIA - UM ESTUDO DE CASO NO SUPERMERCADO NACIONAL DE SANTA MARIA/RS In: XI Semead - Seminários em Administração, 2008, São Paulo - SP. Anais do XI Semead - São Paulo-SP. , 2008.
54. NORO, Greice de Bem, MATTANA, L., MOTTINI, M. M., ABBADE, Eduardo Botti. Metodologia de Comunicação Integrada de Marketing – o caso Orium In: Congresso Internacional de Administração - ADM 2008, 2008, Ponta Grossa - PR. Anais do ADM 2008. , 2008.
55. VIEIRA, C., NORO, Greice de Bem, ABBADE, Eduardo Botti. Modelo Japonês de Organização do Trabalho: um estudo de caso In: CONVIBRA 2008 - CONGRESSO VIRTUAL BRASILEIRO DE ADMINISTRAÇÃO, 2008. ANAIS DO CONVIBRA 2008. , 2008.
56. NORO, Greice de Bem, ABBADE, Eduardo Botti, DENARDIN, Élio Sérgio, BIANCHI, Renata Coradini. MUDANÇA ORGANIZACIONAL: FORÇAS QUE IMPACTAM O AMBIENTE ORGANIZACIONAL In: ENEPO 2008 - 4º ENCONTRO DE ESTUDOS E PESQUISAS EM ORGANIZAÇÕES, 2008, JOAÇABA - SC. ANAIS DO 4º ENEPO - 2008. , 2008.
57. WINCKLER, C., NORO, Greice de Bem, ABBADE, Eduardo Botti. Administração do Estresse: um estudo de caso na empresa Vivo-RS In: V Simpósio de Gestão e Estratégia em Negócios da UFRuralRJ, 2007, Rio de Janeiro. Anais do V Simpósio de Gestão e Estratégia em Negócios da UFRuralRJ. , 2007.
58. ABBADE, Eduardo Botti, NORO, Greice de Bem, MATTANA, L. Análise da racionalidade da Teoria dos Jogos: um ensaio teórico In: Congresso Internacional de Administração - ADM 2007, 2007, Ponta Grossa. Anais do ADM 2007. , 2007.
59. NORO, Greice de Bem, ABBADE, Eduardo Botti, DENARDIN, Élio Sérgio, CARDOSO, M. Competências Gerenciais: um estudo realizado em uma Indústria de Bebidas In: V Simpósio de Gestão e Estratégia em Negócios da UFRuralRJ, 2007, Rio de Janeiro. Anais do V Simpósio de Gestão e Estratégia em Negócios da UFRuralRJ. , 2007.
60. ABBADE, Eduardo Botti, SULZBACH, Cláudia, NORO, Greice de Bem. Comunicação interna organizacional: um estudo de caso em uma agência bancária In: Congresso Internacional de Administração 2007, 2007, Ponta Grossa. Anais do Congresso Internacional de Administração 2007. , 2007.
61. TANSCHKEIT, J. A., NORO, Greice de Bem, ABBADE, Eduardo Botti. Estratégias Competitivas do Setor Hoteleiro de Santa Maria - RS In: V Simpósio de Gestão e Estratégia em Negócios da UFRuralRJ, 2007, Rio de Janeiro. Anais do V Simpósio de Gestão e Estratégia em Negócios da UFRuralRJ. , 2007.
62. NORO, Greice de Bem, ABBADE, Eduardo Botti, BECKER, D., CIPOLAT, C. ESTRATÉGIAS DE CRESCIMENTO NO SETOR SUPERMERCADISTA: UM ESTUDO DE CASO In: Congresso Virtual Brasileiro de Administração 2007, 2007, sem sede - evento virtual. Anais do Convibra 2007. , 2007.
63. NORO, Greice de Bem, ABBADE, Eduardo Botti, SILVA, R. S. Método do estudo de caso como ferramenta de ensino transdisciplinar In: XI Simpósio de Ensino Pesquisa e Extensão - 2007, 2007, Santa Maria. Anais do XI Simpósio de Ensino Pesquisa e Extensão - 2007. , 2007.
64. NORO, Greice de Bem, MARTINS, Ana Cristina Cazorla, ABBADE, Eduardo Botti. O Quadro Evolutivo das Organizações do Setor de Construção Civil da cidade de Santa Maria/RS In: Simposio de Excelência em Gestão e Tecnologia - SEGET - 2007, 2007, Rio de Janeiro. Anais do SEGET - 2007. , 2007.
65. NORO, Greice de Bem, ABBADE, Eduardo Botti, BIANCHI, Renata Coradini. Os Componentes da Excelência em Gestão de Projetos: O caso ALL In: Congresso Internacional de Administração - ADM 2007, 2007, Ponta Grossa. Anais do Congresso Internacional de Administração 2007. , 2007.
66. ABBADE, Eduardo Botti, BULGACOV, Sergio, CUNHA, Cleverson Renan da. Confiança e Oportunismo: Análise dos Custos de Transação na Rede ALES/PR In: X Colóquio Internacional sobre Poder Local, 2006, Salvador. Anais do X Colóquio Internacional sobre Poder Local. Salvador: Universidade Federal da Bahia, 2006.

## **Tese de Doutorado em Agronegócios**

Universidade Federal do Rio Grande do Sul

### **A INSEGURANÇA ALIMENTAR NO AMBIENTE OBESOGÊNICO GLOBAL**

Autor: Eduardo Botti Abbade

Orientador: Prof. Dr. Homero Dewes

Porto Alegre, 2014.

#### **RESUMO**

Esta tese tem como ampla proposta apresentar evidências a respeito da situação de segurança alimentar mundial, já que o mundo enfrenta problemas graves e urgentes relacionados à insegurança alimentar. Para tanto, são apresentados cinco estudos que abordam tal temática. O primeiro estudo se propõe a investigar as exportações de feijão brasileiro, observando as condições de segurança alimentar de seus compradores. O segundo estudo busca discutir os perfis agrícolas das principais regiões da África, bem como a parceria estabelecida entre a África e o Brasil com intuito de fomentar a inovação na agricultura e o desenvolvimento econômico. O terceiro estudo busca identificar e analisar os principais padrões de abastecimento alimentar da população mundial, e, em seguida, relacioná-los com as respectivas condições de desnutrição de suas localidades. A hipótese é que existem padrões de suprimento específicos, geograficamente identificáveis, que estão associados com o desalinhamento nutricional de certas populações em maior grau do que outras. O quarto estudo investiga a situação e a tendência de insegurança alimentar em todo o mundo considerando suas principais regiões geográficas. O quinto estudo objetivou analisar o impacto de fatores sócio-econômicos e comportamentais sobre a situação obesogênica em todo o mundo. Para tanto, os estudos se baseiam em dados disponibilizados por entidades e órgão oficiais como FAO, WHO, UNSD, IBGE e Banco Mundial. Além disso, para a análise dos dados foram empregadas técnicas de estatísticas descritivas, análise do coeficiente de correlação (Pearson e Spearman), regressão linear (múltipla e simples), análise de cluster e análise fatorial. Também foram elaborados diagramas de dispersão e gráficos de séries temporais. Os resultados sugerem que os modelos de suprimento alimentar estão significativamente relacionados aos problemas de insegurança alimentar mundial. Também ficou evidenciado que algumas nações e regiões mundiais enfrentam gravidades severas de segurança alimentar, com tendências alarmantes de agravamento. Especificamente a região do sul da África apresenta aumento tanto de sobrepeso quando baixo peso infantil. Já os países do leste asiático apresentam os melhores indicadores de segurança alimentar. Também o estudo sugere que o Brasil tem potencial de auxiliar na promoção da segurança alimentar, tanto por meio da produção e suprimento de alimentos, como por meio de parcerias inovativas com regiões mais desfavorecidas como a África subsaariana. As implicações deste estudo abrangem o âmbito das políticas públicas, práticas privadas e elementos econômico-sociais. As evidências aqui apresentadas poderão auxiliar no desenvolvimento de iniciativas em prol da promoção da segurança alimentar mundial. Além disso, o papel do agronegócio Brasileiro como potencial atenuador da insegurança alimentar mundial é destacado, necessitando de uma articulação política e privada para seu desenvolvimento sustentável.

**PALAVRAS-CHAVE:** Ambiente obesogênico; Insegurança Alimentar; Agronegócio; Suprimento alimentar; Desnutrição; Obesidade; Sobrepeso; *Staple Food*; Desenvolvimento.



## **Agribusiness Doctoral Thesis**

Federal University of Rio Grande do Sul

### **FOOD INSECURITY IN THE GLOBAL OBESOGENIC ENVIRONMENT**

Author: Eduardo Botti Abbade

Advisor: Prof. Dr. Homero Dewes

Porto Alegre, 2014.

#### **ABSTRACT**

The wide proposal of this thesis is to present evidence about the situation of food security worldwide, since the world is facing severe and urgent problems related to this issue. Considering this finality, this thesis is composed by five studies addressing the food security worldwide issue. The first study aims to investigate the export of Brazilian dry-beans, observing the conditions of food security of importers. The second study aims to discuss the agricultural profiles of the main regions of Africa, as well as the partnership between Africa and Brazil established to foster innovation in agriculture and economic development. The third study seeks to identify and analyze the main food supply patterns of the world's population, and then relate them to their conditions of malnutrition in their localities. The hypothesis is that there are specific supply patterns, geographically identifiable, which are associated with nutritional misalignment of certain populations to a greater degree than others. The fourth study investigates the status and trend of food insecurity around the world considering its major geographic regions. The fifth study aimed to analyze the impact of socio-economic and behavioral factors on obesogenic situation worldwide. All five studies are based on data available at official organizations and institutions as FAO, WHO, UNSD, World Bank and IBGE. In addition, data analysis techniques comprises descriptive statistics, correlation analysis (Pearson and Spearman), linear regression (simple and multiple), cluster analysis and factor analysis. Scatterplots and time series graphs were also elaborated. The main results suggest that food supply patterns are significantly related to the problems of global food insecurity. It was also found that some nations and world regions face severe severities of food security, with alarming trends of worsening. Specifically, Southern Africa region has increased prevalence of overweight and underweight children. The countries of Eastern Asia have the best indicators of food security, considering anthropometric indicators. The study also suggests that Brazil has the potential to assist the promotion of food security worldwide through the production and supply of food, and through innovative partnerships with poorer regions like sub-Saharan Africa. The implications of this study include the realm of public policy, private practices and economic-social elements. The evidence presented here may assist in developing initiatives for the promotion of world food security. Furthermore, the role of the Brazilian agribusiness as potential attenuator of food insecurity worldwide is highlighted, requiring political and private articulation for the sustainable development.

**KEYWORDS:** Obesogenic environment; Food Insecurity; Agribusiness; Food supply; Malnutrition; Obesity; Overweight; Staple Food; Development.

## LISTA DE FIGURAS

### **CAPÍTULO 1: Brazilian dry-beans and food security in developing countries**

Figure 1 – Yield (tonnes/hectare) of dry-beans in Brazil, India, Myanmar and World (1961-2010).....	37
Figure 2 – Total production of dry-beans in Brazil, India and Myanmar (1961-2010)..	37
Figure 3 – Volume imported and exported of dry-beans (tons) by Brazil (1961-2009)	41
Figure 4 – Dispersion Map of importers of Brazilian dry-beans considering total volume imported (1995-2009) and Coefficient of Variation.....	44
Figure 5 – Dispersion Map of importers of Brazilian dry-beans considering total volume imported (1995-2009) and malnourished children.....	46
Figure 6 – Dispersion Map of importers of Brazilian dry-beans considering total volume imported (1995-2009) and population undernourished.....	48

### **CAPÍTULO 2: Brazilian agribusiness facing African food insecurity**

Figure 1 – Harvest area.....	60
Figure 2 – Agricultural productivity (total production / harvest area).....	61
Figure 3 – Fertilizer consumption (tonnes / harvest area).....	62
Figure 4 – Capital investments (US\$ / harvest area).....	62
Figure 5 - Main regions of Africa and active projects (partnership with EMBRAPA).	66
Figure 6 – Global Peace Index and political instability in Africa.....	69

### **CAPÍTULO 3: Food insecurity worldwide derived from food supply patterns**

Figure 1 – Clusters of food supply patterns (FSPs) and their geographical distribution.....	86
Figure 2 – Food supply patterns (FSPs) of the nine clusters, considering grams/person/day of the 14 supplied food groups.....	87
Figure 3 – Comparative analyses between food supply patterns.....	89
Figure 4 – Food supply patterns (FSPs) of main regions and their rates of underweight, overweight, and stunted children in 2012.....	91

### **CAPÍTULO 4: Facing co-occurrence of underweight and overweight populations worldwide**

Figure 1 – Relation between undernourished and overweight population worldwide...	108
Figure 2 – Child Underweight and Overweight Trends for main regions worldwide....	109
Figure 3 – Comparison between current child underweight / overweight situations and trends for food insecurity worldwide.....	111

## LISTA DE TABELAS

<b>CAPÍTULO 1: Brazilian dry-beans and food security in developing countries</b>	
Table 1 - Per head acquisition of beans (Kilograms) in Brazil and its regions in 2002 and 2008.....	38
Table 2 – Total volume imported, coefficient of variation, percentage of malnourished children and undernourished population of importers of Brazilian dry-beans.....	43
<b>CAPÍTULO 2: Brazilian agribusiness facing African food insecurity</b>	
Table 1 – List of projects being implemented in the African continent.....	67
Table 2 – Profile of African countries with active projects.....	70
<b>CAPÍTULO 3: Food insecurity worldwide derived from food supply patterns</b>	
Table 1 – Main variables and their descriptions and sources.....	82
Table 2 – Descriptive statistics for world supplies of main food groups in 2009.....	83
<b>CAPÍTULO 4: Facing co-occurrence of underweight and overweight populations worldwide</b>	
Table 1 – Details and description about indicators.....	105
<b>CAPÍTULO 5: Behavioral and societal drivers of an obesogenic environment worldwide</b>	
Table 1 – Variables, Indicators, Sources and Factorial Analysis.....	129
Table 2 – Profile of the 99 countries with available data.....	130
Table 3 – Regression results for the hypotheses.....	132

## LISTA DE ANEXOS

ANEXO 1 – Primeira página do artigo “ <i>Brazilian dry-beans and food security in developing countries</i> ” publicado.....	153
ANEXO 2 – E-mail de confirmação da submissão do artigo “ <i>Brazilian agribusiness facing African food insecurity</i> ” .....	154
ANEXO 3 - Primeira página do artigo “ <i>Food insecurity worldwide derived from food supply patterns</i> ” publicado.....	155
ANEXO 4 - E-mail de confirmação da submissão do artigo “ <i>Facing co-occurrence of underweight and overweight populations worldwide</i> ” .....	156
ANEXO 5 - E-mail de confirmação do aceite para publicação do artigo “ <i>Behavioral and societal drivers of an obesogenic environment worldwide</i> ” .....	157

## SUMÁRIO

AGRADECIMENTOS.....	V
CURRICULUM VITAE DE EDUARDO BOTTI ABBADE.....	VII
RESUMO .....	XVI
ABSTRACT .....	XVII
LISTA DE FIGURAS .....	XVIII
LISTA DE TABELAS.....	XIX
LISTA DE ANEXOS.....	XX
INTRODUÇÃO .....	23
1. PROPOSTA DO ESTUDO .....	25
2. PROCEDIMENTOS METODOLÓGICOS .....	27
3. MOTIVAÇÃO E JUSTIFICATIVA .....	29
CAPÍTULO 1: BRAZILIAN DRY-BEANS AND FOOD SECURITY IN DEVELOPING COUNTRIES. 31	
ABSTRACT .....	31
1. INTRODUCTION .....	32
2. HUNGER AND FOOD SECURITY .....	33
3. DRY-BEANS: NUTRITIONAL VALUE, PRODUCTION AND CONSUMPTION IN BRAZIL.....	35
4. METHODOLOGICAL PROCEDURES.....	39
5. INTERNATIONAL TRADE OF BRAZILIAN DRY-BEANS .....	40
6. BRAZILIAN EXPORTS OF DRY-BEANS AND FOOD SECURITY OF IMPORTERS .....	42
7. FINAL DISCUSSIONS .....	49
8. REFERENCES .....	51
CAPÍTULO 2: BRAZILIAN AGRIBUSINESS FACING AFRICAN FOOD INSECURITY .....	57
ABSTRACT .....	57
1. INTRODUCTION .....	58
1.1 OBJECTIVE.....	58
1.2 BACKGROUND.....	58
1.3 METHOD.....	59
2. AGRICULTURE IN AFRICA .....	60
3. THE AGRIBUSINESS PARTNERSHIP BETWEEN BRAZIL AND AFRICA .....	63
4. CONCLUSIONS.....	73
5. REFERENCES .....	74
CAPÍTULO 3: FOOD INSECURITY WORLDWIDE DERIVED FROM FOOD SUPPLY PATTERNS 80	
ABSTRACT .....	80
1. INTRODUCTION .....	80
2. METHOD.....	81
3. RESULTS.....	85
4. DISCUSSION.....	92
5. CONCLUSIONS.....	95
6. REFERENCES .....	96
CAPÍTULO 4: FACING CO-OCCURRENCE OF UNDERWEIGHT AND OVERWEIGHT POPULATIONS WORLDWIDE.....	103
ABSTRACT .....	103

<b>1. INTRODUCTION .....</b>	<b>104</b>
<b>2. METHODS.....</b>	<b>105</b>
<b>3. RESULTS .....</b>	<b>106</b>
<b>4. DISCUSSION.....</b>	<b>113</b>
<b>5. CONCLUSIONS.....</b>	<b>116</b>
<b>REFERENCES .....</b>	<b>117</b>
<b>CAPÍTULO 5: BEHAVIORAL AND SOCIETAL DRIVERS OF AN OBESOGENIC ENVIRONMENT WORLDWIDE .....</b>	<b>126</b>
<b>ABSTRACT .....</b>	<b>126</b>
<b>1. INTRODUCTION .....</b>	<b>127</b>
<b>2. METHOD .....</b>	<b>128</b>
<b>3. RESULTS.....</b>	<b>131</b>
<b>4. DISCUSSION.....</b>	<b>133</b>
<b>5. CONCLUSIONS.....</b>	<b>137</b>
<b>REFERENCES .....</b>	<b>138</b>
<b>CONSIDERAÇÕES FINAIS.....</b>	<b>145</b>
<b>REFERÊNCIAS .....</b>	<b>149</b>
<b>ANEXOS (ANNEXES).....</b>	<b>152</b>

## INTRODUÇÃO

A segurança alimentar é definida como a aquisição suficiente de alimentos em termos de quantidades e nutrição (SEN, 1981). Complementarmente, o conceito de segurança alimentar está associado a três condições hierarquizadas - disponibilidade, acesso adequado e condições de uso de alimentos e nutrientes (BARRETT, 2010; WEBB et al., 2006). Além disso, a condição de segurança alimentar deve garantir que todas as pessoas, a qualquer momento, possam ter acesso físico, social e econômico de alimentos nutricionalmente adequados, suficientes e seguros que atendam as suas necessidades e preferências nutricionais, garantindo um estilo de vida ativo e saudável (FAO, 1996; FAO, 2002). Logo, garantir situação de segurança alimentar em nível mundial é desafio que tangencia por uma vasta gama de atividades e áreas do conhecimento. Adicionalmente, considerando o grau de urgência de algumas populações mundiais quando à disponibilidade, acesso e uso de alimentos, garantindo sua saúde e condições de vida saudável, investigações acerca da segurança alimentar mundial, seus antecedentes, direcionadores e consequências são altamente necessárias.

Apesar de a segurança alimentar ser constantemente relacionada com a garantia de suprimento das necessidades alimentares em quantidades suficientes para que não haja fome e desnutrição, a garantia de segurança alimentar também deve considerar que um consumo inadequado de alimentos e macronutrientes pode prejudicar a saúde ocasionando sobrepeso e obesidade. Para tanto, este estudo considera que segurança alimentar é a garantia de uma alimentação suficiente e adequada às necessidades humanas de modo a evitar a fome e a desnutrição, assim como condições de sobrepeso e obesidade.

Muitos países em desenvolvimento apresentam situações com graves problemas de fome e desnutrição. De fato, um dos principais objetivos de desenvolvimento do milênio considerado pela humanidade é a erradicação da extrema pobreza e da fome até 2015 (UNITED NATIONS, 2013). Com isso, considerando o crescimento acentuado da população mundial, a busca por segurança alimentar é tema de amplo debate acadêmico, principalmente no que tange países em desenvolvimento (GODFRAY et al., 2010). Além disso, tanto o setor público como o privado desempenham um papel fundamental no combate à insegurança alimentar. Logo, iniciativas que possam vir a suprir as deficiências nutricionais proporcionando segurança alimentar são consideradas foco estratégico que atinge tanto o setor público como o privado.

Além dos graves problemas de fome e desnutrição observados em diversos países, a obesidade coletiva em algumas nações também é considerada temática urgente, já que é possível considerar que o ambiente mundial atual é encarado como obesogênico (SWINBURN, EGGER e RAZA, 1999). Fração alarmante da população mundial apresenta sintomas de sobrepeso e obesidade e o número de indivíduos com diagnóstico de obesidade tem aumentado drasticamente nos últimos anos. As consequências dessa realidade obesogênica são consideradas graves tanto para os indivíduos obesos como para as sociedades obesogênicas (NEDERKOOORN et al., 2006). A prevalência de obesidade está associada a um aumento da morbidade e mortalidade causadas por diabetes e doenças cardiovasculares (MISRA e KHURANA, 2008).

A desnutrição e a obesidade coletivas são realidades fortemente atreladas aos hábitos de consumo alimentar, dentre outras variáveis sócio-econômicas e comportamentais. Além disso, os impactos negativos da insegurança alimentar, considerada grave em diversos países em desenvolvimento, podem vir a prejudicar sobremaneira o desenvolvimento de tais nações. Estudos evidenciam que a desnutrição infantil grave pode acarretar em um comprometimento significativo das capacidades cognitivas dos indivíduos de forma irreversível, por meio da alteração do sistema nervoso central (DOBBING, 1972). Também é necessário considerar que a desnutrição é causa de mortalidade infantil, do desenvolvimento de propensão à doenças como anemia e infecções, e prejudica significativamente o crescimento e desenvolvimento infantil (ASSIS e BARRETO, 2000; RIBAS et al., 1999). Por outro lado, o ambiente obesogênico tende a impactar significativamente na elevação do risco de desenvolvimento diabetes, hipertensão, derrames e doenças cardiovasculares (MCTIGUE, et al., 2006; MOGHADDAM, WOODWARD e HUXLEY, 2007; MOKDAD, et al., 2001; MUST, et al., 1999). Com isso, a infra-estrutura da saúde pública de sociedades obesogênicas deve estar preparada para atender demandas crescentes de indivíduos que procurarão serviços médicos públicos em decorrência da obesidade.

A promoção da segurança alimentar em nível mundial é iniciativa de alta prioridade e urgência, tanto que uma das principais metas do milênio é a erradicação da pobreza extrema e da fome até 2015 (Divisão de Estatística das Nações Unidas [UNSD], 2013). No entanto, muitos países em desenvolvimento ainda enfrentam a fome severa e problemas de desnutrição. Apesar dos esforços mundiais no sentido de promover a segurança alimentar para as populações mundiais, cerca de 842 milhões de pessoas ainda sofriam de fome crônica em 2011-2013 (FAO, 2013). Nações africanas e asiáticas, em particular, apresentam resultados pouco expressivos no combate à fome e à desnutrição (FAO, 2010b). Aproximadamente 65%



da população mundial que sofre de fome estão concentradas em apenas sete países (Índia, China, República Democrática do Congo, Bangladesh, Indonésia, Paquistão e Etiópia) (FAO, 2010a). Além disso, são as crianças as parcelas populacionais mais fortemente afetadas pela fome e desnutrição em todo o mundo. De fato, a desnutrição está associada com a morte de cinco milhões de crianças menores de cinco anos de idade a cada ano nos países em desenvolvimento (UNICEF, 2006a). Aproximadamente 146 milhões de crianças que vivem em economias em desenvolvimento estão abaixo do peso (UNICEF, 2007), e estas estão na sua maioria concentrados no sul da Ásia e na África (UNICEF, 2006b).

Em contrapartida, em 2008, mais de 1,4 bilhão de adultos com 20 anos de idade ou mais estavam acima do peso; e mais de 200 milhões de homens e quase 300 milhões de mulheres foram diagnosticadas como obesas. Em 2008, cerca de 11% da população adulta do mundo estava diagnosticada como obesa, e 35% dos adultos (20 anos ou mais) estavam acima do peso (WHO, 2013; PATEL, 2008). No entanto, populações podem apresentar paradoxos nutricionais onde podem ser observados altos índices de desnutrição e sobrepeso nas mesmas populações, e até mesmo nos mesmos indivíduos. É possível que indivíduos apresentem sobrepeso/obesidade e ainda deficiências significativas de nutrientes importantes. Citando como exemplo, a população da Índia apresenta proporções alarmantes de pessoas que sofrem tanto por condições de sobrepeso/obesidade assim como por fome e desnutrição (DOAK et al., 2005; STEIN et al., 2005).

## **1. PROPOSTA DO ESTUDO**

Considerando a urgência mundial relacionada à segurança alimentar, este estudo tem como proposta apresentar investigações científicas complementares que tenham potencial de auxiliar no alívio da gravidade de insegurança alimentar. Pelo fato de esta tese ser composta por cinco estudos complementares, cada um apresenta objetivos mais pontuais. No entanto, é possível fragmentar a proposta central desta tese em quatro eixos. O primeiro eixo busca posicionar o agronegócio brasileiro frente à urgência de segurança alimentar em nível mundial, com atenção especial para o continente Africano. O segundo eixo busca analisar os principais padrões mundiais de suprimento alimentar, relacionando tais padrões alimentares com os indicadores de insegurança alimentar das nações mundiais. O terceiro eixo busca confrontar as situações de desnutrição e sobrepeso das populações mundiais identificando as tendências de cada uma das principais regiões do mundo em termos de desnutrição e

sobrepeso infantil. Por fim, o quarto eixo busca analisar a problemática da obesogenia mundial analisando os *drivers* econômicos, sociais e comportamentais de tal pandemia.

Considerando as investigações específicas realizadas, seus objetivos visam apresentar evidências complementares que auxiliem a promoção da segurança alimentar em nível mundial. Para isso, o primeiro artigo, intitulado “*Brazilian dry-beans and food security in developing countries*” objetivou investigar as exportações de feijão brasileiro, observando as condições de segurança alimentar de seus compradores. Considerando o Brasil como um produtor de alimentos com destaque global e a urgência por melhoramento da situação de segurança alimentar em alguns países em desenvolvimento, este estudo procura evidenciar a importância do feijão brasileiro como um “*staple food*” com potencial para aliviar a insegurança alimentar mundial.

O segundo artigo, intitulado “*Brazilian agribusiness facing African food insecurity*” busca discutir os perfis agrícolas das principais regiões da África, bem como a parceria estabelecida entre a África e o Brasil com intuito de fomentar a inovação na agricultura e o desenvolvimento econômico. Tal estudo se justifica pelo fato de a agricultura brasileira ter alcançado altos níveis de produção nos últimos anos. Em contrapartida, a produção agrícola na África ainda é baixa, mas mostra grande potencial para desenvolvimento. A originalidade deste artigo está no uso de evidências empíricas de projetos ativos resultantes da parceria estabelecida entre o Brasil e a África, bem como a sua discussão sobre o possível desalinhamento entre esses projetos e as necessidades urgentes relacionadas à segurança alimentar na África.

O terceiro artigo, intitulado “*Food insecurity worldwide derived from food supply patterns*” tem como objetivo identificar e analisar os principais padrões de abastecimento alimentar da população mundial, e, em seguida, relacioná-los com as respectivas condições de desnutrição de suas localidades. A hipótese é que existem padrões de suprimento específicos, geograficamente identificáveis, que estão associados com o desalinhamento nutricional de certas populações em maior grau do que outras. A humanidade está enfrentando desequilíbrios nutricionais graves, que são dependentes de acesso aos alimentos e dos hábitos alimentares de populações específicas, logo este estudo procura contribuir com um melhor entendimento da relação entre os padrões de suprimento e os indicadores de insegurança alimentar das populações mundiais.

O quarto artigo, intitulado “*Facing co-occurrence of underweight and overweight populations worldwide*” investiga a situação e a tendência de insegurança alimentar em todo o mundo considerando suas principais regiões geográficas. Para tanto, a proposta deste estudo

ecológico foi realizar uma análise global da desnutrição, baixo peso e sobrepeso. O valor original deste artigo está sedimentado no confronto analítico da co-ocorrência de sobrepeso e baixo peso infantil como situações problemáticas oriundas de uma alimentação inadequada.

Por fim, o quinto artigo, intitulado “*Behavioral and societal drivers of an obesogenic environment worldwide*” teve como objetivo analisar o impacto de fatores sócio-econômicos e comportamentais sobre a situação obesogênica em todo o mundo. O valor original neste estudo está no fato de que as economias em desenvolvimento podem enfrentar problemas obesogênicos graves no futuro, dado o seu acesso limitado a alimentos saudáveis e crescente urbanização. Assim, a ingestão nutricional não deve ser vista como o principal antecedente do ambiente obesogênico.

## 2. PROCEDIMENTOS METODOLÓGICOS

Pelo fato de esta tese ser composta por cinco estudos independentes que convergem para temática da segurança alimentar mundial, cada estudo apresenta algumas especificidades quanto ao método. No entanto, cabe ressaltar que os cinco estudos seguiram procedimentos metodológicos semelhantes. Todos os estudos se baseiam em dados disponibilizados por entidades e órgão oficiais. O primeiro artigo (*Brazilian dry-beans and food security in developing countries*) é baseado em dados oficiais obtidos no Instituto Brasileiro de Geografia e Estatística (IBGE, 2013), na *Food and Agriculture Organization* (FAO, 2013), na *World Health Organization* (WHO, 2013) e na *United Nation Statistic Division* (UNSD, 2013). Esse estudo apresenta estatísticas descritivas relacionadas à produção e comércio do feijão brasileiro. Os valores das compras totais de feijão (no período estipulado), os coeficientes de variação (métrica para avaliar a continuidade do relacionamento comercial estabelecido entre o Brasil e seus compradores de feijão), o percentual de crianças desnutridas e a porcentagem da população desnutrida dos 25 principais importadores de feijão do Brasil foram usados para construir três mapas de dispersão. Para cada mapa também foram calculados os coeficientes de correlação de Pearson e de Spearman. O estudo também calcula as equações de regressão linear e os seus respectivos coeficientes de determinação ( $R^2$ ).

O segundo artigo (*Brazilian agribusiness facing African food insecurity*) baseia-se em análises descritivas de dados relacionados às atividades agrícolas e projetos de parcerias estabelecidas entre o Brasil e a África. Esta iniciativa é chamada de “*Africa-Brazil Agricultural Innovation Marketplace*” e destina-se principalmente a beneficiar pequenos produtores por meio de inovação no desenvolvimento da agricultura no continente Africano.

São apresentados dados evolutivos acerca do desenvolvimento agrícola (áreas de colheita, rendimento da colheita, consumo de fertilizantes, e investimento de capital na agricultura) das principais regiões da África e compara a urgência da melhoria da agricultura e os níveis de concentração de projetos em parceria com o Brasil.

O terceiro artigo (*Food insecurity worldwide derived from food supply patterns*) é baseado na análise de dados de 173 países obtidos na FAO (2013) relativas ao suprimento dos principais grupos de alimentos em tais nações. Os dados referentes ao desalinhamento nutricional global (por exemplo, população desnutrida, com baixo peso e sobrepeso) foram obtidos na Divisão de Estatística das Nações Unidas (UNSD, 2013) e da Organização Mundial da Saúde (WHO, 2013). Quatorze grupos de alimentos foram selecionados, tendo em vista a disponibilidade de dados e a quantidade suprida em nível mundial. Posteriormente, foi empregada a análise de cluster com o propósito de agrupar as nações com suprimentos alimentares semelhantes. Assim, foram definidos os principais padrões de suprimento alimentar. Os *clusters* obtidos foram analisados por meio da estatística descritiva (suprimento médio de cada grupo de alimento e coeficiente de variação de Pearson obtido para os *clusters* e para cada uma das nações). Foram ainda avaliados os níveis de correlação entre o balanceamento de cada *cluster* (CV de suprimentos dos grupos de alimentos) e as respectivas situações de desalinhamento nutricional em cada país.

O quarto artigo (*Facing co-occurrence of underweight and overweight populations worldwide*) analisa indicadores mundiais relacionados com a desnutrição, baixo peso e sobrepeso das populações. Os dados para esses indicadores foram obtidos a partir da Organização Mundial de Saúde (WHO, 2013) e os Indicadores de Desenvolvimento do Milênio das Nações Unidas (UNSD, 2013). Os dados foram analisados por meio de gráficos de dispersão, correlação de Pearson e gráficos de séries temporais. Também foram calculadas as tendências lineares (coeficiente angular  $[\alpha]$ ) para medir o comportamento evolutivo dos indicadores de baixo peso e sobrepeso infantil nas nações e regiões mundiais.

O quinto artigo (*Behavioral and societal drivers of an obesogenic environment worldwide*) também é baseado em dados fornecidos por instituições oficiais, como a Organização de Alimentação e Agricultura das Nações Unidas (FAO, 2013), a Organização Mundial de Saúde (WHO, 2013), a Divisão de Estatísticas das Nações Unidas (UNSD, 2013), o Banco Mundial (WORLD BANK, 2013) e Programa de Desenvolvimento das Nações Unidas (UNDP, 2013). Esse estudo está focado na avaliação de um modelo dividido em duas fases. A primeira etapa analisa o impacto dos níveis de urbanização e motorização insuficiência de atividade física das populações em todo o mundo. A segunda etapa avalia o

impacto da ingestão alimentar, da insuficiência de atividade física, do nível educacional e do desenvolvimento econômico sobre a situação obesogênica dos países do mundo. A amostra investigada totalizou 99 países para a primeira parte e 92 para a segunda parte do modelo. A avaliação dos construtos (aspectos comportamentais e sociais) foi realizada por análise de análise fatorial (HAIR et al., 1998). A avaliação do modelo de referência foi realizada através de análise de regressão linear múltipla.

### **3. MOTIVAÇÃO E JUSTIFICATIVA**

Os estudos que compõem esta tese de doutorado foram motivados pela urgência mundial por segurança alimentar. Partimos do argumento de que a segurança alimentar para as populações de todo o mundo é uma necessidade primária que deveria ser garantida a qualquer custo. Consideramos que uma alimentação saudável e suficiente para garantir um estilo de vida saudável e ativo é um direito universal do ser humano. Logo, garantir condições de segurança alimentar para todos os indivíduos em nível global deveria ser a prioridade número 1 de governos e políticas públicas.

Considerando que as atividades relacionadas à produção, distribuição e transação de alimentos são elementos centrais do agronegócio mundial, toda e qualquer motivação que objetive promover a segurança alimentar em termos de disponibilidade, acesso e uso de alimentos saudáveis e suficientes está relacionada com temáticas do agronegócio. Além disso, considerando que o Brasil é um dos grandes produtores de alimentos em nível mundial, suas atividades agropecuárias tem uma projeção altamente significativa para a promoção da segurança alimentar mundial.

Este estudo se justifica por apresentar contribuições importantes tanto para o meio científico quanto prático. Em termos acadêmico-científicos, os resultados oriundos de cada uma das investigações específicas proporcionam um melhor entendimento a respeito dos padrões de suprimento alimentar mais proeminentes em nível mundial e sua associação com realidades de insegurança alimentar, tanto para a desnutrição quanto para o sobrepeso e obesidade. Além disso, a compreensão da co-existência de desnutrição, baixo peso e sobre peso nas mesmas populações mundiais fornece evidências importantes para consolidar os indicadores antropométricos a serem utilizados para avaliar a gravidade de insegurança alimentar em populações. Ao considerarmos que o avanço científico clássico se dá por meio de construções teóricas e análise de tais construções por meio de evidências empíricas, este estudo contribui principalmente no sentido de buscar evidências que corroborem ou refutem

as hipóteses sugeridas neste trabalho. Logicamente este estudo não objetiva encerrar o assunto, mas contribuir com evidências que poderão gerar *insights* para futuros estudos no sentido de dar continuidade à construção do conhecimento relacionado à segurança alimentar.

Com relação às implicações práticas, este estudo busca contribuir com evidências válidas que possam vir a auxiliar na compreensão e, conseqüentemente, no combate à insegurança alimentar mundial, considerando o ambiente obesogênico e a fome e desnutrição. Por meio das evidências a serem apresentadas referentes às relações entre consumo alimentar, segurança alimentar e ambiente obesogênico, este estudo poderá servir como aporte para a elaboração de ações públicas e privadas no sentido de combater a gravidade obesogênica e de segurança alimentar de acordo com as necessidades específicas de cada população. Algumas implicações práticas são no sentido de fornecer um diagnóstico mundial a respeito das relações entre suprimento/consumo alimentar, desnutrição, obesogenia e segurança alimentar. Além disso, o diagnóstico sugere também possíveis relações causais que poderão proporcionar condições para um processo decisório público e privado mais adequado. No entanto, tais relações sugeridas deverão invariavelmente ser testadas por meio de investigações longitudinais mais robustas.

## CAPÍTULO 1:

### BRAZILIAN DRY-BEANS AND FOOD SECURITY IN DEVELOPING COUNTRIES<sup>1</sup>

#### ABSTRACT

**Purpose** – Considering Brazil as a food producer with global prominence and the urgency for food security in some developing countries, this study proposes to investigate the exports of Brazilian dry-beans against food security of its buyers.

**Design/methodology/approach** – The investigation was conducted through analysis of data from official databases as FAO and WHO. This study elaborated dispersion maps crossing characteristics of the international buyers of Brazilian dry-beans considering their food security situations.

**Findings** – Brazil has a high domestic consumption of dry-beans, and exports are seen as a secondary activity. However, its production is superior to their domestic needs. Exports of Brazilian dry-beans are generally volatile and unstable. Evidence suggests that countries with serious problems of child and population's malnutrition (e.g. India and Angola) buy more Brazilian dry-beans. However, their domestic consumptions are still low.

**Research limitations/implications** – This research based only on exports of dry-bean is faced as a significant limitation. Future studies adding other staple foods commonly consumed by economically disadvantaged populations may contribute to the investigation of the role of Brazil against the need for food security in developing countries and emerging economies.

**Managerial or Policy implications** – Practical implications underscore the need for better targeting of dry-bean farmers in Brazil focusing on the foreign market.

**Social implications** – Social implications are focused in the pursuit of malnutrition decrease in the populations of developing countries through the consumption of nutritionally rich and economically viable food, such as dry-beans.

**Originality/value** – The original value is based on the analysis of Brazilian dry-beans production and trades and its potential to contribute to nutritional safety and food security in developing countries.

**KEYWORDS:** Child welfare, Hunger, Poverty, International trade, Nutritional Properties, Millennium Goals; Proteins.

---

<sup>1</sup> This paper has been published at Journal of Agribusiness in Developing and Emerging Economies (ISSN: 2044-0839), Vol. 04, Issue 02, 2014. (ANNEX 1, pp. 155). DOI: 10.1108/JADEE-06-2012-0015.

## 1. INTRODUCTION

In 2000 the United Nations (UN) has set eight major goals considered most urgent problems related to mankind. The proposal is that these goals have to be achieved by the year 2015. The first goal, also regarded as the most urgent, is to halve by 2015 the proportion of people living on less than a dollar a day and the proportion of people who suffer from hunger (United Nations, 2000). With the marked growth of world population, the search for food security is a constant topic of academic debate, especially regarding developing countries (Godfray *et al.*, 2010). Initiatives focused on reduction of nutritional deficiencies, providing food security to populations, is a subject of scientific interest in Brazil (Santos and Santos, 2007; Burlandy, 2009). While Brazil already provide satisfactory results when these goals, some developing countries still have grave situations of food insecurity and poverty. Considering Brazil's position as a greater producer of food for the rest of the world, Brazil could play an important role based in reducing malnutrition and food insecurity of mankind.

Brazil has a prominent position in the production and exports of various classes of foods. Among the crops that Brazil is leader in terms of production there are mate, sugar cane, orange, cashew and green coffee. Brazil also took second position in world production of papayas, manufactured tobacco, dry-beans, soybeans and pineapple. Regarding to exports, Brazil is the world's largest exporter of centrifugal raw sugar, chicken meat, coffee and orange juice, as well as the second largest exporter of soybeans and soybean cake (Food and Agriculture Organization, 2012).

This research is primarily focused on the levels of Brazilian dry-bean's production and domestic consumption. Secondly, this study aims to investigate relational trades of Brazilian dry-beans. Finally, the study is directed toward the investigation of export of Brazilian dry-beans considering nutritional safety and food security of its international buyers. The focus of this research on the production and trade of dry-beans is due to the nutritional characteristics of this staple food. Thus, this study's main objective is to identify the relationship between the levels of imports of Brazilian dry-beans and food security needs of the purchasing countries. Because it is a topic that addresses a commodity in which Brazil has a standout in terms of production, consumption and possible role on the international market, this issue becomes interesting from the academic, practical, social and political standpoints.

This research presents a scientific contribution considering the prominence Brazilian position as a great producer of dry-beans as well as due to the nutritional characteristics of this food that has significant potential to contribute to global needs for food security. In



addition, some important peculiarities concerning international trades that Brazil maintains with other countries regarding dry-beans are interesting and deserve further investigation. The study aims to contribute with a strategic and practical understanding of Brazilian dry-bean's production, consumption and exports given the Brazilian's potential to meet the global needs for food with highly nutritional properties, especially for low-income populations.

Next we present a brief review about hunger and food security worldwide. In the next section we present some issues about the nutritional nature of dry-beans as well as the potential health benefits arising from their consumption. It is also analyzed Brazilian productivity of dry-beans and its comparative position against other global prominent producers. Thus, evidences are presented of the Brazilian domestic consumption per capita of dry-bean. The third section presents the methodological procedures, detailing the sources of the data, the procedures adopted to tabulate and organize the database and the techniques and statistical procedures applied to the data analysis. The fourth section presents the results of the study with greater focus being given to the analysis of international relations between Brazil and its importers and exporters of dry-beans. It is also presented the results of the cross analysis of importers of Brazilian dry-beans facing their nutritional deficiencies and needs for food safety. Finally, the fifth section presents the conclusions and limitations of the study. It is also present some suggestions for future studies following the same line of this research.

## **2. HUNGER AND FOOD SECURITY**

Food security is defined as the acquire condition of sufficient amounts of food and nutrients (Sen, 1981). So, food security is related to the human condition where individuals should be able to acquire and ingest adequate amounts of nutrient without harming their health. Many developing countries are still facing serious problems of hunger and malnutrition. Indeed, one of the main goals of the millennium is the eradication of extreme poverty and hunger by 2015 (United Nations, 2013). Thus, considering the strong growth of the world population, food security is an urgent subject of extensive academic debate, especially regarding to developing economies (Godfray et al., 2010). Furthermore, both public and private organizations play a key role in combating hunger and malnutrition worldwide through initiatives that can attenuate this scenario in developing countries, providing global food security.

It is well known that the performance in combating global hunger needs urgent attention and better delineated actions aiming to fight this severe reality (FAO, 2010a). Some

countries have already reached the target set in the first millennium goal or have a sufficiently and satisfactory progress to reach this goal on time. However, some countries present insufficient performance in their fight against hunger and malnutrition. Countries with urgent problems regarding their performance in fighting hunger and malnutrition are mostly African and Asian countries (e.g. India, Pakistan, the Democratic Republic of Congo and Somalia). These countries showed no progress in combating hunger or have an increased number of hungry and malnourished people (FAO, 2010b). Despite the efforts of humanity to fight hunger and malnutrition, in 2010-2012 about 868 million people (12% of world population) were in a state of malnutrition (FAO, 2012). Indeed, about 65% of the world's population that suffers from hunger lives in just seven countries - India, China, Democratic Republic of Congo, Bangladesh, Indonesia, Pakistan and Ethiopia (FAO, 2010a). Also, Asian countries like India, Pakistan and Mongolia have large portions of their population undernourished (between 20% and 34%). A comparative analysis between the world hunger map (WFP, 2011) and the progress fighting hunger map (FAO, 2010b) shows that African and Asian countries are those with the worst conditions in terms of food security as well as the worst progress towards achieving the millennium goal related to eradicate hunger. Therefore, these evidences indicate that efforts to alleviate hunger need to be concentrated in specific regions.

Considering population's characteristics related to higher severity in food insecurity, evidence indicates that women and children are the most affected people. Women account for over 60% of the world's hungry population (ECOSOC, 2007). Considering the child population, malnutrition contributes to the deaths of 5 million children a year (aged under 5 years) in developing countries (UNICEF, 2006a). Approximately 146 million children living in developing countries are underweight (UNICEF, 2007) and more than 70% of the world's children aged under 5 years and underweight are in just 10 countries, with more than 50 % of them are concentrated in South Asia (UNICEF, 2006b).

Related to nutrients intake, iron deficiency is the most severe malnutrition worldwide, affecting approximately 2 billion people. Furthermore, malnutrition related to protein, iron and vitamin A low-intake, is considered one of the main problems of child health. Thus, the nutritional status exerts a highly significant influence on the risk of morbidity, mortality and child growth and development (Ribas, Philippi, Tanaka and Zorzatto, 1999). Also, studies suggest that severe malnutrition levels can compromise significantly cognitive capabilities of individuals in an irreversible way through alteration of the central nervous system (Dobbing, 1972). It is also necessary to consider that malnutrition is strongly related to child mortality, propensity for diseases (e.g. anemia and infections) and significantly affect the child growth

(Assis and Barreto, 2000; Ribas, Philippi, Tanaka and Zorzatto, 1999). Indeed, malnourished children are especially vulnerable and fight disease and can die from common infections, such as measles and diarrhea (Caulfield et al, 2004). Furthermore, this malnutrition is strongly associated to low intake of protein and iron.

Despite the advances of globalization, which facilitates transactions food worldwide aiding access to food from countries with insufficient food production, food security in many developing countries depends strongly on its local production (Funk and Brown, 2009). Evidences indicate that significant portion of households in developing countries are involved in agricultural activities and their productions are consumed locally (Lamb, 2000). It is considered, therefore, that local production of small farms in developing countries plays a key role in combating food insecurity worldwide, particularly in poorer regions like sub-Saharan region (Devereux and Maxwell, 2001). Increased local production in poorer regions with serious problems of food security can alleviate hunger worldwide (Schmidhuber and Tubiello, 2007). We also need to consider the logistic infrastructures of these poorer regions. The access to staple foods rich in nutrients that might alleviate hunger worldwide is strongly dependent of the logistic. However, based on the evaluation of the LPI (Logistic Performance Index) calculated by the World Bank, evidences suggest that countries with severe problems of food insecurity present deficient logistic performance (WFP, 2011; World Bank, 2013).

### **3. DRY-BEANS: NUTRITIONAL VALUE, PRODUCTION AND CONSUMPTION IN BRAZIL**

The common bean is considered a protein source for a great part of the worldwide population, especially for populations of countries where animal protein consumption is limited for economic, religious (e.g. India) and cultural reasons (Antunes *et al.*, 1995). There are just a few kinds of food that are able to provide a varied nutritional profile as the common beans. Considered a food highly rich in protein, fiber, vitamins and minerals, some studies suggests that consumption of beans can be associated with cardiovascular disease prevention (Kushi *et al.*, 1997; Anderson and Gustafson, 1988; Anderson *et al.*, 1999; Bazzano *et al.*, 2001), colon cancer, breast cancer, other cancers and diabetes (Mathers, 2002).

Some phenolic and antioxidant elements, which are related to a lower risk of developing some cancers and degenerative diseases, are found among the main components of dry-beans (Machado *et al.*, 2008). The nutritional composition of this common food makes this ideal to meet some nutritional recommendations like the increasing consumption of

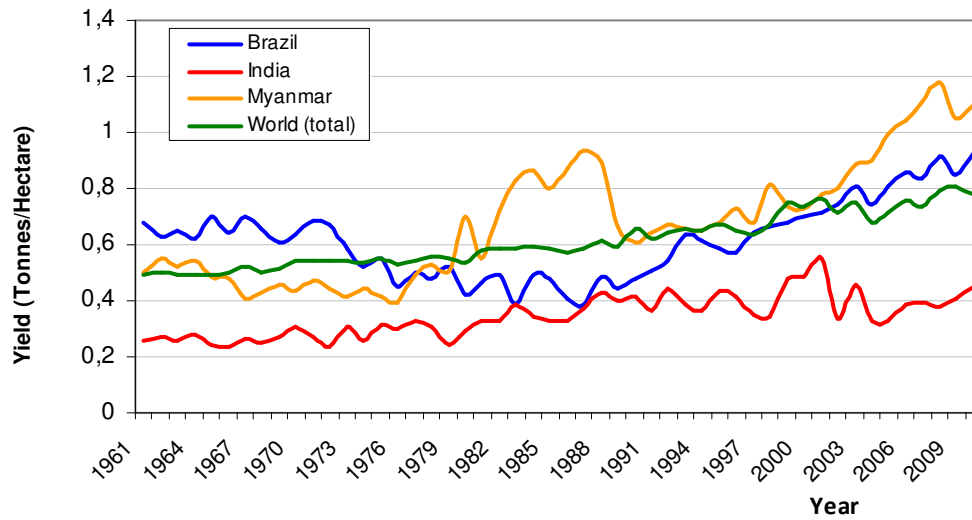
starches and complex carbohydrates and the reduced fat ingestion, indicated for the maintenance of a good health. Beans are highly rich in complex carbohydrates, fiber, vitamins and minerals, have low levels of fat and sodium, and do not have cholesterol in its natural composition (Geil and Anderson, 1994). However, a standing point constantly discussed and faced as a limitation related to the nutritional composition of beans is the presence of protein with lower digestibility and reduced concentration of sulfur amino acids (Bodwell *et al.*, 1980). Another point that deserves attention is the storage conditions necessary to beans, since the stored grain tends to lose sensory quality besides the fact that it needs more time to be cooked, becoming less suited to the needs of consumers (Jones and Boulter, 1983; Garcia and Lajolo, 1994).

In the Brazilian daily diet, beans are great source of protein, complemented by the consumption of meat and rice. These three foods are responsible for 70% of the protein consumed by Brazilians. Besides, beans are a staple food linked to cultural and socio-economic factor of Brazil (Machado *et al.*, 2008). Bean has a great share in the Brazilian nutritional model due to its lower cost compared to alternatives sources of protein like meat (Mesquita *et al.*, 2006).

Brazil is the second major producer of beans in the world, only behind India. In 2010, the Brazilian bean production totalized about 3.2 million tons (Food and Agriculture Organization, 2012). Most part of the Brazilian bean is produced by small producers with limited use of inputs, obtaining low production yields. In Bahia State, the main production regions are located in semi-arid zones (Seagri, 2012). The beans produced in Brazil are strongly intended for feeding people. However, the grain can also serve as an important component in the production of animal feed and used for sowing new crops. Also, a remaining portion of the crop can be incorporated into the soil to improve its physical properties. Considering the use of beans for animal feed, evidence suggests that in comparison with soybeans, beans have lower performance in nutrition and animal productivity (Magalhães *et al.*, 2008).

Given continuity to the analysis of the countries featured in the production of beans, India has a leading position in the production of dry-beans, with about 4.9 million tons. The third position belongs to Myanmar with about 3 million tons. In terms of share in world production, Brazil produces 13.78% of dry-beans, which gives it a position of great prominence (Food and Agriculture Organization, 2012). Figure 1 shows the annual evolution of the production yield of dry-beans per hectare of the three largest producers (Brazil, India and Myanmar) and the average yield of the world.

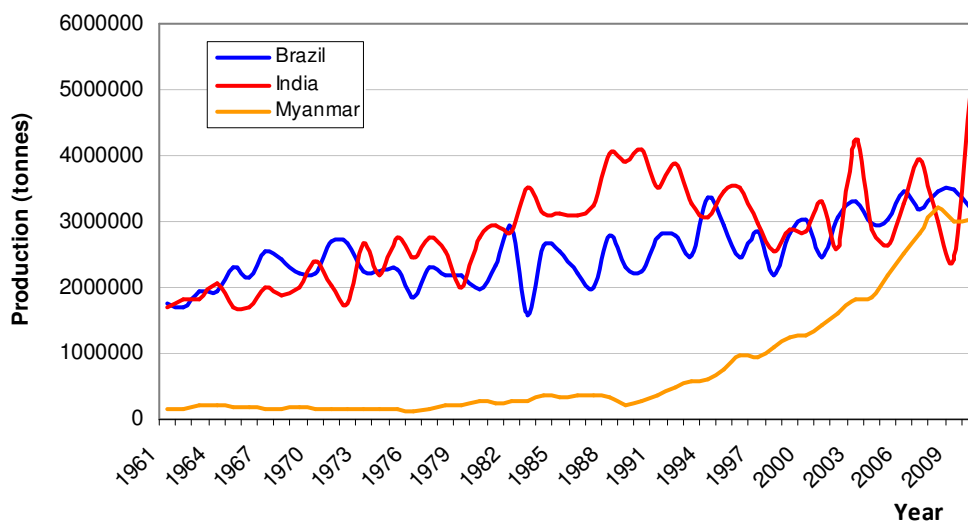
Figure 1 – Yield (tonnes/hectare) of dry-beans in Brazil, India, Myanmar and World (1961-2010).



Source: Food and Agriculture Organization (2012).

This study presents evidences that the productive yield evolution of dry-beans in Brazil (tonnes/hectare) is ascending, surpassing the yield of India and the world average. However, Myanmar has higher yields which can be possibly achieved due to several factors like technology, climate, water resources etc. Yield of dry-beans in India can be considered as stationary. Another evaluations performed in this study is the comparison of total production of dry-beans in Brazil, Indi and Myanmar (figure 2).

Figure 2 –Total production of dry-beans in Brazil, India and Myanmar (1961-2010).



Source: Food and Agriculture Organization (2012).

Although Brazil holds the second position of dry-beans production in the world, India shows a larger production level.. Thus, considering the volatility, Brazilian production of dry-beans is less volatile when comparing to Indian production of such commodity, as evidenced in Figure 2. On the other hand, Myanmar has shown steady growth since 1991 and had a slight drop in 2009. However, if Myanmar continues to maintain its growth rates of previous production in the coming years, this country could take the world leadership of dry-beans production.

Also, evidences suggest that there are just a few regions of Brazil that are dedicated to dry-bean crops. Only some restricted areas with high concentration of dry-beans crops are observed in the states of Bahia, Paraná and Minas Gerais (Brazilian Institute of Geography and Statistics, 2010). This reality is explained by the fact that beans crops are strongly dependent of specific temperature and rainfall conditions. These climatic factors strongly influence the production of beans. High temperatures affect the flowering and fruiting of bean, while low temperatures can cause the loss of flowers. Thus, high temperature associated to low relative humidity and strong winds can influence the retention of pods (Ministry of Agriculture, Livestock and Food Supply, 2013). So, the southern and northern Brazil does not have suitable conditions for growing beans. Additionally, farms dedicated to the cultivation of dry-beans are essentially small properties. Almost 93% of these properties have up to 5 hectares and 77% have up to 2 hectares (Brazilian Institute of Geography and Statistics, 2006). Despite this small amount of area dedicated to the cultivation of dry-beans, Brazil holds the second position worldwide in the production of this staple food. An interesting point that can be made is that bean production is more heavily concentrated in Paraná state (south region), which belongs to the region with the lowest per capita beans consumption. This evidence can be observed in Table 1.

Table 1 - Per head acquisition of beans (Kilograms) in Brazil and its regions in 2002 and 2008.

	<b>2002</b>	<b>2008</b>	<b>Variation (kg)</b>	<b>Variation (%)</b>
BRAZIL	12.39	9.12	-3.27	-26.39%
North	10.13	10.1	-0.03	-0.30%
Northeast	17.28	12.3	-4.98	-28.82%
Southeast	11.05	7.96	-3.09	-27.96%
South	9.27	6.15	-3.12	-33.66%
Midwest	10.15	8.41	-1.74	-17.14%

Source: Brazilian Institute of Geography and Statistics (2002; 2008)

Evidences suggest that per capita consumption of beans in Brazil showed a decrease in recent years. In 2002, Brazil consumed an average of 12.39 kilograms/per capita of beans. In

2008, the consumption of beans decreases to 9.12 kilograms/per capita. This represented a reduction of 26.29% in per capita consumption of beans in six years. The Brazilian region that has a higher per capita consumption of beans is the Northeastern. On the other hand, southern region has the lowest per capita consumption of beans (Brazilian Institute of Geography and Statistics, 2002; 2008). A first reasonable explanation for this reduction of beans consumption is the growing level of urbanization. The dynamism of an urban lifestyle implies in a reduction of the consumption of some food items that require too much time for their preparation, such as beans (Brazilian Enterprise of Agricultural Research, 2002). Furthermore, an improvement in economic conditions of population can result in a transition of nutritional behavior. Regarding to food acquisition, evidences suggest that the acquisition of cereals, some vegetables and beans by Brazilian population are decreasing. On the other hand, the acquisition of fruits, meats and processed food are increasing (Brazilian Institute of Geography and Statistics, 2002; 2008). This suggests a transition in Brazilian nutritional model.

In order to complement this analysis, evidences show that in 2010 the per capita production of beans in Brazil was 16.43 kilograms, and in 2002 was 17.09 kilograms (Food and Agriculture Organization, 2012). Based on this evidence, it is reasonable to argue that the quantity of beans produced in Brazil is sufficient to meet the domestic demand and still generate a surplus. However, Brazil is a country that imports more than exports beans. So, why Brazil imports a greater amount of beans, given that produces a sufficient amount to meet their demands? It is reasonable to assume that the levels of waste beans are high, which increases the need for imported beans (see figure 3 ahead). Also, a reasonable explanation for the amount of beans imported is the discontinuity of Brazilian production given climatic issues and specific conditions of small rural properties. The volatility of beans production in Brazil (figure 2) helps to explain its import need. However, this is an important issue that deserves additional empirical research to better understand these international trade relations. This study is not engaged on these specific analyses and we consider these questions as suggestions for future studies.

#### **4. METHODOLOGICAL PROCEDURES**

This study is based on analysis of data obtained from official databases. The data for per capita consumption of beans in Brazil presented previously were obtained from the Consumer Expenditure Survey of Brazilian Institute of Geography and Statistics (2002,

2008). Data related to historical production and productive yield of dry-beans in Brazil, India and Myanmar and historical data about import and export volumes of Brazilian dry-beans were obtained in Food and Agriculture Organization (2012). Finally, data about food security (malnourished children and malnourished population) were obtained in World Health Organization (2012) and Millennium Development Goals Indicators of the United Nations (Mdgi, 2012). The data that evaluates child malnutrition is the percentage of children aged between 0 and 59 months whose weight for age is two standard deviations below from median weight for the same age. This reference is commonly called NCHS / WHO which is formulated by the National Center for Health Statistics and is adopted by the WHO. The proportion of population in worse situation of food and nutrition conditions considering the reference energy is taken as the percentage of population undernourished and food deprivation. Individuals malnourished or with food deprivation are those whose food intake is below the minimum level of dietary energy.

Data regarding the volume of Brazilian dry-beans exported to its 25 largest buyers in the period 1995 to 2009, obtained at Food and Agriculture Organization (2012), were analyzed using descriptive statistics. This study calculates the total sales in the period to their respective destination as well as the average annual values. The study also calculated the values of standard deviation and coefficient of variation (ratio between annual average and standard deviation) for the distribution of sales volume in the period. The values of total purchases of beans from the stipulated period, the coefficients of variation, the percentage of malnourished children and the percentage of malnourished population of the 25 major importers of Brazilian dry-beans were used to elaborate 3 maps of dispersion. For each map were also calculated values of the Pearson ( $r_p$ ) and Spearman ( $r_s$ ) coefficients of correlation. The last one is more suitable when working with small samples and with non-normal distribution. Thus, it was calculated the statistical significance values for the correlations ( $p_p$  to Pearson and  $p_s$  to Spearman). The study also estimates the linear regression equations and their coefficients of determination ( $r^2$ ) which were included in the maps of dispersion. The dispersion maps and other calculations procedures were accomplished through the software Statistica 8.0.

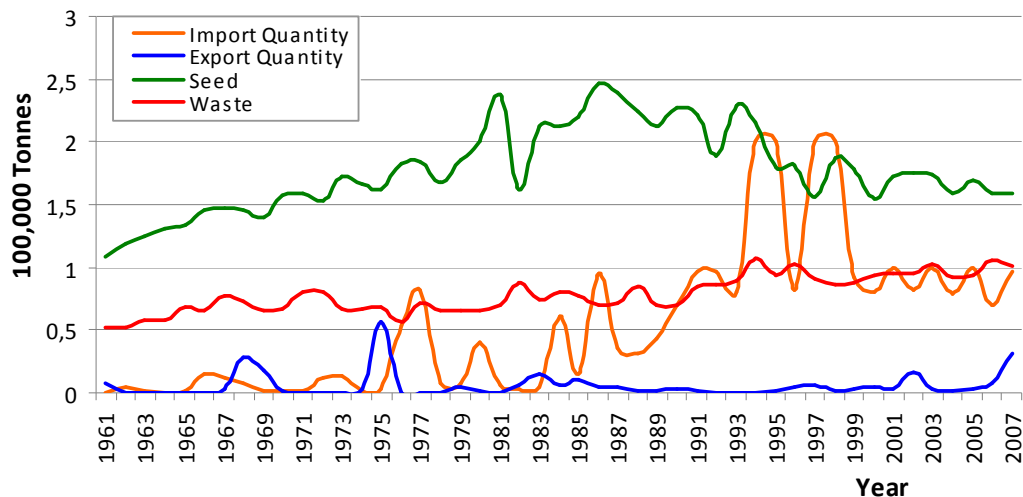
## **5. INTERNATIONAL TRADE OF BRAZILIAN DRY-BEANS**

Although Brazil has a prominent position in world production of dry-beans, its international trade relations are strongly volatile. In addition, imports exceed exports strongly



(figure 3). We can assume that Brazilian dry-beans production is destined to meet the domestic demand (Ministry of Agriculture, Livestock and Food Supply, 2013). Moreover, given the volume of imported dry-beans annually, this evidence suggests that the Brazilian production of beans is not always enough to meet the domestic demand, although the amount produced is superior to the volume consumed per capita. As both exports and imports show a great level of annual volatility, we can assume that trade import and export of Brazilian beans are fragile and dysfunctional. Despite the fact that the amount of beans produced domestically can supply the Brazilian market, the volatility of beans production, possibly due to adverse climate conditions, pests and diseases (Ministry of Agriculture, Livestock and Food Supply, 2013), justifies beans imports.

Figure 3 – Volume imported and exported of dry-beans (tons) by Brazil (1961-2009).



Source: Food and Agriculture Organization (2012).

Brazil was placed in the 16th world position considering its volume of dry-beans exported in 2009, with 33,014 tons. The countries that led the ranking of exportation of dry-beans in 2009 were China (1,046,017 tonnes), Myanmar (863,131 tons) and United States (433,553 tons) (Food and Agriculture Organization, 2012). Referring to Brazilian exports in the period of 23 years (1987 to 2009), South Africa had the highest volume acquired (28,110 tons), but with ascending volume traded from 1996 to 2007. The second place in volume of dry-beans imported from Brazil is India, which totaled a volume of 24,540 tons in the period 1987 to 2009. However, 94.61% of India acquisition from Brazil occurred in 2009. Angola shows a less volatile trade relationship with Brazil, considering its buy of 18,989 tonnes of dry-beans from 1987 until 2009 making purchases in the 22 years period. Although the

acquisitions of Brazilian dry-beans made by Angola shows decrease in volume in recent years, this is the country that has long-lasting imports of Brazilian dry-beans. Evidence suggests that Brazilian exports of dry-beans can be considered fragile and unstable. This may be due to the Brazilian focus on production for domestic consumption, which means that exports are putted in second place.

Regarding Brazilian imports of dry-beans, in 2009, Brazil imported 133,197 tons of beans, of which 43.94% were acquired from Argentina, 28.16% were acquired from Bolivia and other 8.74% came from China. In 2009, Brazil acquired 20.05% of total exports of dry-beans of Argentina and 64.17% of total exports of dry-beans of Bolivia. Considering the volatility and continuity, different of Brazilian exports, imports of dry-beans are more uniform and constant regarding to its sources. Also, evidences show that Brazil maintains lasting business relationships with key suppliers of dry-beans (Argentina and Bolivia).

Considering the great potential of dry-beans to meet international needs for food supply and nutritional deficiencies of poor and developing countries, the study is focused on the investigation of export of Brazilian dry-beans considering the nutritional problems and necessity for food security of the importing countries.

## **6. BRAZILIAN EXPORTS OF DRY-BEANS AND FOOD SECURITY OF IMPORTERS**

Brazil has low levels of export of dry-beans. However, given the importance of this staple food as a possible solution of serious problems of food security in developing countries, some important considerations based on exports of Brazilian dry-beans are made in this study. This study aimed to investigate the relationships of Brazilian exports of dry-beans to their destinations considering the situation of child malnutrition and population malnutrition, the period of analysis of was from 1995 to 2009.

Initially this study analyses the volume (total exports in tonnes) and volatility (coefficient of variation) of trade relations between Brazil and its importers of dry-beans. Total exports provides an opportunity to assess the full participation of importers of Brazilian dry-beans comprising the whole period. The coefficient of variation is adopted to evaluate the volatility of trade relations in terms of quantity exported (tonnes) by Brazil to its respective importers. The greater is the coefficient of variation, greater is the volatility of trade relationship between Brazil and its importers of dry-beans. Considering the food security of importers of Brazilian dry-beans, it was analyzed the percentage of children under 5 years age

under conditions of malnutrition and the percentage of the population undernourished. These four variables are presented in table 2.

Table 2 – Total volume imported, coefficient of variation, percentage of malnourished children and undernourished population of importers of Brazilian dry-beans.

	<b>Total in tones (1995-2009)</b>	<b>CV (standard deviation / average)</b>	<b>Malnourished children under 5 years (%)</b>	<b>Population undernourished (%)</b>
Angola	17806	1.88	15.6 (2007)	41
Canada	582	3.65	1.8 (1972)	< 5
Cape Verde	675	1.67	11.8 (1994)	11
Costa Rica	813	3.87	1.1 (2009)	< 5
Cuba	639	2.28	3.4 (2000)	< 5
Dominican Republic	735	3.87	3.4 (2007)	24
Egypt	8255	2.38	6.8 (2008)	< 5
France	808	1.32	Na	< 5
Germany	559	1.39	1.1 (2006)	< 5
India	24540	3.65	43.5 (2006)	19
Italy	1238	3.19	1.3 (1977)	< 5
Japan	5118	0.60	3.2 (1981)	< 5
Netherlands	4095	1.66	1.6 (1980)	< 5
Pakistan	373	2.83	31.3 (2001)	25
Panama	410	3.87	6.3 (1997)	15
Paraguay	1383	1.45	3.4 (2005)	10
Portugal	2656	2.65	Na	< 5
South Africa	28106	2.20	8.7 (2008)	< 5
Spain	896	2.44	Na	< 5
Turkey	631	3.25	3.5 (2004)	< 5
United Arab Emirates	1803	2.30	Na	< 5
United Kingdom	462	1.31	1.9 (1979)	< 5
Uruguay	2367	0.49	6 (2004)	< 5
USA	4942	1.55	1.3 (2004)	< 5
Venezuela	6163	2.75	3.7 (2007)	7

Note: This study selected the 25 largest importers of Brazilian dry-beans considering the total purchases made between 1995 and 2009. The CV is the Coefficient of Variation standardized. Na = not available data. In parentheses are presented the years of available data.

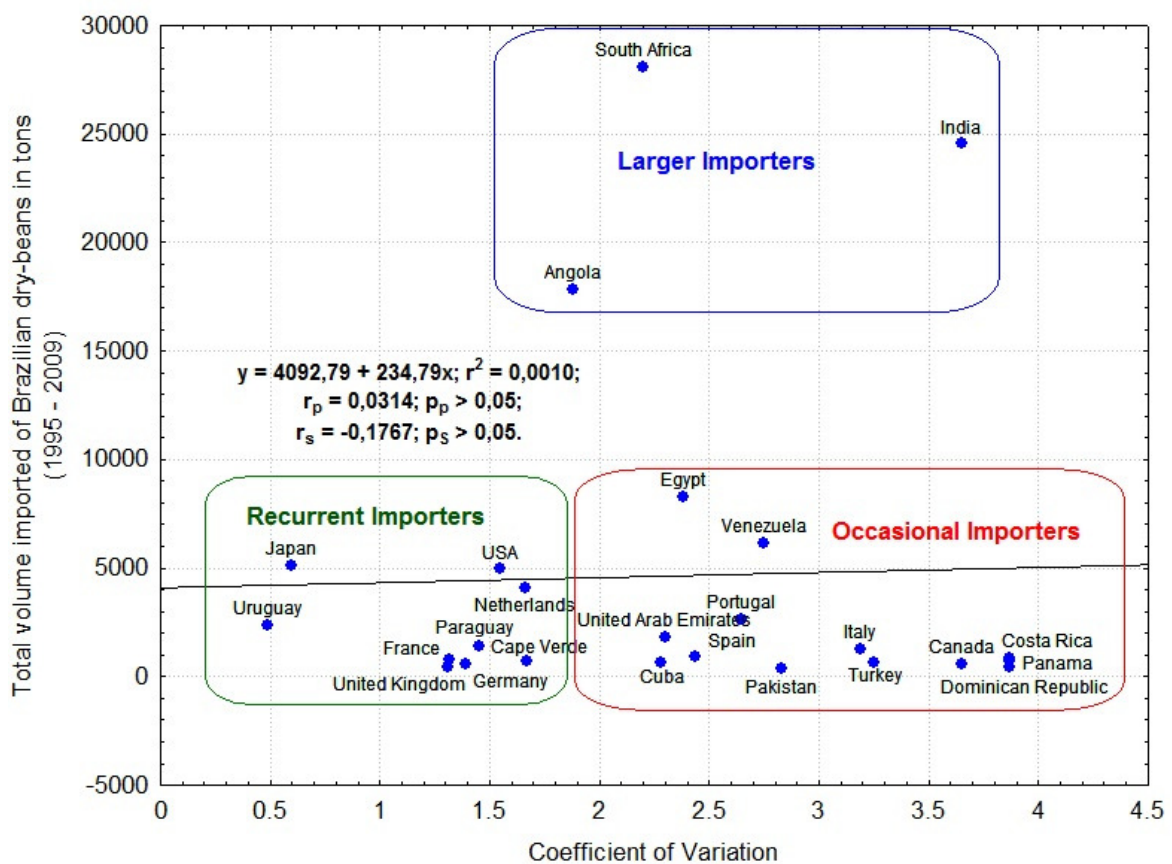
In terms of volume imported during the analyzed period, the most representative countries in the portfolio of Brazilian dry-beans exports are South Africa, India and Angola. However, these countries do not have constant commercial relations with Brazil. The countries with the greatest constancy (lower CV) buying Brazilian dry-beans are Uruguay and Japan, despite the fact that they do not have significant import volumes. The other countries surveyed do not presents significant volumes and constant relationship.

Among the countries that purchase Brazilian dry-beans, this study shows that some have very serious problems of food security (e.g. Angola, India and Pakistan). Also, other countries can be classified under a condition of severe or intermediate food insecurity, such as Cape Verde, Panama, South Africa, Egypt, Dominican Republic, Paraguay and Venezuela.

On the other hand, other countries like Canada, Germany, USA, United Kingdom, Italy and Costa Rica have no troubling situations of food security.

In order to cross the variables related to Brazilian exports of beans (total exports and coefficient of variation) with variables related to food security of importers of Brazilian dry-beans, three dispersion maps were prepared allowing better analysis. The first dispersion map (figure 4) shows the crossing relation between coefficient of variation and the total Brazilian dry-bean purchased by importers.

Figure 4 – Dispersion Map of importers of Brazilian dry-beans considering total volume imported (1995-2009) and Coefficient of Variation



Note: It was included in the map the linear regression equation, the correlation coefficients of Pearson ( $r_p$ ) and Spearman ( $r_s$ ), their respective significance ( $p_p$  and  $p_s$ ) and the coefficient of determination ( $r^2$ ).

In this first analysis, countries buyers of Brazilian dry-beans were classified into three different groups: (1) the greater importers, (2) relational importers, and (3) eventual importers. The first group – greater importers - is formed by South Africa, India and Angola. This group presents a greater volume of purchases made in the period of 1995 to 2009. Considering these three countries, India is the importer who presents greater relationship volatility. Angola, on the other hand, presents a more consistent relationship with Brazil. Thus, evidence shows that Angola and India are countries with very serious problems of food security. This initial

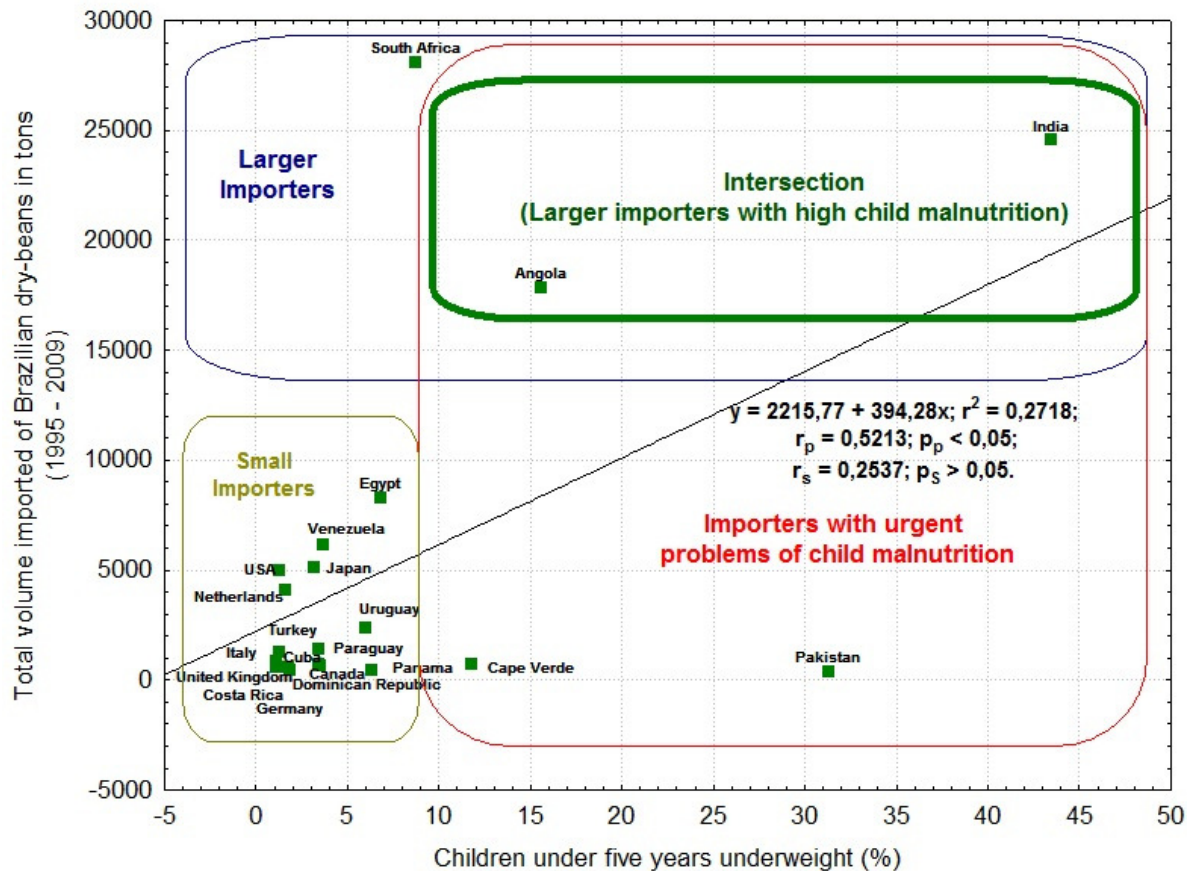
evidence supports the idea that Brazilian dry-beans may play a key role in minimizing serious problems of food security in these countries.

The second group observed in the first map – relational importers - is formed by different countries profiles like developed and developing countries and located in different geographical regions. The evidence shows that these countries have a low volume of purchases of Brazilian dry-beans. However, its trade relations are frequent. Finally, the third group – eventual importers - is also formed by a great diversity of countries buyers of dry-beans. However, this third group is characterized by a low volume of purchases as well as scattered and inconsistent trade relations with Brazil.

In order to evaluate the relationship between the two variables comprised in this first dispersion map, this study calculate the coefficients of correlation (Pearson and Spearman), their statistical significance, the coefficient of determination and the linear regression equation. It is observed that the relationship between the amount of dry-beans imported and the coefficient of variation has no statistical significance ( $p_p > 0.05$  and  $p_s > 0.05$ ). It is also observed a low coefficient of determination, demonstrating that these variables have no statistical relation.

The second dispersion map (figure 5) presents the crossing analysis of the total Brazilian dry-beans imported and the percentage of children under 5 years old in a situation of malnutrition. Thus, this second map provides an overview of the profile of importers of Brazilian dry-beans regarding their food security situation.

Figure 5 – Dispersion Map of importers of Brazilian dry-beans considering total volume imported (1995-2009) and malnourished children



Note: It was included in the map the linear regression equation, the correlation coefficients of Pearson ( $r_p$ ) and Spearman ( $r_s$ ), their respective significance ( $p_p$  and  $p_s$ ) and the coefficient of determination ( $r^2$ ).

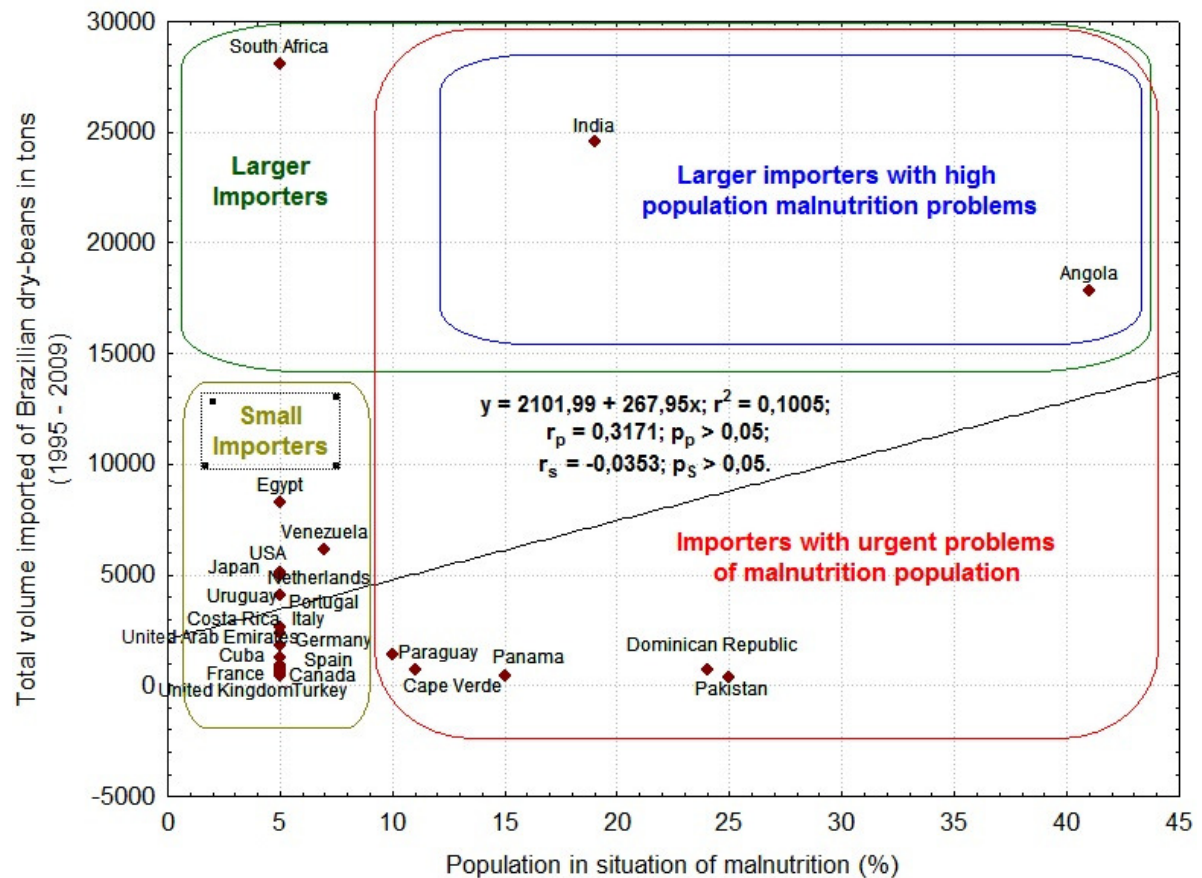
Considering the analysis of the second dispersion map, importers of Brazilian dry-beans were also classified into three distinct groups, with an important intersection between groups 2 and 3. The first group - small importers - is formed by a large proportion of countries that are characterized by low volume of imports of Brazilian dry-beans and a low percentage of malnourished children. Therefore, these countries do not show urgency in acquisition of nutritionally rich and economically cheap food to help their deficiencies in children nutrition. The second group – greater importers – is formed by three countries with a high volume of purchases of Brazilian dry-beans in comparison to the others (South Africa, Angola and India). The third group – importers with urgent problems of child malnutrition – is formed by four countries with alarming levels of child food insecurity (Cape Verde, Pakistan, Angola and India). It was outlined an intersection between the second and third group highlighting Angola and India. These countries stand out for having a high volume of purchases of Brazilian dry-beans as well as high levels of food insecurity and malnutrition. It is possible to consider that the Brazilian dry-beans can act as a staple food with high potential to reduce the

food insecurity situation given its nutritional characteristics and easy access to low-income populations.

The relation between the amount of beans imported and the percentage of malnourished children presents initial evidence of a possible statistical significance given that Pearson correlation was statistically significant ( $p_p < 0.05$ ). However, Spearman correlation does not present statistical significance ( $p_s > 0.05$ ). Thus, despite a strong positive correlation ( $r_p = 0.5213$ ), the sample size and non-normal distribution of data seriously undermines this conclusion. It is possible to suggest that these variables may have statistical relation, but further studies are needed. Results suggests that countries with greater severity of food insecurity and malnutrition buy more Brazilian dry-beans, possibly as a way to improve their food security given the economic conditions of its population.

Finally, the third dispersion map (figure 6) shows the results obtained from the crossing of the total imports of Brazilian dry-beans and the percentage of population under conditions of malnutrition of importer countries. Thus, the third map seeks to complement the evidences observed in the second map.

Figure 6 – Dispersion Map of importers of Brazilian dry-beans considering total volume imported (1995-2009) and population undernourished



Note: It was included in the map the linear regression equation, the correlation coefficients of Pearson ( $r_p$ ) and Spearman ( $r_s$ ), their respective significance ( $p_p$  and  $p_s$ ) and the coefficient of determination ( $r^2$ ).

Finally, the final dispersion map also shows three groups of countries with an important intersection area. The first group - small importers - is formed by a large group of countries with different geographic and economic characteristics which is characterized by low volumes of imports of Brazilian dry-beans and low rates of population malnourished. The second group – great importers – is the same group presented in figure 5. The third group – importers with urgent problems of malnutrition population - consists of seven countries that have serious problems of food security and malnutrition of their populations. The second and third groups also form an important intersection that presents India and Angola as countries characterized by a high volume of purchases of Brazilian dry-beans as well as serious problems of population malnutrition.

The Pearson and Spearman correlation coefficients between volume imported and population undernourished are too weak ( $r_p = 0.3171$  and  $r_s = -0.0353$ ) presenting no statistical significance ( $p_p > 0.05$  and  $p_s > 0.05$ ). So, evidences indicate the absence of significant relation between the volume of dry-beans purchased and the percentage of population



undernourished of importers. Furthermore, the coefficient of determination is low ( $r^2 = 0.1005$ ). However, the absence of detailed data for countries with percentages of malnourished population lower to 5% reduces the reliability of the results showed in this study.

## 7. FINAL DISCUSSIONS

This study aimed to perform an overview about Brazilian dry-beans considering its domestic consumption, international trade relations and the food security situations of importers. This issue is considered highly relevant given the global need for food security, especially in developing continents like Africa and Asia. Moreover, the discussion is focused on the possible role of Brazil, considering its remarkable position as food producer, in attending some demands of staple food with high nutritional value for low-income populations with serious nutritional deficiencies. Dry-beans are then considered a proxy for this evaluation.

Evidences suggest that Brazil maintains volatile trade relations with importers of its dry-beans. It also notes that Brazil, despite being the second largest producer of dry-beans in the world, has low levels of export volumes. Although, Brazilian production has potential to meet its domestic demand and still provide a substantial surplus. Of course, this finding deserves further investigation since there is a large variety of beans as well as alternative uses such as animal feed, planting new crops and soil fertilization.

Considering the food security of importers, evidence suggests that countries that import beans from Brazil have different food security situations. The Brazilian bean is destined for developed countries (e.g. European countries and U.S.) as well as for developing countries (e.g. India, Angola and South Africa). However, it was found that countries that purchase higher volumes of Brazilian dry-beans also have greater severity of food security. Special attention should be given to India and Angola that shows severe situations of child and population malnutrition (FAO, 2010a; WFP, 2011) in comparison with other buyers of Brazilian beans. India, despite being considered the world's largest producer of beans, was the largest buyer of Brazilian beans in 2009. It is further understood that India is a country with a large population with food shortages in terms of protein, since the consumption of animal protein is limited by cultural and religious issues. Beans can be considered as an alternative to animal protein given its high levels protein and other nutritional composes. So, the

consumption of beans can potentially contribute to the improvement in food security conditions in that country, especially regarded to child malnutrition.

Despite the fact that India and Angola, countries with severe problems of food security, import great amount of Brazilian beans, their domestic consumption is still low. Comparing to the domestic consumption of Brazil (approximately 16.3 kg/per capita in 2009), India, the greatest producer of beans, has no significant domestic consumption of this staple food (approximately 2.5 kg/per capita in 2009). On the other hand, Angola shows a moderate level of beans consumption (near to 7.5 kg/per capita in 2009). (FAO, 2012). Regarded to India, its production of dry-beans is almost entirely designated to the domestic consumption (FAO, 2012). This suggests that their domestic production and imports are not sufficient to supply their population needs with this staple food, rich in protein and iron. So, increasing Brazilian production of beans might attenuate Indian needs for this important staple food and their urgency for food security, considering the nutritional value of beans (iron and proteins).

This study has some limitations that deserve attention. Considering the role of Brazil as a possible food supplier to developing countries with serious food security problems, the fact of this research being based solely on exports of dry-beans is configured as a significant limitation. However, the purpose of this investigation was to use dry-beans as a proxy to investigate the Brazilian trade relations with developing countries, especially those with low food security. Clearly, future studies that add evidence related to other foods commonly consumed by economically disadvantaged populations may contribute to this investigation.

The practical implications suggest the need for better targeting of Brazilian bean producers with a sharp focus on foreign markets in order that the rural productive units of beans are mostly micro and small farms. It was identified some programs and initiatives focused on the Brazilian production of beans. One valid example is the South-Central Project of Beans and Maize, developed by EMATER from Paraná state (Treasure Secretary of Paraná, 2012), that is focused on growing production of beans and maize. Also, some initiatives of the Pesagro-Rio, an enterprise associated to the Rio de Janeiro state government, are focused on growing beans production and imports reduction (Official Press of Rio de Janeiro State, 2012). However, we consider that additional government incentives are necessary to promote the targeting of small farms to the foreign market, not only focusing on growing production and yield. A sharp focus on international trade might be necessary. Social implications are focused on the search for a significant reduction of populations' malnutrition in developing countries through the consumption of nutritionally rich and economically

viable, such as beans. This implication is consistent with the first millennium goal that aims to drastically reduce hunger and poverty.

## 8. REFERENCES

Anderson, J. W. and Gustafson, N. J. (1988), “Hypocholesterolemic effects of oat and bean products”, *The American Journal of Clinical Nutrition*, Vol. 48, No. , pp. 749-753.

Anderson, J. W., Smith, B. M. and Washnock, C. S. (1999), “Cardiovascular and renal benefits of dry bean and soybean intake”, *The American Journal of Clinical Nutrition*, Vol. 70 No. 3, pp. 464-474.

Antunes, P. L., Bilhalva, A. B., Elias, M. C. and Soares, G. J. D. (1995). “Valor nutricional de feijão (*phaseolus vulgaris*, L.). Cultivares Rico 23, Carioca, Piratã-1 e Rosinha-G2”, *Revista Brasileira de Agrocência*, Vol. 1, No. 1, pp. 12-18.

Assis, A. M. O. and Barreto, M. L. (2000). “Condições de vida, saúde e nutrição na infância em Salvador”. Salvador: UFBA.

Bazzano, L. A., He, J., Ogden, L. G., Loria, C., Vupputuri, S., Myers, L. and Welton, P. K. (2001). “Legume consumption and risk of coronary heart disease in US men and women: NHANES I Epidemiologic Follow-up Study”, *Archives of Internal Medicine*, Vol. 161, No. 21, pp. 2573-2578.

Bodwell, C. E., Satterlee, L. D. and Hackler, L. R. (1980). “Protein digestibility of the same protein preparations by human and rat assays and by in vitro enzymic digestion methods”, *The American Journal of Clinical Nutrition*, Vol. 33, No. 3, pp. 677-686.

Brazilian Enterprise of Agricultural Research [EMBRAPA] (2002), “Feijão na economia nacional”, available at: <http://www.infoteca.cnptia.embrapa.br/bitstream/doc/192830/1/doc135.pdf> (accessed May 19, 2013).

Brazilian Institute of Geography and Statistics [IBGE] (2002), “Household Budget Survey 2002”, available at: <http://www.ibge.gov.br> (accessed May 12, 2012).

Brazilian Institute of Geography and Statistics [IBGE] (2006), “Census of Agriculture 2006”, available at: <http://www.ibge.gov.br> (accessed May 12, 2012).

Brazilian Institute of Geography and Statistics [IBGE] (2008), “Household Budget Survey 2008”, available at: <http://www.ibge.gov.br> (accessed May 12, 2012).

Brazilian Institute of Geography and Statistics [IBGE] (2010), “Municipal Agricultural Production 2010”, available at: <http://www.ibge.gov.br> (accessed May 12, 2012).

Burlandy, L. (2009). “Construction of the food and nutrition security policy in Brazil: strategies and challenges in the promotion of intersectorality at the federal government level”, *Ciência & Saúde Coletiva*, Vol. 14, No. 3, pp. 851-860.

Caulfield, L. E., Onis, M., Blössner, M. and Black, R. E. (2004). “Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles”. *The American Journal of Clinical Nutrition*. Vol. 80, No. 1, pp. 193-198.

Devereux, S. and Maxwell, S. (2001). “Food Security in Sub-Saharan Africa”. ITDG, London.

Dobbing, J. (1972). “Nutrition, the nervous system and behavior”. OPAS, No. 251.

Food and Agriculture Organization [FAO] (2010a). “Global hunger declining, but still unacceptably high: International hunger targets difficult to reach”. Economic and Social Development Department, available at: <http://www.fao.org/docrep/012/al390e/al390e00.pdf> (accessed May 18, 2013).

Food and Agriculture Organization [FAO] (2010b). “Progress towards millennium development goal 1: hunger Target”, available at: <http://www.fao.org/hunger> (accessed May 18, 2013).

Food and Agriculture Organization [FAO] (2012), “Food and Agriculture Organization of United Nations”, available at: <http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en/> (accessed May 05, 2012).

Funk, C. C. and Brown, M. E. (2009). “Declining global per capita agricultural production and warming oceans threaten food security”. *Food Security*, Vol. 1, pp.271–289.

Garcia, O. E. and Lajolo, F. M. (1994). “Starch alterations in hard-to-cook beans (*Phaseolus vulgaris*)”, *Journal of Agricultural and Food Chemistry*, Vol. 42, No. 3, pp. 612-615.

Geil, P. B. and Anderson, J. W. (1994). “Nutrition and health implications of dry beans - a review”, *Journal of the American College of Nutrition*, Vol. 13, No. 6, pp. 549-558.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M. and Toulmin, C. (2010). “Food security: the challenge of feeding 9 billion people”, *Science*, Vol. 327, No. 5967, pp. 812-818.

Jones, P. M. B. and Boulter, D. (1983). “The cause of reduced cooking rate in *Phaseolus vulgaris* following advance storage conditions”, *Journal of Food Science*, Vol. 48, No. 2, pp. 623-626.

Kushi, K. H., Meyer, K. A. and Jacobs, D. R. Jr. (1999). “Cereals, legumes, and chronic disease risk reduction: Evidence from epidemiologic studies”, *The American Journal of Clinical Nutrition*, Vol. 70, pp. 451-458.

Lamb, R. L. (2000). “Food crops, exports, and the short-run policy response of agriculture in Africa”. *Agr Econ*, Vol. 22, No. 3, pp. 271–298.

Machado, C. M., Ferruzzi M. G. and Nielsen, S. S. (2008). “Impact of the hard-to-cook phenomenon on phenolic antioxidants in dry beans (*Phaseolus vulgaris*)”, *Journal of Agricultural and Food Chemistry*, Vol. 56, No. 9, pp. 3102-3110.

Magalhães, A. L. R., Zorzi, K., Queiroz, A. C., Mello, R., Detmann, E. and Pereira, J. C. (2008). “Resíduo proveniente do beneficiamento do feijão (*Phaseolus vulgaris* L.) em rações

para vacas em lactação: consumo, digestibilidade, produção e composição do leite e eficiência de alimentação”, *Revista Brasileira de Zootecnia*, Vol. 37, No. 3, pp. 529-537.

Mathers, J. C. (2002). “Pulses and carcinogenesis: Potential for the prevention of colon, breast and other cancers”, *British Journal of Nutrition*, Vol. 88, No. 3, pp. 273- 279.

Mdgi (2012), “Millennium Development Goals Indicators of United Nations”, available at: <http://mdgs.un.org/unsd/mdg/Default.aspx> (accessed May 15, 2012).

Mesquita, F. R., Corrêa, A. D., Abreu, C. M. P., Lima, R. A. Z. and Abreu, A. F. B. (2007). “Linhagens de feijão (*Phaseolus vulgaris* L.): Composição Química e digestibilidade protéica”, *Ciência e Agrotecnologia*, Vol. 31, No. 4, pp. 1114-1121.

Ministry of Agriculture, Livestock and Food Supply [MAPA] (2013), “Ministério da Agricultura”, available at: <http://www.agricultura.gov.br/vegetal/culturas/feijao> (accessed May 18, 2013).

Official Press of Rio de Janeiro State [IOERJ] (2012), “Incentivo para a produção de feijão”, available at: <http://www.ioerj.com.br/portal/modules/news/article.php?storyid=1501> (accessed May 19, 2013).

Ribas, D. L. B., Philippi, S. T., Tanaka, A. C. and Zorzatto, J. R. (1999). “Saúde e estado nutricional infantil de uma população da região centro-oeste do Brasil”, *Rev Saúde Pública*, Vol. 33, No. 4, pp. 358-365.

Santos, S. M. C. and Santos, L. M. P. (2007). “Evaluation of public policies for food security and hunger control in Brazil, 1995-2002: 1 - Methodological framework”, *Cadernos de Saúde Pública*, Vol. 23, No. 5, pp. 1029-1040.

Schmidhuber, J. and Tubiello, F. N. (2007). “Global food security under climate change”. *Proc Natl Acad Sci*, Vol. 104, pp. 19703–19708.

Seagri (2012), “Secretaria de Agricultura, Irrigação e Reforma Agrária da Bahia”, available at: <http://www.seagri.ba.gov.br/> (accessed May 10, 2012).

Sen, A. (1981). "Poverty and famines: an essay on entitlement and deprivation". Clarendon Press/Oxford University Press: Oxford, UK.

Treasure Secretary of Paraná (2012), "Projeto da Emater aumenta a produtividade do feijão no Paraná", available at: <http://www.fomento.pr.gov.br/modules/noticias/article.php?storyid=238&tit=Projeto-da-Emater-aumenta-a-produtividade-do-feijao-no-Parana-> (accessed May 20, 2013).

United Nations (2012), "Department of public information. Goal 1: eradicate extreme poverty and hunger", available at: [www.un.org/millenniumgoals](http://www.un.org/millenniumgoals) (accessed May 05, 2012).

United Nations Children's Fund [UNICEF]. (2006a). "Under five deaths by cause". available at: [http://www.unicef.org/media/files/Under\\_five\\_deaths\\_by\\_cause\\_2006\\_estimates3.doc](http://www.unicef.org/media/files/Under_five_deaths_by_cause_2006_estimates3.doc) (accessed May 15, 2013).

United Nations Children's Fund [UNICEF]. (2006b). "Progress for Children: A Report Card on Nutrition (No. 4)", available at: [http://www.unicef.org/publications/index\\_33685.html](http://www.unicef.org/publications/index_33685.html) (accessed May 15, 2013).

United Nations Children's Fund [UNICEF]. (2007). "The State of the World's Children 2007: Women and Children - The double dividend of gender equality", available at: <http://www.unicef.org/sowc/> (accessed May 15, 2013).

United Nations Economic and Social Council [ECOSOC]. (2007). "Strengthening efforts to eradicate poverty and hunger, including through the global partnership for development", available at: <http://documents.wfp.org/stellent/groups/public/documents/communications/wfp224568.pdf> (accessed May 15, 2013).

United Nations. (2013). "Department of public information. **Goal 1:** eradicate extreme poverty and hunger", available at: <http://www.un.org/millenniumgoals> (accessed May 20, 2013).

World Bank. (2013). “The World Bank Database”, available at: <http://www.worldbank.org/> (accessed May 22, 2013).

World Food Programme [WFP]. (2011). “World Food Programme”, available at: <http://http://www.wfp.org> (accessed May 22, 2013).

World Health Organization [WHO]. (2012). “Global Health Observatory Data Repository”, available at: <http://www.who.int/en/> (accessed May 15, 2012).

World Health Organization [WHO]. (2013). “Micronutrients deficiencies”, available at: <http://www.who.int/nutrition/topics/ida/en/> (accessed May 18, 2013).



## **CAPÍTULO 2:**

### **BRAZILIAN AGRIBUSINESS FACING AFRICAN FOOD INSECURITY<sup>2</sup>**

#### **ABSTRACT**

**Purpose** – Brazilian agriculture has achieved high production levels in recent years. In contrast, agricultural production in Africa is low, but it shows great potential. This paper discusses the agricultural profiles of the main regions of Africa as well as the agribusiness partnership established between Africa and Brazil.

**Design/methodology/approach** – This research is based on descriptive analyses of data collected in official agencies, such as FAO, the World Bank, the United Nations, and the Africa–Brazil Institute. This study compares collaborative projects currently active in the agribusiness partnership between Africa and Brazil.

**Findings** – Several active collaborative projects are located in Western and Eastern Africa, which are problematic and unstable regions. We argue that Brazil can help African development through a sharp focus on both elementary and emancipatory projects. Thus, attention to Middle Africa should focus on political and conflict instabilities, since these problems might prevent a collaborative partnership with the Brazilian agribusiness sector.

**Research limitations/implications** – The main limitation of this study is that it is based on vague data obtained in official agencies. Another limitation is the absence of details about the active projects.

**Practical implications** – This paper is an important contribution to the literature regarding food security, political instability, and economic development in Africa. It suggests the need for a better alignment between political and private efforts focused on the alleviation of urgent problems.

**Originality/value** – The originality of this paper is its use of empirical evidence of active projects resulting from the partnership established between Brazil and Africa, as well as its discussion of the possible misalignment between these projects and the urgent needs of Africa.

**KEYWORDS:** Agribusiness; African Development; Emerging Economies; Agricultural Efficiency; Food Security.

---

<sup>2</sup> This paper is in evaluation process at Journal of Agribusiness in Developing and Emerging Economies (ISSN: 2044-0839). The first version of the paper was submitted in 15-January-2014 and the revised version submitted in 29-August-2014. (ANNEX 2, pp. 156).

## 1. INTRODUCTION

### 1.1 OBJECTIVE

In recent decades, the Brazilian agribusiness sector has sharply improved its capabilities and performance. In contrast, the African continent, although it has vast tracts of land with great potential for agribusiness activities, requires attention to its agricultural practices and performance. This study aims first to describe the evolution of the main regions of Africa regarding their agricultural yield and main agricultural factors. Second, we discuss the nature of the cooperative relationship between Brazil and Africa in order to help the African continent to enhance economic development and agricultural innovation (Africa-Brazil.org, 2013). Thus, this paper also argues that, considering the urgent situation of undernourishment and food insecurity in Africa, the initiatives and projects established in partnership with Brazil should target these as major problems. In addition, we present empirical evidence of some potential barriers and limitations to this partnership. Furthermore, this study intend to present a practical contribution that could promote a better understanding about this partnership, which would allow the promotion of initiatives and projects specifically focused on higher food production and economic development.

### 1.2 BACKGROUND

The production of sufficient quantities of food is one of the most important challenges of humanity because of the need for food security in the world (Godfray et al., 2010). In addition, as a global goal, food security is defined as sufficient food acquisition in terms of quantity and nutritional elements (Sen, 1981; FAO, 2013). Thus, agricultural activities and improvement have important social implications. Moreover, because agriculture activity has a high economic impact, developing countries take advantage of their agricultural potential and natural resources to maintain sustainable economic growth. In 2009, the total amount of arable land in the world was estimated at 1.38 billion hectares, 5.41% and 23.75% of which are in Brazil and Africa, respectively (FAO, 2012).

Brazil is currently seen as one of the greatest “barns” of the world (The Economist, 2010), with potential for the production of food for worldwide distribution (Contini and Martha, 2010). Brazil holds a prominent position in the production of many foods, such as sugar cane, orange, green coffee, papaya, dry-beans, soybeans, cattle and chicken meats, and pineapple. Brazilian exports also have international prominence. The country is the world's largest exporter of sugar (raw centrifuged), chicken meat, coffee, and orange juice. It is also

the second largest exporter of soybeans and soybean cake (FAO, 2012). Thus, Brazil has a prominence position as a great world exporter of meats and meat products, and corn. On the other hand, Brazil is also an important importer of wheat, maize, and dry-beans (FAO, 2012), which are important staple foods of the Brazilian diet. Brazilian agribusiness is an important driver of the country's economic growth. However, authors argue that this economic development based on agricultural exploration had significant impacts on Brazilian ecosystem, and also aggravated social inequality (Martinelli et al., 2010). Nevertheless, the Brazilian agribusiness sector still has great potential for economic exploitation.

Africa also has a high potential for food production, and its agricultural activities have attracted the attention of the world. With its wide range of arable land, Africa has important advantages, such as differing climatic conditions and low labor costs. On the other hand, politics (Olukoshi, 2006), land control (Connolly, Connolly and Lyon, 2012) and the movement of the population to urban areas (Van Rooyen and Sigwele, 1998; Haggblade, 2011) represent great challenges to agricultural activities on the African continent. Previous studies suggested that the poor performance of agriculture in Africa is caused by inadequate investment and policies in the agricultural sector (Fan, Zhang and Rao, 2004; Timmer, 2005). Small farm sizes, poor access to knowledge and support services, low investments in infrastructure, and weak irrigation schemes have also limited agricultural development in Sub-Saharan Africa (Faurès and Santini, 2008). Considering the fact that the African continent has a significant portion of the world's hungry and undernourished population (FAO, 2013; WFP, 2011), the development of its agricultural potential can alleviate food insecurity in not only African countries but also the rest of the world. Therefore, the partnership established between Brazil and Africa to develop their agribusiness sectors is strategic in its possible positive effects on the entire world. Therefore, active projects should be investigated to determine their focus on urgent issues, such as 1) fighting hunger and poverty; 2) the empowerment of African societies and small farms; and 3) sustainable economic development.

### 1.3 METHOD

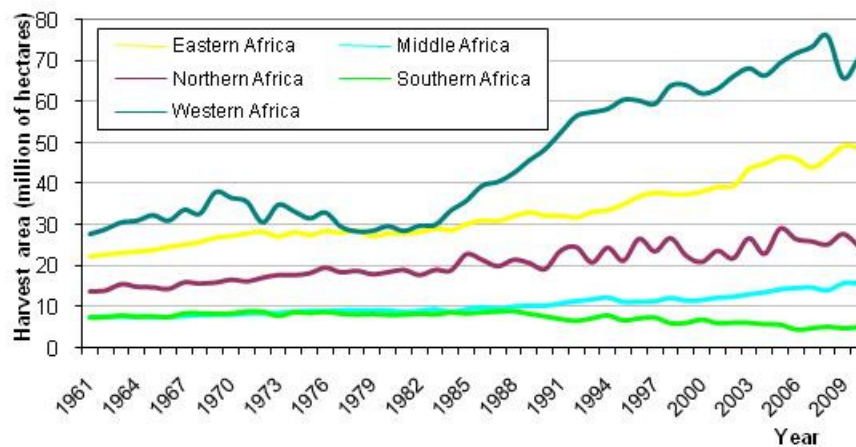
The present study is based on descriptive analyses of data related to agricultural activities and partnership projects established between Brazil and Africa. Brazil and Africa are developing some important initiatives in order to enhance their agricultural activities. Thus, Brazil and Africa have similar conditions regarding geography and climatic conditions. So, Brazil can serve as a good example to African initiatives. It focuses on the agricultural

evolution of the main regions of Africa and compares the urgency of agricultural improvement and the concentration levels of projects in partnership with Brazil. The comparison of the main regions of Africa was designed to consider specific issues, such as harvest areas, agriculture yield, fertilizer consumption, and capital investment in agriculture. The data for these four variables in agricultural activities were obtained from the Food and Agriculture Organization of the United Nations (2012). In this study, these four variables concern the period between 1975 and 2010. The subdivision of the five regions in Africa is based on the classifications provided by the Food and Agriculture Organization (2012). Although different classifications are available, but this study adopted the classifications suggested by the Food and Agriculture Organization because they suit the objectives of this study and thus are convenient for the researcher.

## 2. AGRICULTURE IN AFRICA

The first analysis provides a comparison of the historical evolution of the harvest area of cereals, fruits, legumes, roots, tubers, and vegetables grown in African regions (Figure 1). Evidence indicates that the West African region has the largest amount of harvest areas of the above crops. Thus, in the present study, harvest areas in Western Africa have sharply increased since the early 1980s. In comparison, in other regions production has been stationary. The African region with the lowest amount of harvest area is Southern Africa.

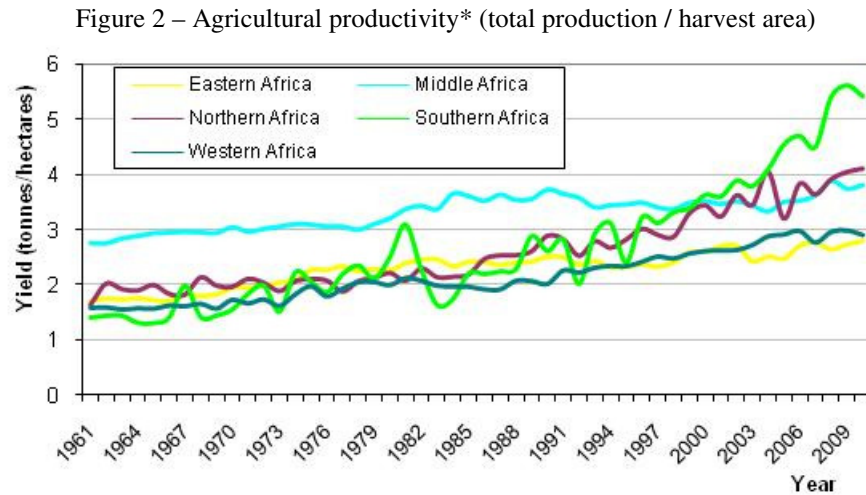
Figure 1 – Harvest area\*



Note: \* Cereals, fruits, pulses, roots, tubers and vegetables.

Source: Food and Agriculture Organization (2012).

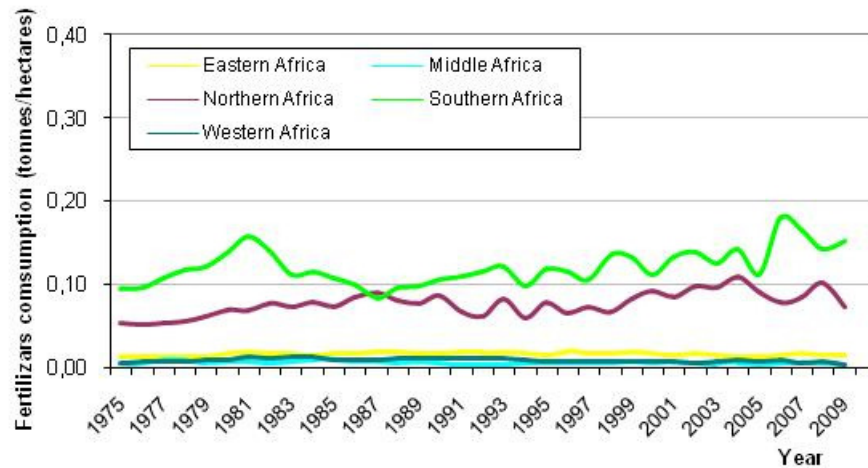
Regarding the evolution of harvest areas, Eastern Africa has also experienced strong growth, having doubled its harvest area between 1961 and 2009. This increase suggests that this region has aimed to improve its agricultural activities dramatically. This argument might be reinforced by evidence of the evolution of agricultural productivity, or yield (Figure 2).



Note: \* Cereals, fruits, pulses, roots, tubers and vegetables.  
Source: Food and Agriculture Organization (2012).

The agricultural productivity presented in Figure 2 is focused on the agricultural yields of cereals, fruits, pulses, roots, tubers, and vegetables crops. The Eastern and Western regions of Africa have the least agricultural productivity. However, these regions have the greatest amount of harvest areas, which may suggest that because low productivity, the amount of area used for agriculture should be increased in order to achieve sufficient and satisfactory agricultural production. However, low productivity may also indicate that these regions do not use agricultural technology to grow their crops. Middle and Northern Africa show intermediate levels of agricultural productivity. Despite the great extension of the desert area in Northern Africa, its productivity is higher than in other areas of Africa, which have better and more suitable climatic conditions for agriculture. Another indicator that helps to evaluate the adoption of efficiency and technology in agriculture is the amount of fertilizer consumed in each main region of Africa (Figure 3).

Figure 3 – Fertilizer consumption\* (tonnes / harvest area)

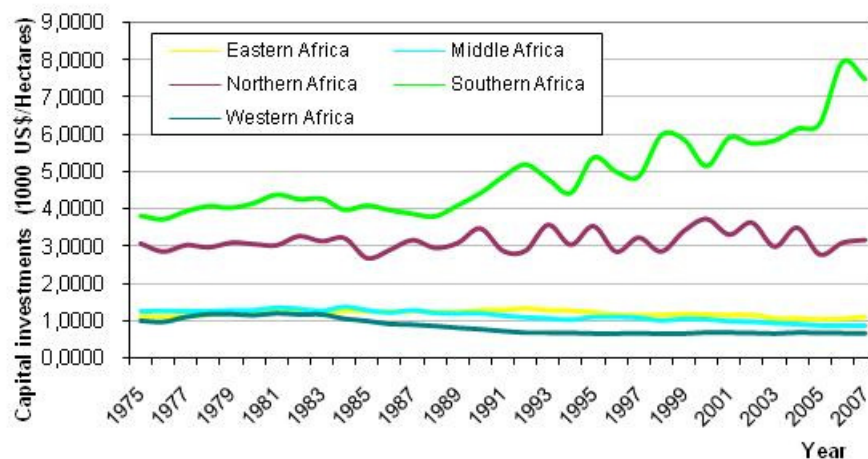


Note: \* Cereals, fruits, pulses, roots, tubers and vegetables crops.

Source: Food and Agriculture Organization (2012).

Evidence indicates that the regions of Southern and Northern Africa have the greatest consumption of fertilizer per hectare. On the other hand, the fertilizer consumption in Western, Eastern, and Middle Africa is negligible. The greater consumption of fertilizers in Northern Africa could be because its climatic conditions are unfavorable, which is a plausible explanation for its moderate agricultural productivity. However, Eastern and Western Africa, which are regions with lower agricultural productivity, do not consume significant amounts of fertilizer, which affects their agricultural performance. Evidence suggests that a possible way of improving the agricultural productivity in these regions could be by the more efficient use of fertilizers. Moreover, the evolution of capital investments is seen as an important variable in agricultural production (Figure 4).

Figure 4 – Capital investments \*\* (US\$ / harvest area\*)



Note: \* Cereals, fruits, pulses, roots, tubers and vegetables. \*\* Investments in land development, machinery, equipment, and plantation crops with US\$ in 2005 as constant.

Source: Food and Agriculture Organization (2012).

Another factor contributing to the agricultural development considered in this study is the amount of capital investment per hectare of harvest area. Evidence shows that Southern Africa has the largest capital investments in agriculture, Northern Africa has moderate amounts of capital investments in agriculture, and Eastern, Western, and Middle Africa have the lowest amounts of capital investments in agriculture. These evidences related to productivity and fertilizer consumption show that the regions of Eastern and Western Africa have low capital investments, low use of fertilizers, and low agricultural productivity. This evidence suggests that these regions have the weakest agricultural profiles, in terms of the variables investigated in this study.

### **3. THE AGRIBUSINESS PARTNERSHIP BETWEEN BRAZIL AND AFRICA**

Brazil is currently recognized as one of the major food producers in the world (Contini and Martha, 2010; The Economist, 2010). This position in world food production has been achieved only recently because of domestic changes. Despite the increase in food production in Brazil, the country still has great potential for exploitation. In less than 30 years, Brazil has reversed its position as an importer of food to one of the most important “barns” of the world. Brazil is considered the first country to achieve levels of productivity and exports on par with the traditional “Big Five” (i.e., the five largest grain exporters, which are USA, Canada, Australia, Argentina, and the European Union). Between 1996 and 2006, the total value of crops in Brazil increased from R\$ 23 billion to R\$ 108 billion, representing an increase of 365% (The Economist, 2010). Brazil increased its exports of meat, overtaking Australia to assume the position of the largest exporter of meat in the world. Since 1990, Brazilian soybean production has increased from around 15 million tonnes to over 60 million tonnes. Brazil is the second largest exporter of soybeans and is responsible for about one third of the world’s exports of soybeans (Food and Agriculture Organization, 2012).

In recent decades, Brazil has shown strong growth in its Gross Domestic Product (GDP). In 2012, with \$2.3 trillion dollars, Brazil was seventh among the highest GDPs in the world (International Monetary Fund, 2012). Evidence indicates that gross investment has been mainly responsible for the growth in the Brazilian GDP in recent years (Ferreira and Malliagros, 1998; Bonelli and Fonseca, 1998; Gomes, Pessôa and Veloso, 2003). These investments had positive effects on agricultural activities in the country and thus increased its food productivity. Regarding Brazilian agricultural development, the focus has been on the introduction of new technologies, fertilizers, and pesticides to increase productivity

(Rodriguez, 2006). The excellent performance of Brazil can also be attributed to a series of reforms in agricultural policy promoted by the government, especially regarding agricultural exports (Yan, Yi-Xiang and Yi, 2009). Among the factors that have led Brazil to a prominent position in food production are the following: 1) industrialization and migration of population from rural to urban areas; 2) subsidized financial credit, primarily capital finance and to acquire modern agricultural inputs; 3) extension activities; and (4) support for agricultural research under the leadership of the Brazilian Agricultural Research Corporation (EMBRAPA) (Contini and Martha, 2010).

In Africa, agribusiness has the great potential for exploitation in future decades. Furthermore, the growth in African agro-industrial productivity will dramatically affect the growth rate of Africa in wide socio-economic and environmental terms and its initiatives to reduce poverty. However, the efficiency necessary to improve Africa's performance will depend on the focus of African agribusiness activities on fostering private investment, promoting regional trade, improving urban and regional planning, and funding scientific research (Haggblade, 2011).

Furthermore, improvements in agriculture and food production in Africa have the potential to alleviate hunger and malnutrition worldwide. However, despite this potential, in their fight against hunger and malnutrition, some African regions are the most affected by food insecurity and lower performance levels. Several African countries, such as the Democratic Republic of Congo, Somalia, Zambia, Uganda, United Republic of Tanzania, and Botswana have shown no progress in combating hunger and some have increased numbers of hungry and undernourished people (FAO, 2010). In addition, in ten African nations (i.e., Chad, Angola, Zambia, Democratic Republic of Congo, Mozambique, Ethiopia, Central African Republic, Eritrea, Burundi, and Sierra Leone) large percentages of the population are (more than 35%) undernourished (WFP, 2011). Furthermore, some of these nations have shown dire weaknesses in their logistics performance (World Bank, 2013) and alarming levels of political instability and conflict (Global Observatory, 2013). Such evidence could explain the weak agricultural and economic development in these regions.

Evidence has shown that in Southern African, a great part of the population, which is mainly concentrated in rural areas, faces urgent problems of food insecurity and poverty. This condition is intensified by adverse weather conditions, which negatively affect food production. Nevertheless, agriculture is a primary economic activity in this region. Logically, the achievement of sustainable agriculture in Africa has a key role in promoting food security. Another issue is urbanization, which is expected to increase dramatically in the coming



decades. The provision of nutritional conditions and food security to large urban populations should be given high priority (Van Rooyen and Sigwele, 1998).

A study conducted in Morocco, Algeria and Tunisia (Benjelloun, 2004) found that the agricultural activities of these countries play an important role in their GDP. However, these three countries have serious problems in food security. Imports of cereals and sugar are very high, and milk production in the region is far from the recommended nutritional intake in these three countries (Benjelloun, 2004), which suggests trade opportunities. Therefore, investment in the African agricultural sector (e.g., Sub-Saharan Africa) is required for the reduction of poverty and food insecurity (Mwabu and Thorbecke, 2004).

Considering the political debate about agricultural and economic development in Africa, market liberalization, and the promotion of private property, higher agricultural productivity and the desired economic growth have not been achieved. Furthermore, these policies have accelerated new forms of inequality that manifest through a dual process of land concentration and the dispossession of communities and individuals (Olukoshi, 2006). Consequently, the political debate faces elementary issues regarding the structured development of agricultural production. Thus, initiatives are needed concerning the effects of agribusiness on economic development, particularly with regard to African societies and environments.

Accordingly, Brazil and Africa have established an innovative partnership to boost agriculture in sub-Saharan Africa, based on the agricultural model used in Brazil. This initiative is called the “Africa–Brazil Agricultural Innovation Marketplace” and is primarily intended to benefit small producers. The core objective is to promote innovation in the development of agriculture on the African continent. This should be accomplished through creating and strengthening partnerships between African and Brazilian organizations, promoting research and agricultural development in Africa and Brazil (initially through EMBRAPA), and by supporting small producers. Some projects have already been implemented, some of which are focused on specific regions in Africa, such as Burkina Faso, Kenya, Mozambique, Tanzania, and Togo. Furthermore, these projects are aimed at ameliorating important issues, such as food security, production of ethanol, and water use (World Bank, 2010; Africa-Brazil.org, 2012). Figure 5 shows the location of these active projects on the African continent.

Figure 5 - Main regions of Africa and active projects (partnership with EMBRAPA).



Source: Based on the classification of FAO (2012) and data from Africa-Brazil.org (2013).

As Figure 5 shows, the active projects are concentrated in Western and Eastern Africa. These regions are considered poor in terms of agricultural development (e.g., fertilizer consumption, agricultural yield, and capital investments) and economic development. Moreover, the projects include a series of efforts and concerns regarding the development of agricultural production and the number of small producers. In addition, some projects are focused on issues related to the social and environmental concerns of the poorest regions of Africa. A list of projects currently being implemented is presented in Table 1.

Table 1 – List of projects being implemented in the African continent

Country	Project Title	
Benin	Production and management options for improved smallholder goat profitability	●
Burkina Faso	Study of the Ecology and Nutritional Potential of Native Food Tree Species used by local communities in Burkina Faso and Brazilian Amazon: A Food security and conservation strategy in the context of climate change	●
	Swidden Systems for Poverty Alleviation and Provision of Environmental Services	●
Cameroon	Coffee genetic diversity in relation to drought tolerance (COFDRONet)	●
	Development and sustainable breeding of local chicken for improved productivity under local alternative feed management system and health control	●
	Introduction of Napier grass elite lines for screening for stunt resistance to provide feed for improved smallholder dairy productivity	●
	Swine Improvement in Ethiopia through Genetic and Socio-Economic Characterization and Development of a Production System	●
Ethiopia	Improving livelihoods of smallholders through implementation of sustainable small ruminant improvement programs	●
	Bee Diversity And Crop Pollination For Food Security	●
	Narrowing the yield gap of food legumes through integrated management of parasitic weeds in the highlands of Ethiopia	●
	Improving crop productivity through use of efficient, low cost and climate smart irrigation technologies	●
	Enhancing small-holder cowpea legume production using rhizobium inoculants	●
Ghana	Characterization, conservation and domestication of indigenous edible and medicinal mushrooms on agricultural residues	●
	Comparative evaluation of different manual cassava harvesting tools	●
	Rehabilitation of degraded rangeland using planned grazing and animal impact in the arid and semi-arid lands of Kenya	●
	Facilitating local level dairy innovation platforms for smallholder farmers	●
	Fostering knowledge sharing for integrated natural resource management in agricultural landscapes of Southern Africa	●
Kenya	Application of DNA-markers for development of drought tolerant potato germplasm	●
	Developing a push-pull IPM strategy for smallholder cotton for Female in Africa and Northeast of Brazil	●
	Sweet sorghum varietal adaptation for ethanol production	●
	Confidence-Building in Modern Biotechnology: Optimizing Best Communication Practices and Policies to Guide Deployment of Biotech/GM crops in Africa and Brazil	●
Malawi	Enhancing Crop Productivity through Solar-Powered Groundwater Based Drip Irrigation System in Malawi.	●
Mozambique	Sustainable Rice Production Intensification in Conservation Agriculture: Incorporation of Legume and Grass as Cover Crops for Weed Management and Soil Health Enhancement	●
	Participatory Evaluation and Promotion of Improved Pepper Cultivars (Capsicum Spp) Among Small Holder Farmers	●
Nigeria	Nutritional properties and health functionality of wholegrain millet sourdoughs	●
	Generation of virus resistant cowpea	●
	Comprehensive Molecular Genetic Characterization Among West Africa and Brazil Locally Adapted Poultry Breeds: Creation of a Basis for Germplasm Exchange	●
Tanzania	Species identification of root-knot nematodes (RKN) through improved diagnostic techniques aimed at durable resistance in vegetables grown in peri-urban systems in Africa	●

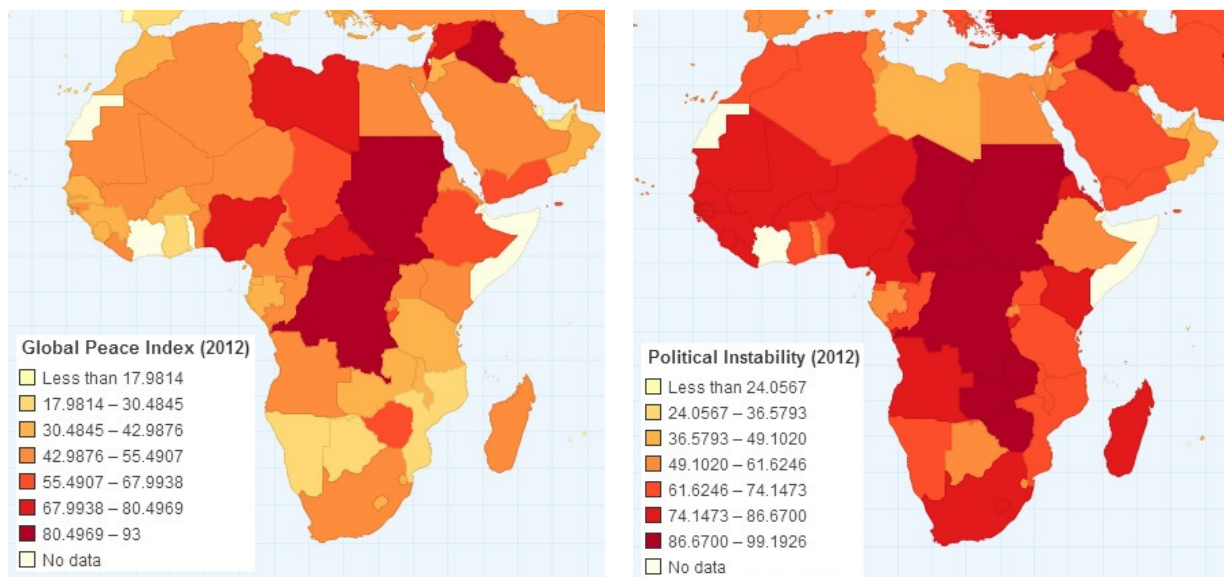
Country	Project Title	
	Cotton varieties and pest management in Tanzania	●
	Exchange of banana and plantain ( <i>Musa</i> spp.) varieties and hybrids between IITA and EMBRAPA - widening the genetic base for the development of new cultivars and direct use by farmers	●
Togo	Pesticide leaching and loss to groundwater in coastal vegetable growers in Togo	●
	Enhancing Cowpea Production And Nutrition Through Developing Drought Tolerant And High Protein Lines	●
	Validation of molecular-assisted selection for cassava mosaic disease and screening of cassava wild relatives as resistance sources for cassava brown streak virus	●
	Identification of broad resistance sources to anthracnose and rust in common bean and resistance gene tagging using SNP markers	●
Uganda	Utilization of Hydraulic Ram Pumps for promoting small-scale Irrigation	●
	Utilizing Sustainable Energy for Water Management in Semi-intensive Aquaculture	●
	Towards genetic improvement of farmer preferred rice varieties to the stalk-eyed fly ( <i>Diopsis</i> sp): an emerging pest in rainfed irrigated rice growing ecosystems	●
	Inoculation of efficient rhizobial strains as an approach to increase the pigeonpea production of smallholders in Uganda.	●

Note: ● Natural Resource Management Improvement; ● Policy, Institutional and Market Strengthening and Knowledge Management; ● Productivity Enhancing Technologies; ● Smallholder and Poverty-Alleviation Targeted Technologies.

Source: Adapted from Africa-Brazil.org (2013).

As Table 1 indicates, the greatest number of agribusiness projects is in the categories of productivity and technology. Thus, a strong focus is on the development of smallholders. Evidence suggests that the positive impact of agricultural growth on rural development is stronger in nations where agricultural activities are dominated by small farms (Rosegrant and Hazell, 2000). Furthermore, projects with heterogeneous goals are located mostly in Western and Eastern Africa. This can be related to the fact that the economic conditions facing low-income African countries are widespread (Diao, Hazell and Thurlow, 2010). Moreover, the possible barriers imposed by the conflict levels and political instability in some African nations (Figure 6) could explain the lack of active projects in Middle Africa.

Figure 6 – Global Peace Index and political instability in Africa



Source: International Peace Institute (2012).

As Figure 6 shows, Middle Africa indicates lower levels of the Global Peace Index as well as high levels of political instability (International Peace Institute, 2013). The negative profile of some African nations might impose strong barriers to the establishment of projects that are focused on the improvement of their agricultural activities. Furthermore, the level conflict can discourage foreign nations from sending specialist teams to develop agribusiness in such regions. Political instability urgently requires attention in Africa (Van Dijk, 2008) in order to develop its agricultural sector. Thus, political instability and hunger in African continent are related issues (Kitissou, 2014). Indeed, food security in Africa is an issue that has already addressed considering political aspects like trade liberalization strategies (Chikhuri, 2013) and political leadership (Diriye, Nur and Khalif, 2013; Mwichabe, 2013) in

order to enhance African agricultural development. The profile of 13 African countries that have active projects in partnership with Brazil (Table 2) shows that agriculture can assist economic development and poverty reduction in these nations.

Table 2 – Profile of African countries with active projects

Countries	Rural pop. (%) (2012)	HDI (2012)	Undernourished pop. (%) (2011)	GDP per capita US\$ (2011)	Balance of Trade (million US\$) (2009)	Cultivated area (%) (2011)	Permanent Pasture area (%) (2011)
Benin (1)	54.43	0.436	8.1	802	-1,123.62	25.54	4.88
Burkina Faso (1)	72.65	0.343	25.9	595	- 1,074.74	21.07	21.93
Cameroon (3)	52.67	0.495	15.7	1,319	-2,056.19	16.08	4.23
Ethiopia (6)	82.75	0.396	40.2	357	-6,355.71	15.68	20
Ghana (3)	47.45	0.558	< 5	1,570	-1,389.27	33.40	36.48
Kenya (7)	75.63	0.519	30.4	819	-5,738.56	10.81	37.42
Mali (1)	64.43	0.344	7.9	671	Na	5.72	28.39
Nigeria (4)	49.75	0.471	8.5	1,509	+16,031.18	43.04	40.62
Tanzania (3)	72.82	0.476	38.8	526	-3,548.42	15.01	27.09
Togo (1)	61.51	0.459	16.5	600	-249.16	50.01	18.39
Uganda (7)	84.02	0.456	34.6	558	-2,679.76	44.79	25.58
Malawi (1)	84.19	0.418	23.1	388	+833.75	39.56	19.62
Mozambique (1)	68.57	0.327	39.2	536	+1617.04	6.87	55.95

Note: na = not available; HDI = Human Development Index; GDP = Gross Domestic Product.

Source: Adapted from FAO (2013), World Bank (2013) and UNSD (2013).

Table 2 shows that the greatest portion of the population of African nations with active projects in partnership with Brazil is concentrated in rural areas. This suggests that these nations might be strongly dependent on agricultural activities. Furthermore, the Human Development Index (HDI) and the GDP per capita indicate that these nations have urgent problems in human and economic development. With regard to the Balance of Trade, the amount of area designated for agricultural activities, and the portion of undernourished population, Nigeria presents the best profile. On the other hand, Ethiopia, Tanzania, Kenya, Uganda, Mozambique, and Burkina Faso show poorer profiles, indicating that attention to issues related to agricultural development and food security is urgently needed. The evidence shows that with the exception of Ghana, which has undernourished population of less than 5%, the African countries with which Brazil maintains cooperative relations through agribusiness projects have urgent problems regarding the size of their undernourished populations. Undernourishment is defined as a state lasting for at least one year in which the inability to acquire enough food persists, which is characterized by a level of food intake insufficient to meet dietary energy requirements (FAO, 2013). Therefore, this study argues that the projects developed in Africa in partnership with Brazil should attend more strongly to the problems related to the antecedents and consequences of undernourishment. Regarding to

this issue, it is known that African countries face severe conditions of food insecurity, and an unsatisfactory progress toward reducing hunger and undernourishment levels (WFP, 2011; FAO, 2010). Indeed, Sub-Saharan Africa is responsible for 223 million undernourished people (FAO, 2013).

Benin has a diverse agricultural profile because of the change in climate from savannah-desert in the north to tropical rainforest in the south. In the north, agricultural activities focus on cotton and livestock. Thus, the most important food crops in the north are maize, sorghum, millet, and beans. On the other hand, in the south, agriculture is dominated by food crops, such as rice, cassava, yams, and beans. Palm oil, cashews, and peanuts are the main cash crops of this country (Agri-Profocus, 2013; New Agriculturist, 2013).

Burkina Faso is a landlocked country strongly dependent on cotton exports. Given this level of dependency on cotton exports, its farmers are extremely vulnerable to global price fluctuations. To fight this situation, the government has tried to diversify the country's agricultural base. However, previous efforts have met with unsatisfactory results (World Bank, 2013). In addition to cotton, the main agricultural products of this country are peanuts, shea nuts, sesame, sorghum, millet, corn, rice, and livestock (New Agriculturist, 2013).

Cameroon is a prominent producer of cocoa. However, the ageing trees are an urgent problem for cocoa producers, who are discouraged from investing in replanting programs because of problems related to payment. Indeed, one of the main barriers to the economic progress of Cameroon's smallholder farmers is related to the lack of access to credit. Thus, in addition to cocoa, the main agricultural products of Cameroon are coffee, cotton, rubber, bananas, palm oil, grains, root starches, livestock, timber, rice, and maize (New Agriculturist, 2013).

Ethiopia's economy is also strongly dependent on agriculture. This country has one of the largest populations in Africa. Agriculture, which is based on food crops and traditional livestock, is responsible for a great share of the country's GDP (Diao, Hazell and Thurlow, 2010). The main agricultural products are coffee, pulses, oilseeds, cereals, potatoes, sugarcane vegetables, and livestock is prominent. An interesting point is that Ethiopia's new Growth and Transformation Plan aims to improve the agribusiness sector through investments in commercial agriculture, which are focused on advanced farming technology, progressive irrigation techniques, high value crops, improved seeds, increased fertilizer consumption, and strategies for yielding multiple harvests each year (Agri-Profocus, 2013).

The agricultural growth in Mali is strongly attributed to rice and cotton. However, the production of dry cereal in Mali, which is the staple food of its population, is very low. Thus,

access to food is inhibited by poverty and transportation costs (Agri-Profocus, 2013). In Malawi, agriculture is strongly focused on subsistence farming; thus, the food supply situation is precarious. This country is also highly vulnerable to natural disasters. However, in recent years, a government program that subsidizes fertilizers has helped to increase agricultural production, making Malawi a prominent exporter of food (BBC NEWS, 2013).

In Mozambique, agriculture is responsible for 31% of its GDP and 80% of employment. Major crops are cassava, corn, rice, tropical fruits, beef, and poultry. In addition, some crops, such as prawns, cashews, cotton, sugar, and copra are focused on the foreign market. Mozambique's agricultural profile is based on a great number of small properties. Production levels are low because of the use of traditional methods, few inputs, and lack of access to fertilizer, pesticides, manure, and animal traction. However, although the amount commercial agriculture is small it has some economic potential.

The geographical conditions of Uganda, Ghana, and Kenya are favorable for agricultural activities. Ghana and Kenya also have coastal areas. Farming in Kenya is mainly carried out by smallholder producers. Because of the need for a structural reform in the agricultural sector of Kenya, the central theme of the government's Agricultural Sector Development Strategy is "farming as a business" (Agri-Profocus, 2013). The main agricultural products of Kenya are tea, coffee, maize, wheat, sugarcane, fruit, vegetables, dairy products, beef, pork, poultry, and eggs (New Agriculturist, 2013).

In addition, Ghana and Uganda are part of a small group of African nations that have experienced high and stable agricultural growth (Diao, Hazell and Thurlow, 2010). Uganda has vast tracts of arable land, regular rainfall, and sizeable mineral deposits, which has led to robust economic growth in recent years (Agri-Profocus, 2013). The main agricultural products of Uganda are coffee, tea, cotton, tobacco, cassava, potatoes, maize, millet, pulses, cut flowers, beef, goat milk, and poultry. The main agricultural products of Ghana are cocoa, rice, coffee, cassava, yam, groundnuts, maize, beans, bananas, and vegetables (New Agriculturist, 2013).

In a few areas of the African continent, farmers have achieved significant agricultural production. In a survey of 3,000 small-scale farmers in eight sub-Saharan countries (i.e., Ethiopia, Malawi, Nigeria, Tanzania, Ghana, Kenya, Uganda, and Zambia), researchers found evidence of farms that have achieved agricultural yields that are greatly superior to the national average (Djurfeldt, Holmen, Jirstrom and Larsson, 2005). The evidence also suggests that this intensification in performance is more often observed in some specific African



regions and among specific categories of farmers (Gabre-Madhin and Haggblade, 2001; Haggblade et al., 2002).

#### 4. CONCLUSIONS

By examining the evidence of African regions regarding factors of agricultural production, this study found that Southern African has strong agricultural productivity and capital investments in agriculture. On the other hand, the agricultural realities of Middle, Eastern and Western Africa are more fragile in terms of fertilizer consumption, capital investments and, consequently, agricultural productivity. Therefore, this study suggests that Eastern and Western Africa are the weakest regions in terms of agricultural development. These findings are based on the evidence of active projects implemented in the partnership between Brazil and Africa. These projects are strongly concentrated in the two regions that need the greatest development of their agriculture activities.

Through the collaborative initiative of Brazil and Africa, projects focused on the innovative development of agricultural practices are underway in Africa in partnership with EMBRAPA. The currently active projects are concentrated in Eastern and Western Africa. This suggests that these regions are considered the most fragile in terms of investment and agricultural development. However, the active projects in these regions have differing goals, and they are weakly related. The active projects are related to agricultural productivity, food security, shared use of agricultural resources, environmental resources, and development of smallholders. However, an increased focus on basic aspects of agricultural activity, such as the efficient use of fertilizers, the use of advanced techniques of cultivation, and emancipatory social investments in the poorest African regions may have more immediate results and could make effective contributions to economic development in these regions. In addition, the enhancement of agricultural productivity in Africa and the consequent greater production of food and food security could be effectively promoted globally.

We argue that Brazil could aid agricultural development in Africa. Evidence confirms that increased investment in agricultural research leads to stronger agricultural development (Alston, Norton and Pardey, 1998; Fan et al., 2004). However, agricultural development needs to be associated with the development of supportive activities related to economic agents of the supply chains of small-scale farmers (e.g., input markets and suppliers, retailers, seasonal finance, and logistics infrastructure) (Poulton, Kydd and Dorward, 2006). Thus, agricultural development needs to be associated with the development of a broad class of

entrepreneurs (Staatz and Dembélé, 2007). Indeed, this complex development might be hampered by political instability and conflict threats. We argue that these issues need to be faced because their resolution is antecedent to strong agricultural development. Furthermore, this study supports the idea that initiatives focused on fighting undernourishment among the African population should be given priority. Assuming that undernourishment, especially during childhood, causes weakness in the cognitive and physiological activities of individuals, undernourishment can be seen as a significant antecedent of the low economic development in Africa. Therefore, it is necessary to concentrate efforts on solving the basic problem of undernourishment.

With regard to the limitations of this study, the analyses do not consider animal and livestock productivity and the impact of agribusiness activities on economic development. In addition, the general evaluation presented in this study needs evidence of specific aspects of agricultural activities. It should be noted that initially the agricultural experience of Brazil could assist in developing an agricultural model that enhances African agricultural productivity and fosters its economic development. It also appears that, although the collaborative initiative between Brazil (EMBRAPA) and Africa is focused on the development of Eastern and Western Africa, currently active projects are scattered, and they focus on achieving different purposes. We suggest that such unfocused efforts on agricultural development in Africa will not enhance the development of elementary actions that aim at addressing urgent and emancipatory agricultural issues. Hence, we suggest that additional studies focused on the Eastern and Western regions of Africa should be developed in order to identify their agricultural limitations. In addition, future research could study social and environmental issues in relation to agricultural activities. Finally, a structured research agenda should be adopted in order to promote research on the development of the agricultural potential of Africa, especially in Eastern and Western Africa.

## **5. REFERENCES**

Africa-Brazil.org (2013), "Africa-Brazil Agricultural Innovation Marketplace", available at: <http://www.africa-brazil.org/> (accesses 03July 2012).

Agri-ProFocus (2013), "Agri-ProFocus", available at: <http://www.agri-profoc.us.nl/> (accessed 10August 2013).

BBC NEWS (2013), “Malawi Profile”, available at: <http://www.bbc.co.uk/news/world-africa-13864367> (accessed 13 October 2013).

Benjelloun, S. (2004), “Food security prospects in the Maghreb”, *ARW Seminar on Environmental Challenges in the Mediterranean 2000-2050*. Dordrecht Kluwer Academic Publisher.

Bonelli, R. and Fonseca, R. (1998), “Ganhos de Produtividade e de Eficiência: Novos Resultados para a Economia Brasileira”, *Pesquisa e Planejamento Econômico*, Vol. 28, No. 2, pp. 273-314.

Chikhuri, K. (2013), “Impact of alternative agricultural trade liberalization strategies on food security in the Sub-Saharan Africa region”, *International Journal Of Social Economics*, Vol. 40, No. 3, pp. 188-206. doi:10.1108/03068291311291491

Connolly, A.J., Connolly, K.P. and Lyon, M. (2012), “A Seismic Change: Land Control in Africa. Is this a Wake-Up Call for Agribusiness?”, *International Food and Agribusiness Management Review*, Vol.15, No. 2, pp. 171-177.

Contini, E. and Martha Jr., G.B. (2010), “Brazilian agriculture, its productivity and change”, *Bertebos Conference on “Food security and the futures of farms: 2020 and toward 2050*, Falkenberg: Royal Swedish Academy of Agriculture and Forestry.

Diao, X., Hazell, P. and Thurlow, J. (2010), “The Role of Agriculture in African Development”, *World Development*, Vol. 38, No. 10, pp. 1375–1383.

Diriye, M., Nur, A. and Khalif, A. (2013). “Food Aid and the Challenge of Food Security in Africa”, *Development*, Vol. 56, No. 3, pp. 396-403. doi:10.1057/dev.2014.15

Djurfeldt, G., Holmen, H., Jirstrom, M. and Larsson, R. (2005), *The African food crisis: Lessons from the Asian Green Revolution*, Wallingford: CABI Publishing.

Fan, S., Zhang, X. and Rao, N. (2004), “Public expenditure, growth and poverty reduction in rural Uganda”, DSG discussion paper no. 4. Washington, DC: IFPRI.

Faurès, J.M. and Santini, G. (2008), “Water and the Rural Poor: Interventions for Improving Livelihoods in Sub-Saharan Africa”, Food and Agricultural Organization of the United Nations, Rome.

Ferreira, P. C. and Malliagos, T. G. (1998), “Impactos produtivos da infra-estrutura no Brasil – 1950-1995”, *Pesquisa e Planejamento Econômico*, Vol. 28, No. 2, pp. 315-338.

Food and Agriculture Organization [FAO] (2012), “Food and Agriculture Organization of United Nations”, available at: <http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en/> (accessed 05June 2012).

Food and Agriculture Organization [FAO] (2010), “Progress towards millennium development goal 1: hunger Target”, available at: <http://www.fao.org/hunger> (accessed 18 May 2013).

Gabre-Madhin, E. Z. and Haggblade, S. (2001), “Success in African agriculture: Results of an expert survey”, MSSD discussion paper 53. Washington, DC: IFPRI.

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. and Toulmin, C. (2010), “Food security: the challenge of feeding 9 billion people”, *Science*, Vol. 327, No. 5967, pp. 812-818.

Gomes, V., Pessôa, S. A. and Veloso, F. (2003), “Evolução da Produtividade Total dos Fatores na Economia Brasileira: Uma Análise Comparativa”, *Pesquisa e Planejamento Econômico*, Vol. 33, No. 3, pp. 389-434.

Haggblade, S. (2011), “Modernizing African agribusiness: reflections for the future”, *Journal of Agribusiness in Developing and Emerging Economies*, Vol. 1, No. 1, pp. 10-30.

Haggblade, S., Hazell, P. and Reardon, T. (2002), “Strategies for stimulating growth of the rural nonfarm economy in developing countries”, EPDT discussion paper no. 92. Washington, DC: IFPRI.

International Monetary Fund [IMF] (2012), “International Monetary Fund: data and statistics”, available at: <http://www.imf.org/external/index.htm> (accessed 20 June 2012).

International Peace Institute [IPI] (2013), “The Global Observatory”, available at: <http://theglobalobservatory.org/indices/351-indices.html> (accessed 02 September 2013).

Kitissou, M. (2014), “Africa South of the Sahara 2008-2011: hunger as a factor in political instability”, *The Journal of Pan African Studies*, Vol.6, No.7, pp. 187-195.

Martinelli, L.A., Naylor, R., Vitousek, P.M. and Moutinho, P. (2010), “Agriculture in Brazil: Impacts, costs, and opportunities for a sustainable future”, *Current Opinion in Environmental Sustainability*, Vol. 2, No. 5-6, pp. 431-438.

Mwabu, G. and Thorbecke, E. (2004). “Rural development, growth and poverty in Africa”, *Journal of African Economies*, Vol. 13, No. 1, pp. 16-65.

Mwichabe, S. (2013), “The African Agrarian Ideology and the Food Security Challenge in Sub-Saharan Africa”, *Development*, Vol. 56, No. 3, pp. 412-420. doi:10.1057/dev.2014.14

New Agriculturist (2013), “New Agriculturist Country Profile”, available at: <http://www.new-ag.info/en/country.php> (accessed 15 August 2013).

Olukoshi, A. (2005), “Investing in Africa: The political economy of agricultural growth”, *IDS Bulletin-Institute of Development Studies*, Vol. 36, No. 2, pp. 13-+.

Rodriguez, R. (2006), “Agricultural development and trade liberalization”, *Agro-Food Chains and Networks for Development*, Vol. 14, pp. 29-39.

Rosegrant, M.W. and Hazell, P. (2000), “Transforming the rural Asian economy: The unfinished revolution”, Hong Kong: Oxford University Press.

Sen, A. (1981), “*Poverty and Famines: an essay on entitlement and deprivation*”, Clarendon Press: Oxford.

Staatz, J.M. and Dembélé, N.N. (2007), “Background paper to the World Development report 2008: Agriculture for development in sub-Saharan Africa”.

The Economist (2010), “*The miracle of the cerrado: Brazil has revolutionized its own farms. Can it do the same for others?*”, The Economist, August 26, 2010, available at: [www.economist.com/node/16886442](http://www.economist.com/node/16886442).

Timmer, C.P. (2005), “Agriculture and pro-poor growth: What the literature says”, Draft paper. World Bank, Washington, DC: Agricultural and Rural Development Department.

United Nations Statistics Division [UNSD] (2012), “National Accounts Main Aggregates Database”, available at: <http://unstats.un.org/unsd/snaama/selbasicFast.asp> (accessed 05 June 2012).

Van Dijk, H. (2008), “Political Instability, Chronic Poverty And Food Production Systems Incentral Chad”, Inside Poverty and Development in Africa, pp.119–143. Available at: <http://dx.doi.org/10.1163/ej.9789004158405.i-306.40>.

Van Rooyen, J. and Sigwele, H. (1998), “Towards regional food security in southern Africa: a (new) policy framework for the agricultural sector”, *Food Policy*, Vol. 23, No. 6, pp. 491-504.

WFP, 2011. World Food Programme. Available at: <http://http://www.wfp.org> (accessed 22 May 2013).

World Bank (2010), “*Africa and Brazil Form Knowledge Partnership to Boost African Agriculture*”, The World Bank, November 02, 2010, available at: <http://www.worldbank.org/en/news/2010/11/02/africa-brazil-form-knowledge-partnership-boost-african-agriculture> (accessed 07 June 2012).

World Bank (2013). “The World Bank Database”, available at: <http://www.worldbank.org/> (accessed 22 May 2013).

World Food Programme [WFP] (2011), “World Food Programme”, available at: <http://http://www.wfp.org> (accessed 22 May 2013).

Yan, Y., Yi-Xiang, Z. and Yi, L. (2009), “The Policies for Promoting Agricultural Export in Brazil and the Reference Meaning to China”, *Proceedings of 2009 International Conference on Public Administration (5<sup>th</sup>)*, Vol. 2, pp. 919-923.

## **CAPÍTULO 3:**

### **FOOD INSECURITY WORLDWIDE DERIVED FROM FOOD SUPPLY PATTERNS<sup>3</sup>**

#### **ABSTRACT**

Worldwide, humanity is facing severe nutritional imbalances, which are dependent on access to food and the dietary habits of particular populations that can make them susceptible to malnutrition. This study aims to identify and analyze the main food supply patterns (FSPs) of populations worldwide, and then to relate them to their respective malnutrition conditions. The hypothesis is that there are specific, geographically identifiable FSPs that are associated with the nutritional misalignment of certain populations to a greater degree than others. This investigation is based on data regarding the supply of the main food groups worldwide, as well as the metrics associated with malnutrition. Data analyses were performed using descriptive statistics, cluster analysis, ANOVA, and correlation analysis. The results suggest the existence of nine clusters of countries with specific FSPs that differ significantly regarding their supplies of macronutrients and their malnutrition traits. Furthermore, using Pearson's coefficient of variation (CV) to assess the balance level (or symmetry) of each FSP, reflecting the average supplies of food groups, the results suggest the existence of a positive and significant correlation ( $r=0.6364$ ;  $p=0.000$ ) between the imbalance level of particular FSPs and the prevalence of underweight children in their respective populations. Thus, FSPs 1, 3, and 4 are strongly associated with obesogenic traits, with FSP 3 being the most strongly associated with the prevalence of overweight. According to our analyses, the FSPs of Southern Africa (with a strong prevalence of child overweight) and Southern Asia (with a strong prevalence of child underweight) lead to the worst conditions observed, while the populations with the best nutritional status are based on the FSP of Eastern Asia.

**Keywords:** food security; world development; dietary models; nutritional composition; obesogenic environment; malnutrition

#### **1. INTRODUCTION**

According to the United Nations Food and Agriculture Organization (FAO), food security refers to a situation where “all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and

---

<sup>3</sup> This paper has been published at Food Security (ISSN: 1876-4525) in version Online First in 26-November-2014. (ANNEX 3, pp. 158). DOI: 10.1007/s12571-014-0405-x.



food preferences, for an active and healthy life” (FAO 1996; FAO 2002). Thus, food security is related to the availability, accessibility, and use of adequate food (Barrett 2002; Barrett et al. 2010; Webb et al. 2006). Therefore, assuming that provision of food security involves ensuring the conditions under which individuals can purchase/acquire enough food and nutrients to meet their needs (Sen 1981), it has become necessary to conduct an investigation based on identifying the main global food supply patterns (FSPs).

Food security is a complex concept that encompasses several indicators and diagnoses. The present investigation uses the anthropometry perspective of measuring food insecurity (Cunningham 2005) using specific indicators as proxies, such as prevalence of underweight and overweight children, undernourished population, and average body mass index (BMI) (Maxwell and Frankenberger 1992; FIVIMS 2002; Cogill 2003). It is also important to emphasize that overweight and obesity are considered serious nutritional disorders arising from food insecurity, as these diagnoses, together with underweight and hunger, result from inadequate human nutrition (Eckholm and Record 1976). Furthermore, these nutritional anomalies, although they may be seen as paradoxical (Caballero 2005), can coexist in some regions or societies.

In light of the global challenge to properly feed the world’s growing population (Godfray et al. 2010), the aim of this study is to identify and analyze the main FSPs of the world’s populations and to relate them to their respective malnutrition conditions. It is important to highlight that malnutrition is a broad concept that includes diagnoses related to obesogenic problems as well as to underweight and undernourishment. The main hypothesis of this research is that there are specific, geographically referenced FSPs that are associated with the nutritional misalignment of populations. This study also uses FSPs as proxies for dietary patterns, as data regarding food consumption are not available on a global scale.

## **2. METHOD**

This ecological study is based on the analysis of data obtained from the FAO (2013a) regarding supplies of the main food groups in populations around the world. In terms of population groups and types of food, the data included 19 people groups and 95 major types of food produced and consumed worldwide. The data relating to global nutritional misalignment (e.g., undernourished, underweight, and overweight populations) were obtained from the United Nations Statistics Division (UNSD 2013) and the World Health Organization (WHO 2013). The main variables used in the empirical investigation are described in Table 1.

Table 1 – Main variables and their descriptions and sources

Variables	Definition	Source	Year of data
Supplies of food groups	Supply of the main food groups in a population (grams/person/day). Values are based on estimates of per capita food supplies available for human consumption during the reference period in terms of quantity (FAO 2013a).	FAO	2009
CV for food supply pattern	Coefficient of variation (ratio between standard deviation and arithmetic mean) of the supply quantity of each main food group by given population.	Based on FAO data	Based on 2009
Energy supply (kcal/capita/day)	Total energy supply in a population (kcal/capita/day). Values are based on estimates of per capita food supplies, in kilocalories, available for human consumption during the reference period (FAO 2013a).	FAO	2009
Overweight population	Percentage of defined population with a body mass index (BMI) of 25 kg/m <sup>2</sup> or higher (WHO 2013).	WHO	2008
Obese population	Percentage of defined population with a body mass index (BMI) of 30 kg/m <sup>2</sup> or higher (WHO 2013).	WHO	2008
Average BMI	Mean body mass index (BMI), aged standardized estimate, in kg/m <sup>2</sup> of defined population (WHO 2013).	WHO	2008
Children <5 years of age who are moderately or severely underweight	Percentage of children aged 0–59 months whose weights for age are more than two standard deviations below the median weight for age of the international reference population. Severely underweight children are those whose weight for age is less than minus 3 standard deviations below the median weight for age (UNSD 2013).	UNSD	2005–2010 <sup>a</sup>
Undernourished population	Percentage of the population that is undernourished or food deprived. This category includes individuals whose food intake falls below the minimum level of dietary energy requirements (UNSD 2013).	UNSD	Mean 2006–2011 <sup>b</sup>
Children <5 years of age who are underweight	Percentage of underweight (weight-for-age less than -2 standard deviations of the WHO Child Growth Standards median) among children aged 0–5 years (WHO 2013; de Onis and Blössner 2003).	WHO	2012
Children <5 years of age who are overweight	Percentage of overweight (weight-for-height above +2 standard deviations of the WHO Child Growth Standards median) among children aged 0–5 years (WHO 2013; de Onis and Blössner 2003).	WHO	2012
Children <5 years of age whose growth is stunted	Percentage of stunting (height-for-age less than -2 standard deviations of the WHO Child Growth Standards median) among children aged 0–5 years (WHO 2013; de Onis and Blössner 2003).	WHO	2012

Note: <sup>a</sup> We used available data for each nation between 2005 and 2010; <sup>b</sup> We calculated the average using available data between 2006 and 2011.

Using the available data, this study considered 173 countries. Analyses could not be performed for all countries worldwide, as data for some variables were missing for some nations. In order to select the most important food groups for the composition of worldwide FSPs, basic descriptive statistics of food supplies were analyzed for 19 food groups (Table 2).

Table 2 – Descriptive statistics for world supplies of main food groups in 2009

<b>Food Group</b>	<b>N Valid</b>	<b>Average<sup>a</sup></b>	<b>Minimum<sup>a</sup></b>	<b>Maximum<sup>a</sup></b>	<b>Standard Deviation<sup>a</sup></b>	<b>Coefficient of Variation (%)<sup>b</sup></b>
Alcoholic beverages	175	124.13	0	561	112.08	90.29
Cereals (excluding beer)	176	370.43	95	678	107.34	28.98
Fruits (excluding wine)	176	233.42	2	1091	144.85	62.06
Oil crops	174	28.93	0	492	63.69	220.17
Pulses	175	17.53	0	88	16.81	95.86
Starchy Roots	176	204.73	21	1154	189.79	92.70
Sugar and sweeteners	176	83.02	7	177	42.78	51.52
Vegetable oils	176	31.37	3	77	16.37	52.20
Vegetables	176	237.12	24	881	173.62	73.22
Animal fats	176	11.55	0	73	14.54	125.91
Eggs	176	17.58	1	53	13.16	74.83
Fish, seafood	176	49.71	1	381	49.46	99.50
Meat	176	130.61	11	329	83.58	63.99
Milk (excluding butter)	176	299.20	6	1028	244.81	81.82
Spices	176	2.73	0	20	3.46	126.92
Stimulants	176	12.19	0	57	10.97	90.00
Tree nuts	173	5.97	0	43	7.27	121.83
Offal	176	6.93	0	29	4.93	71.14
Aquatic products, other	164	0.68	0	50	4.38	647.01

Note: The food groups in black were selected to be evaluated through cluster analyses. The food groups in red were not selected to be evaluated through cluster analyses; <sup>a</sup> grams/person/day; <sup>b</sup> ratio between standard deviation and average.

Source: Adapted from FAO (2013a)

From these nineteen groups, fourteen food groups were selected, taking into account the availability of data, the average world supply, and the maximum amount observed. Five food groups were not considered for further analysis due to the low average supply or the low maximum amount supplied. The food groups were initially selected considering their average supply value. Food groups with average supplies of less than 10 grams/person/day (spices, tree nuts, offal, and other aquatic products) were excluded. Then, taking the standard deviation and considering the low average and standard deviation values of stimulants, we decided to exclude that group as well, leaving 14 food groups.

After selecting the most important food groups, data regarding their worldwide supplies were analyzed through a cluster analysis that aimed to group countries with similar FSPs of the 14 food groups selected. Cluster analysis is based on procedures and classification algorithms that can be used to develop taxonomies. In this study, we used cluster analysis based on the joining method (or tree clustering), which aims to join objects together into successively larger clusters, using some measure of similarity or distance. Usually, the result of this type of clustering is a hierarchical tree (dendrogram). The joining method uses dissimilarities or distances between objects when forming the clusters. As the first step, the distances between the objects are defined by the chosen distance measure. In this study, we used a distance measure based on Pearson's correlation (distances were computed using one

minus the Pearson product-moment correlation coefficient for each pair of objects). It is also necessary to define a linkage or amalgamation rule to determine when two clusters are sufficiently similar to be linked together. In this study, we used complete linkage as the amalgamation rule. In this method, the distances between clusters are determined by the greatest distance between any two objects in the different clusters. All clustering procedures were performed using Statistica 8.0 software. This technique made it possible to observe the major global food compositions by considering food supplies as well as their respective countries.

The clusters obtained were analyzed using descriptive statistics (average supply and CV for each food group for each cluster). These findings were then elaborated as radar graphs, using average supply data of each of the 14 food groups in the countries in each cluster. Thus, the values presented in the radar graphs are arithmetic means of the data provided by the FAO regarding the supply quantities of each food group in the nations of each cluster in 2011. These radar graphs were elaborated to facilitate visual comparisons of the clusters. Finally, the clusters were subjected to ANOVA and Kruskal–Wallis tests in order to test the hypothesis of significant differences between clusters in terms of the supply of macronutrients.

The study also used Pearson's CV to assess the balance (or imbalance) levels of the FSPs. Balance level is a metric that evaluates the symmetry of nations' food group supplies and the symmetry of FSPs. For example, a nation strongly dependent on just one food group has a strong imbalanced (or asymmetric) supply. The CV, which measures the balance level of a food supply, is the ratio between the standard deviation and the arithmetic mean. In this study, the CV was calculated using the food group supplies (grams/person/day) addressed by the study, weighted by considering the average ingestion (grams) per capita per day. This metric was calculated initially using the supply data of each nation. Then, the CVs of the nations were used to calculate the average CVs of the clusters (or FSPs). Thus, we studied the CV of each nation and of each cluster. Regarding this metric, it is important to note that we understand that there are currently no nutritional recommendations pertaining to food groups that can be applied in all countries. Indeed, we assume that there is no recommendation for a better or worse CV, as a perfectly balanced FSP (with equal quantities of food group supply/intake) is far from ideal, given the different levels of nutrients and energy densities across the food groups. However, the CV was used to assess the balance levels of the FSPs, assuming that this specificity could test the premise that extremely imbalanced FSPs are strongly associated with food insecurity. Thus, we assessed the correlation levels between the

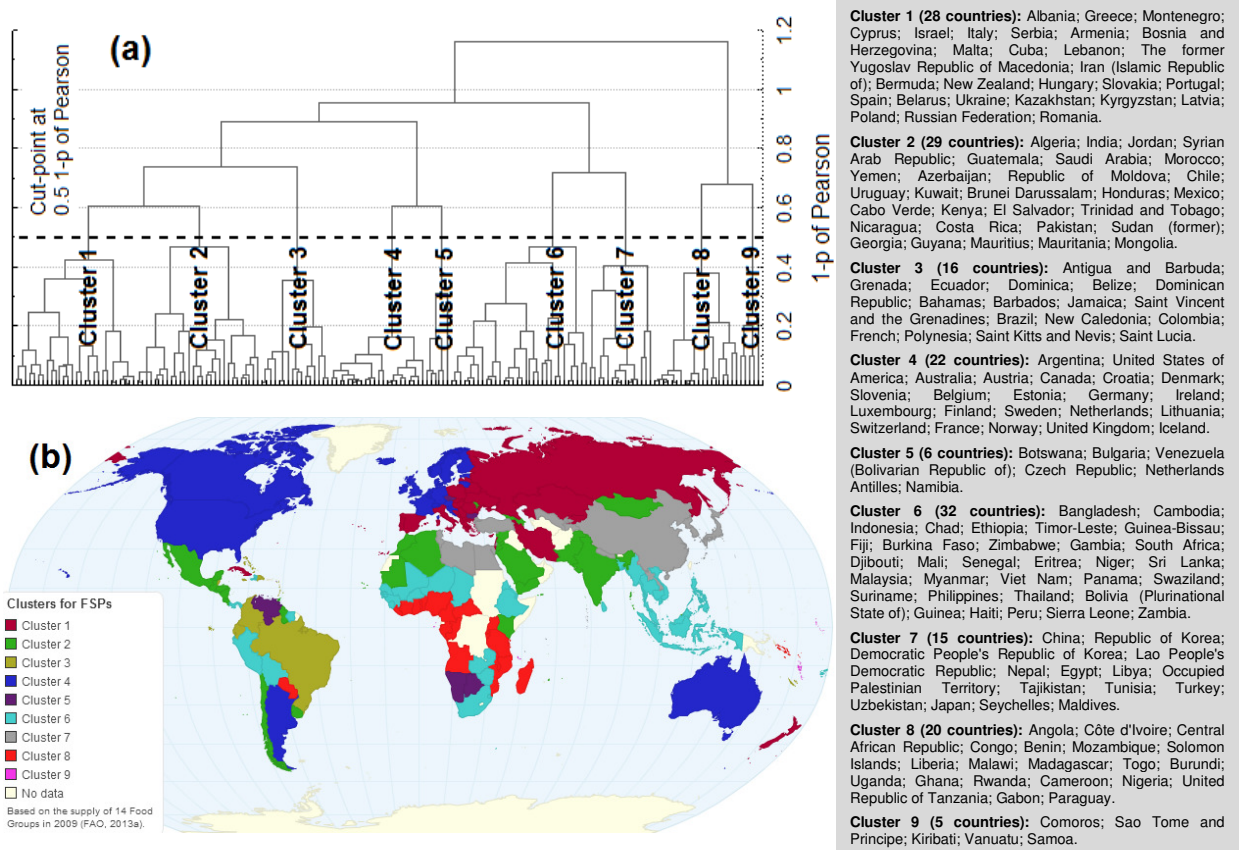
balance of each FSP (CV of food group supplies) and the respective nutritional misalignment situation in each country.

### 3. RESULTS

This section explores the empirical evidence obtained through a cluster analysis of the 173 countries that presented valid data regarding the average supply of the 14 main food groups selected. Considering the results obtained from the cluster analysis, it was possible to define nine clusters of countries representing the main FSPs worldwide. After these descriptive analyses, the nine patterns were located geographically. This section presents the analyses of variance performed to compare the nine clusters in terms of energy intake, average BMI, undernourishment, and overweight in the different populations. We chose these indicators assuming that they are capable of identifying food insecurity issues associated with obesogenic conditions as well as with hunger and underweight problems. The obesogenic condition is related to the definition of the obesogenic environment, which is “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations” (Swinburn and Egger 2002).

A cluster analysis was adopted to identify the main clusters of countries delineated by their food supplies, and the dendrogram resulting from this analysis (Figure 1a) shows nine groups with different FSPs. The criteria adopted to select these nine groups were the 1-Pearson lower than 0.5. A careful analysis of this dendrogram can suggest the existence of other specific FSPs in addition to the nine models discussed. However, this study is limited to exploring the peculiarities of the nine FSPs. Figure 1 shows the dendrogram resulting from the cluster analysis, the countries in each cluster, and the geographical distribution of the FSPs.

Figure 1 – Clusters of food supply patterns (FSPs) and their geographical distribution



Note: This figure shows: (a) the dendrogram obtained through cluster analysis; (b) the geographical distribution of FSPs worldwide. Countries for each cluster are listed in order. Number of countries in each cluster is indicated in parentheses.

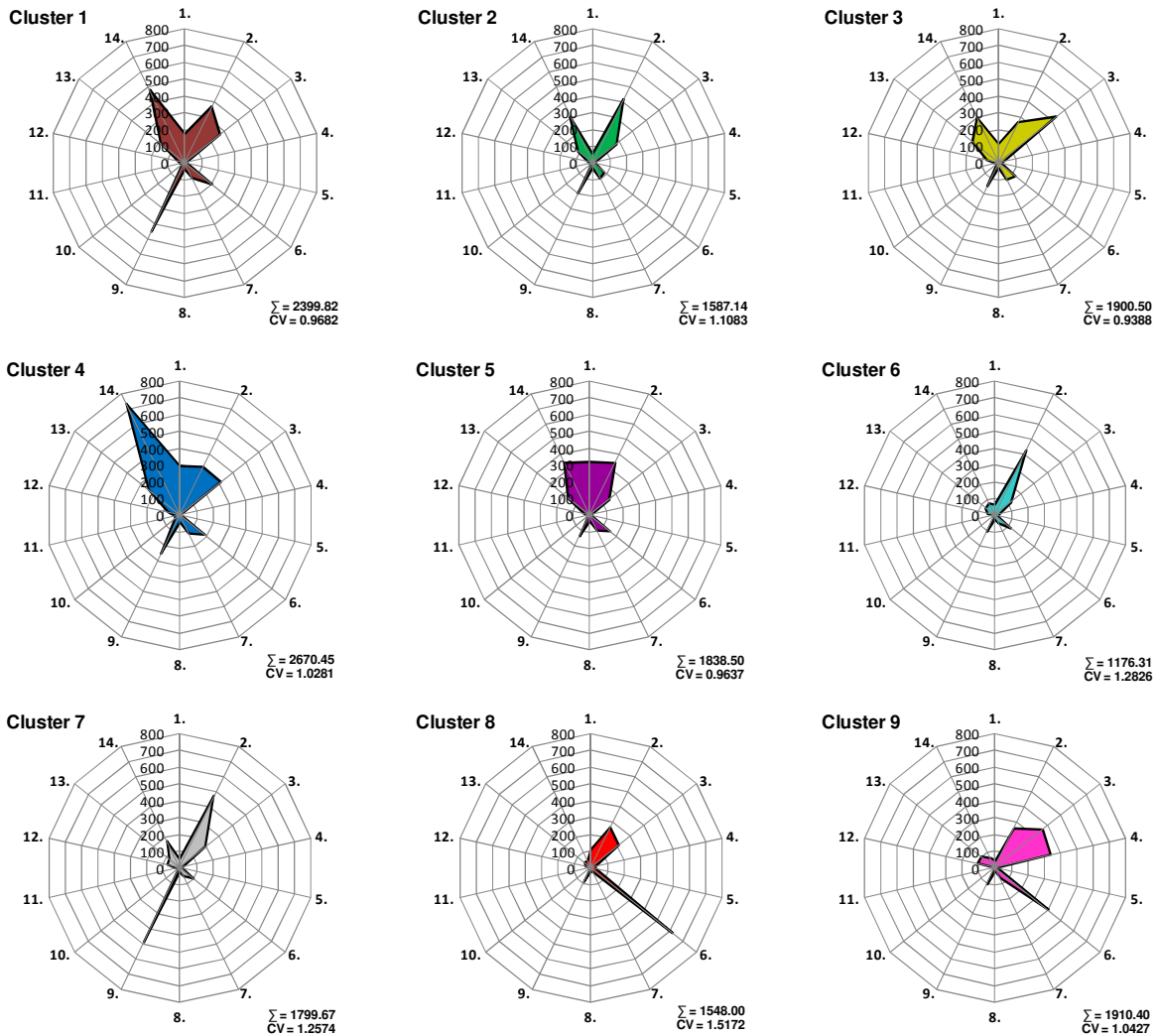
Preliminary analysis of the dendrogram resulting from the cluster analysis highlights nine groups of countries with similar FSPs. Despite the fact that those clusters could be split into more specific clusters, given the intentions of this study, the subgroups will not be explored in depth. However, this evidence might support additional studies in the future. In addition, it should be noted that the decision to subdivide the sample of countries into groups and subgroups adopts a subjective criterion based on a cutoff of significant 1-Pearson. Thus, different views and interpretations can be considered.

It is noteworthy that FSP 8 is more strongly present in central Africa, where some poor countries show serious undernourishment problems. FSP 6 is also observed in Africa, as well as in Southern Asia and South America, which are also regions with seriously undernourished populations. Initial evidence suggests that FSPs 6 and 8 are associated with regions where there is the greatest severity of food insecurity, involving problems of undernourishment.

Considering the nine main country groups highlighted above, the nine FSPs derived from the cluster analysis will now be presented (Figure 2), considering the average supply (g/person/day) of the 14 selected food groups. To perform the comparative analysis, radar

charts were used in this study in order to facilitate the visualization. In addition, this report presents the CVs of all nine FSPs, based on the heterogeneity of the food group supplies.

Figure 2 – Food supply patterns (FSPs) of the nine clusters, considering grams/person/day of the 14 supplied food groups



Note: 1. Alcoholic beverages; 2. Cereals; 3. Fruits; 4. Oil crops; 5. Pulses; 6. Starchy roots; 7. Sugar and sweeteners; 8. Vegetable oils; 9. Vegetables; 10. Animal fats; 11. Eggs; 12. Fish and seafood; 13. Meat; 14. Milk. Values in the radar graphs were calculated through the arithmetic mean of food supplies of nations in each cluster. CV is Pearson's coefficient of variation obtained from the ratio between the standard deviation and the arithmetic mean. CV presented for each cluster is the arithmetic mean obtained from the CVs of the respective countries.

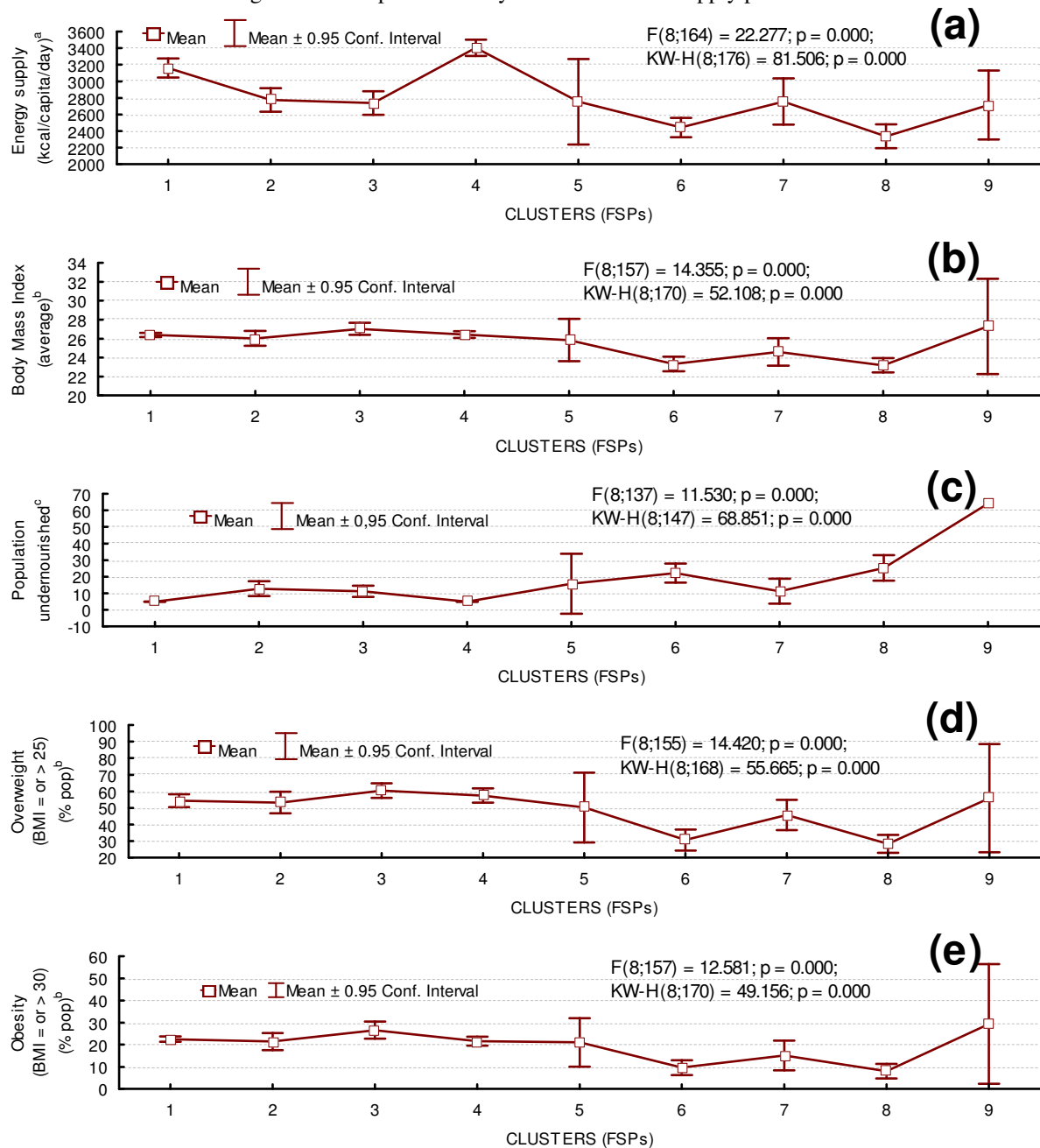
This study presents original findings and an alternative worldwide clustering of dietary patterns relative to an earlier study (GEMS/Food cluster diets 2012) that reported 17 clusters of nations with similar dietary models (Sy et al. 2013; WHO 2014). We derived nine convergent FSPs, showing their food supply characteristics; it is possible to derive clusters and FSPs that are more specific through observation of the dendrogram (Figure 1). Another original issue is that this study considers the imbalance level of FSPs as an important metric

that deserves attention. Thus, we used these initial findings to verify whether specific FSPs are more closely associated with the nutritional misalignment of populations (considering undernourishment, underweight, and overweight) than others.

Evidence suggests that each of the nine FSPs is associated with a different condition of nutritional supply and consumption. Thus, the FSPs addressed here, such as FSPs 6 and 8, might be associated with the undernourishment condition common in certain regions, given the fact that those two models provide an inadequate amount of macronutrients to ensure food security. On the other hand, other FSPs might be associated with obesogenic conditions. An analysis of variance can elucidate these assumptions, based on the initial findings (Figure 3).



Figure 3 – Comparative analyses between food supply patterns



Note: <sup>a</sup> data for 2009 obtained from FAO (2013a); <sup>b</sup> data for 2008 obtained from WHO (2013); <sup>c</sup> data regarding the average between 2006 and 2011 obtained from UNSD (2013). Graphs show a comparison between clusters (or FSPs) regarding specific data of nations. The comparison was performed considering (a) food supply (kcal/capita/day); (b) average BMI; (c) prevalence of undernourished people; (d) prevalence of overweight people; and (e) prevalence of obese people.

The results obtained through the ANOVA and Kruskal–Wallis test, testing the differences between the nine FSPs in terms of energy supply, average BMI, undernourishment, and prevalence of overweight/obesity, suggests that the FSPs differ significantly ( $p < 0.001$ ). Furthermore, FSPs 1 and 4 have higher energy (kcal) levels and lower rates of undernourished people. The evidence suggests that FSPs 1, 3, and 4 are associated

with regions with greater food supplies. On the other hand, the evidence also suggests that the countries of clusters 1, 3, and 4 may be associated with obesogenic environments. Indeed, cluster 3 has the highest prevalence of obesity. In addition, the evidence suggests that FSPs 6 and 8 have a lower average supply of energy, with higher levels of undernourishment. Therefore, those FSPs may be associated with regions with greater food insecurity and problems related to undernourishment and severe hunger. Considering that food security is associated with the availability, accessibility, and use of adequate food (Barrett et al. 2010), it is logical to assume that clusters 6 and 8 are strongly associated with food insecurity, as their FSPs are strongly dependent on just one food group (cereals in cluster 6 and starchy roots in cluster 8).

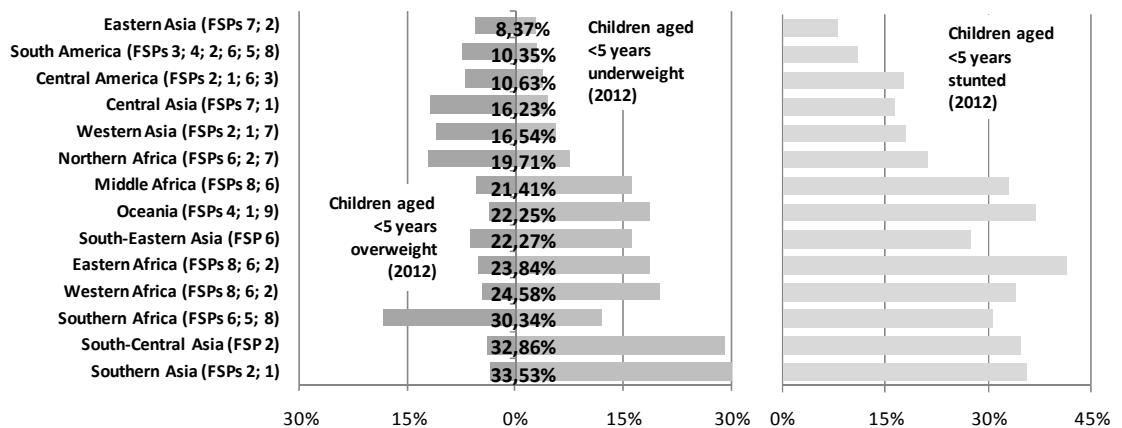
Giving continuity to the analysis of the relationship between the specific FSPs and the food insecurity level faced by particular nations, this study correlates the balance level of the different FSPs (CV of food group supplies) with the prevalence of underweight children, highlighting that this relationship is significant and indicating concerns about the implications of imbalance in FSPs. The findings reinforce the argument that imbalances in FSPs aggravate food insecurity worldwide, as indicted by the prevalence of underweight children. The correlation between the balance level achieved by the supply of food groups and the proportion of children under the age of 5 years who are moderately and severely underweight is strongly positive and significant ( $r=0.6364$ ;  $p<0.001$ ). Thus, the coefficient of determination ( $R^2$ ) indicates that the balance level of food group supply is strongly associated with the proportion of underweight children worldwide (0.4051). We also observed that African nations in the sub-Saharan region are among those with a pronounced imbalance in their FSPs and higher rates of underweight children. On the other hand, European and American countries have FSPs that are more balanced and lower rates of underweight children.

Regarding the correlation between the balance level of the food group supply and the average BMI, evidence suggests a strong negative and significant association ( $r= -0.6536$ ;  $p<0.001$ ). Thus, the coefficient of determination ( $R^2$ ) indicates that the balance level of the food group supply is strongly associated with the average BMI of populations worldwide (0.4272). Regarding the correlation between the balance level of the food group supply and the prevalence of obese people ( $BMI \geq 30$ ), the evidence suggests a strong negative and significant association ( $r= -0.5977$ ;  $p<0.001$ ). Thus, the coefficient of determination ( $R^2$ ) indicates that the balance level of food group supplies is moderately associated with a significant number of obese people in nations worldwide (0.3573). These results corroborate

the other correlations. In addition, the findings related to obesogenic problems show that the balance level of an FSP is strongly associated with malnutrition problems.

Considering the hypothesis that specific FSPs are more strongly associated with food insecurity conditions, resulting in both underweight and overweight traits, we combined the rates of overweight, underweight, and stunted children in Figure 4, associating these data with the main global regions and the main FSPs of the clusters addressed in this study.

Figure 4 – Food supply patterns (FSPs) of main regions and their rates of underweight, overweight, and stunted children in 2012



Source: Adapted from WHO (2013).

Evidence indicates that Southern Asia and South-Central Asia face high rates of underweight and stunted children, suggesting that FSPs 1 and 2 are more strongly associated with underweight conditions than with obesogenic problems. We can also observe that Oceania, which has FSPs 4, 1, and 9 as the most pronounced patterns, faces moderate problems of underweight children and low rates of overweight children. On the other hand, Western Africa, Eastern Africa, South-Eastern Asia, and Middle Africa have moderate rates of underweight children and low rates of overweight children. This profile is strongly associated with FSPs 8 and 6. Another group of regions, formed by Central America, South America, and Eastern Asia, presents low rates of both underweight and overweight children. In that group, the FSPs are based on a wide supply, suggesting the absence of a specific supply pattern that could explain their profile with regard to their rates of underweight and overweight children. In addition, Northern Africa, Western Asia, and Central Asia have moderate levels of overweight and underweight children in their populations, and their diets are strongly based on FSPs 1, 2, and 7. The evidence suggests that FSP 3, which is strongly based on fruit supplies and is observed strongly in South America, is associated with low rates of underweight and overweight children. The results also suggest that FSP 7 is associated with

lower rates of underweight children. Thus, FSPs 6 and 8 are observed in regions that face moderate rates of underweight children and high rates of stunted children. Southern Africa is a region that faces high rates of overweight children, moderate rates of underweight children, and high rates of stunted children, showing a prominence of FSPs 6 and 8. On balance, the empirical evidence supports the main hypothesis of this study, which is that specific, geographically referenced FSPs are associated with nutritional misalignment and food insecurity problems worldwide, considering child overweight, underweight, and stunting as proxies.

#### **4. DISCUSSION**

Bearing in mind the prediction that the world will have approximately nine billion people by 2050, the question is raised whether there will be enough food to meet the nutritional needs of the entire world population in the future (Godfray et al. 2010). This concern is exacerbated by the fact that despite global efforts to combat hunger and undernourishment, an estimated 842 million people suffered from chronic hunger in 2011–2013, meaning that they did not have enough food to meet their nutritional needs and to conduct an active life (FAO 2013b). On the other hand, in 2008, more than 1.4 billion adults (20 years of age and older) were overweight, and over 200 million men and nearly 300 million women were diagnosed as obese. In 2008, nearly 11% of the world's adult population was obese, and 35% of adults (age 20 and over) were overweight (WHO 2013, Patel 2008).

Despite the fact that one of the main goals of the millennium is the eradication of extreme poverty and hunger by 2015 (United Nations Statistics Division [UNSD] 2013), many developing nations are still facing severe hunger and undernourishment problems. Indeed, global strategies to combat hunger need to be far more clearly defined if this reality is to be achieved (FAO 2010a). It seems reasonable that global food distribution is not aligned to global food needs (De Schutter 2011). India, for example, is a country where alarming proportions of its population suffer from food anomalies, both in terms of overweight/obesity and hunger/undernourishment (Doak et al. 2005; Stein et al. 2005). African and Asian countries, in particular, have little evidence to indicate positive results in their fight against hunger, undernourishment, and diagnoses of underweight populations (FAO 2010b). Approximately 65% of the world's population that suffers from hunger lives in one of seven countries (India, China, Democratic Republic of Congo, Bangladesh, Indonesia, Pakistan, and Ethiopia) (FAO 2010a). Many African and Asian countries are included among those with the

worst conditions in terms of food security, as well as the least progress toward achieving the millennium goal relating to the eradication of hunger (FAO 2013b; FAO 2010b). Furthermore, evidence shows that it is children who are most strongly affected by the nutritional disorders of hunger and undernourishment worldwide. Indeed, undernourishment is associated with the deaths of five million children under five years of age every year in the developing countries (UNICEF 2006a). Approximately 146 million children living in developing economies are underweight (UNICEF 2007), and these are mostly concentrated in South Asia and Africa (UNICEF 2006b).

It is known that regular consumption of important nutrients (Eppolito and Papareschi 2009; Klein and Moller 2010) can lead to better health, thereby fighting food insecurity. It is also known that insufficient consumption of fruits and vegetables in childhood significantly increases the risks associated with developing chronic diseases, such as cardiovascular disease (Wolfenden et al. 2012). The Dietary Guidelines for Americans recommend a regular intake of five servings of fruits and/or vegetables a day, arguing that individuals who follow this guideline tend to be healthier (U.S. Department of Agriculture and U.S. Department of Health and Human Services 2010). Thus, a significant increase in the availability, affordability, and consumption of vegetables and fruits can contribute to the fight against food insecurity (Keatinge et al. 2011). Empirical results show that FSPs 1 and 7 have prominent supply levels of vegetables, and FSP 3 has a high fruit supply, suggesting that these FSPs have positive specificities.

Important evidence suggests that regular ingestion of fruits and vegetables can improve the food security condition of people (Miewald, Holben, & Hall 2012). Evidence shows that FSPs 3, 7, and 9 have significant supply levels of fish and seafood, probably associated with their wide coastal area. It is reasonable to assume that a high level of fish and seafood consumption is related to the health of a population, as evidence suggests that seafood consumption has positive effects on human health (Mozaffarian and Rimm 2006; Sioen et al. 2007). Aquatic food is an important component of a healthy diet, improving nutrition and overall health (Tacon and Metian 2013). Fish consumption is specifically associated with a lower risk of type 2 diabetes (Patel et al. 2009). A healthy diet should ensure the ingestion of at least two portions of fish per week (Moore et al. 2010), and FSPs 3, 7, and 9 have the appropriate conditions to ensure this.

Observing the locations of the nine main FSPs, we raised the likelihood of a possible relationship between the FSPs and the urgency of some countries regarding food security. The ANOVA results suggested that the nine FSPs are significantly different, varying in the

average intake of energy (kcal), average BMI, prevalence of undernourishment, and prevalence of overweight in the populations involved. These findings, therefore, reinforce the argument that the specific traits of FSPs identified worldwide are associated with the food insecurity faced in some of these countries. FSPs 1 and 4 are associated with obesogenic problems, while FSPs 6 and 8 are associated with higher levels of hunger and undernourishment (UNICEF 2006b). The assumption that FSPs may be associated with food insecurity is corroborated through evidence that suggests a strong positive correlation between the imbalance levels of the world's FSPs and the proportion of children who are underweight, as well as a strong negative correlation between this imbalance level and the average BMI. These findings suggest that imbalanced FSPs are often associated with undernourishment and underweight problems. Therefore, populations that strongly depend on just one or two food groups (e.g., FSPs from clusters 6 and 8) to sustain their nutritional necessities have a higher tendency toward undernourishment.

Our results indicate that imbalanced FSPs are associated more closely with child undernourishment. Severe undernourishment in childhood can significantly compromise the cognitive capabilities of individuals in an irreversible way (Dobbing 1972). In addition, undernourished children are especially vulnerable to disease, and they can die from common infections, such as measles and diarrhea (Caulfield et al., 2004). Efforts to avoid this scenario should be made a priority by governments and the private sector.

Despite globalization, which facilitates food transactions between nations and aims to provide adequate food access to people with insufficient food production, the food supply in many developing countries still depends strongly on local production (Funk and Brown 2009). Evidence indicates that the majority of households in developing countries are involved in agricultural activities, and that their production is consumed locally (Lamb 2000). Local production by small farms in developing countries plays a key role in supplying the food necessities of its population, particularly in poorer regions, such as sub-Saharan Africa (Devereux and Maxwell 2001). Therefore, it is reasonable to argue that increasing local production in poorer regions with serious food security problems has the potential to alleviate hunger and undernourishment (Schmidhuber and Tubiello 2007). However, these local populations generally have limited access to just a few food groups, such as cassava in some regions of Africa (Babaleye 2005) and rice in some Asian countries. This limited access can be associated with the existence of an inadequate logistics infrastructure, with evidence suggesting that countries with severe hunger and malnutrition problems also have deficient logistics infrastructures (FAO 2013b; World Bank 2013).

Furthermore, dietary changes observed globally indicate a diet dominated by a higher consumption of caloric sweeteners and animal foods (Popkin 2006). In addition, large-scale reductions in food prices (e.g., the price of beef), increased access to supermarkets (Popkin 2009), and the growth and dominance of multinational food companies (Big Food) that offer cheap products rich in fat (Stuckler et al. 2012) are all factors that strongly contribute to the nutritional changes that humanity has experienced in recent decades in both developed and developing countries. Evidence indicates that increased consumption of such “unhealthy” foods has been higher in low- and middle-income countries than in high-income countries (Stuckler et al. 2012). Thus, it is reasonable to assume that the negative effects of the high intake of such foods, with their resulting aggravation of nutritional anomalies, will continue to increase in developing countries.

Another important issue to be discussed is the environmental implications of FSPs, as the production and supply of food strongly affects climate change (Skouteris et al. 2013). Evidence shows that the production and supply of some food groups, such as meat, are responsible for a greater portion of the main environmental effects (Hoolohana et al. 2013; Van Kernebeeka et al. 2013; Carlsson-Kanyama and González 2009). In terms of water footprint, 15,415 liters of water are required to produce 1 kg of bovine meat, and 8,763 liters of water are required to produce 1 kg of sheep/goat meat. On the other hand, only 322 liters of water are needed to produce 1 kg of vegetables, and 387 liters are needed to produce 1 kg of starchy roots (Mekonnen and Hoekstra, 2010). It seems reasonable, then, to suggest that the high supply levels of meat and milk in FSP 4 are associated with high levels of environmental impact. On the other hand, FSPs 6, 7, 8, and 9 are associated with lower levels of environmental impact.

## **5. CONCLUSIONS**

While a similar study (WHO 2014), using a methodological approach proposed by Sy et al. (2013), reported 17 food cluster diets worldwide, the present investigation used a different methodological approach, with different empirical results, thereby justifying its originality. The empirical findings reported in this paper potentially contribute to the theoretical field as practical initiatives that can help in fighting food security problems and nutritional disorders worldwide. This goal might be ambitious, but the implications of these findings regarding the positive association of the imbalance levels of FSPs and malnutrition severity worldwide might affect theoretical fields related to nutrition, public health,

agriculture, social sciences, natural resources, and economic development. In addition, we need to emphasize the implications of these findings for the field of agribusiness (production, trade, logistics, and consumption of foods). Thus, political and private actions concerned with fighting food insecurity worldwide might start their efforts by supplying the world's population with balanced FSPs in order to guarantee their nutritional safety and health.

Actions focused on agricultural production and yield, diversification of crops, and guarantees of a balanced diet for the world's population might have positive effects in the fight against malnutrition by promoting food security. Furthermore, efforts focused on the integration of food, health, and environmental approaches, thereby creating resilient regional food systems (Wahlqvist et al. 2012), are urgently needed. The results presented in this paper should make policy makers aware of the need to consider the implications of balancing food intake modes in relation to food security, in order to be able to better articulate food and nutritional programs to fight hunger and undernourishment. It is important to highlight that an essential issue to be investigated and improved upon is the worldwide logistics infrastructure, in order to allow certain food groups to reach nations that have an urgent need for balanced FSPs (e.g., sub-Saharan Africa and the extreme south of Asia). We consider this to be a research opportunity for future studies.

It should be emphasized that this study has some significant limitations, as the findings can be regarded as vague, with results needing further and more specific investigation. An important limitation is the fact that available data are from different years and for different countries. Some nations, given their territory extension and different food habits, have a more complex food supply profile than others. Furthermore, we suggest additional investigations highlighting the relationship between the details of the FSPs and the severe malnutrition experienced in certain societies. Additional issues should be considered for future studies, such as processing food and climate change. Some continental countries, such as Brazil, the USA, and China, enjoy a wide range of FSPs, and specific investigations of their regions and provinces might better elucidate this issue of FSPs and food security.

## **6. REFERENCES**

Babaleye, T. (2005). Can cassava solve Africa's food crisis? *African Business*. 314, 24-25.



Barrett, C.B. (2002). Food Assistance and Food Security Programs, in: Gardner B.L., Rausser, G.C. (Eds.), *Handbook of Agricultural Economics*, Elsevier Science, Amsterdam, Vol. 2B.

Barrett, C.B. (2010). Measuring food insecurity. *Science*. 327 (5967), 825-828.

Caballero, B. (2005). A nutrition paradox – underweight and obesity in developing countries. *N Engl J Med*. 352, 1514–1516. doi: 10.1056/NEJMp048310.

Carlsson-Kanyama, A., & Gonzales, A. (2009). Potential Contributions of Food Consumption Patterns to Climate Change. *Epidemiology*, 20, S238. doi:10.1097/01.ede.0000362799.46174.56

Caulfield, L.E., Onis, M., Blössner, M., & Black, R. E. (2004). Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. *Am J Clin Nutr*. 80(1), 193-198.

Cogill, B. (2003). *Anthropometric Indicators Measurement Guide*. Food and Nutrition Technical Assistance Project, Washington, DC.

Cunningham, L. (2005). Assessing the contribution of aquaculture to food security: a survey of methodologies. *FAO Fisheries Circular*. No. 1010. Rome, FAO.

de Onis, M., & Blössner, M. (2003). The World Health Organization Global Database on Child Growth and Malnutrition: methodology and applications. *International Journal of Epidemiology*, 32(4), 518-526.

De Schutter, O. (2011). Report submitted by the Special Rapporteur on the right to food. Geneva: United Nations. Available at: <http://www2.ohchr.org/english/issues/food/docs/A-HRC-16-49.pdf> (accessed 25 November, 2012).

Devereux, S., & Maxwell, S. (2001). *Food Security in Sub-Saharan Africa*, ITDG, London.

Doak, C., Adair, L.S., & Bentley, M. (2005). The dual burden household and nutrition transition paradox. *Int J Obesity*. 29, 129–136. doi: 10.1038/sj.ijo.0802824.

Dobbing, J. (1972). Nutrition, the nervous system and behavior. *OPAS*. 251.

Eckholm, E., & Record, F. (1976). The two faces of malnutrition. *Worldwatch*. Available at: <<http://www.worldwatch.org/bookstore/publication/worldwatch-paper-9-two-faces-malnutrition>>. (accessed 15 May, 2013).

Eppolito, H., & Papareschi, A. (2009). *Fruit and Vegetable Consumption and Health*, Nova Science Publishers, New York.

FAO (1996). Rome Declaration on World Food Security and World Food Summit Plan of Action. *World Food Summit*, 13-17 November 1996, Rome.

FAO (2002). *The State of Food Insecurity in the World 2001*. Rome, pp. 4-7.

FAO (2010a). Global hunger declining, but still unacceptably high: International hunger targets difficult to reach. *Economic and Social Development Department*. Available at: <<http://www.fao.org/docrep/012/a1390e/a1390e00.pdf>>(accessed 18 May, 2013).

FAO (2010b). Progress towards millennium development goal 1: Hunger Target. Available at: <<http://www.fao.org/hunger>>(accessed 18 May, 2013).

FAO (2013a). Food and Agriculture Organization of United Nations. Available at: <<http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en/>> (accessed 05 February 2013).

FAO (2013b). *The State of Food Insecurity in the World 2013*. Available at: <<http://www.fao.org/publications/sofi/en/>> (accessed 31 March 2014).

FIVIMS. (2002). *Measurement and Assessment of Food Deprivation and Undernutrition*. FAO, Rome.

Funk, C.C., & Brown, M. E. (2009). Declining global per capita agricultural production and warming oceans threaten food security. *Food Security*. 1, 271–289.

Godfray, H. C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M., & Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. *Science*. 327(5967), 812-818.

Hoolohan, C., Berners-Lee, M., McKinstry-West, J., & Hewitt, C.N. (2013). Mitigating the greenhouse gas emissions embodied in food through realistic consumer choices. *Energy Policy*, 63, 1065–1074. doi:10.1016/j.enpol.2013.09.046

Keatinge, J. D. H., Yang, R. -, Hughes, J., Easdown, W. J., & Holmer, R. (2011). The importance of vegetables in ensuring both food and nutritional security in attainment of the millennium development goals. *Food Security*, 3(4), 491-501.

Klein, F., & Moller, G. (2010). *Dietary Fiber, Fruit and Vegetable Consumption and Health*, Nova Science Publishers, New York.

Lamb, R. L. (2000). Food crops, exports, and the short-run policy response of agriculture in Africa. *Agr Econ*. 22(3), 271–298.

Maxwell, S., & Frankenberger, T.R. (1992). *Household Food Security: Concepts, Indicators, Measurements*. UNICEF/IFAD, New York.

Mekonnen, M.M., & Hoekstra, A.Y. (2010). The green, blue and grey water footprint of farm animals and animal products. [Report]. Available at: <<http://doc.utwente.nl/76912/>> (accessed 02 August, 2014).

Miewald, C., Holben, D., & Hall, P. (2012). Role of a food box program in fruit and vegetable consumption and food security. *Canadian Journal of Dietetic Practice And Research: A Publication Of Dietitians Of Canada = Revue Canadienne De La Pratique Et De La Recherche En Diététique: Une Publication Des Diététistes Du Canada*, 73(2), 59-65.

Moore, C.S., Lindroos, A.K., Kreutzer, M., Larsen, T.M., Astrup, A., Van Baak, M.A., Handjieva-Darlenska, T., Hlavaty, P., Kafatos, A., Kohl, A., Martinez, J.A., Monsheimer, S., & Jebb, S. A. (2010). Dietary strategy to manipulate ad libitum macronutrient intake, and glycaemic index, across eight European countries in the Diogenes Study. *Obesity Reviews*. 11, 67–75.

Mozaffarian, D., & Rimm, E. B. (2006). Fish intake, contaminants, and human health - evaluating the risks and the benefits. *J. Am. Med. Assoc.* 296, 1885–1899.

Patel, P.S., Sharp, S.J., Luben, R.N., Khaw, K., Bingham, S.A., Wareham, N.J., & Frouhi, N. G. (2009). Association Between Type of Dietary Fish and Seafood Intake and the Risk of Incident Type 2 Diabetes. *Diabetes Care*. 32(10), 1857-1863. doi:10.2337/dc09-0116

Patel, R. (2008). *Stuffed and Starved: The Hidden Battle for the World Food System*. Melville House.

Popkin, B.M. (2006). Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr.* 84, 289–98.

Popkin, B.M. (2009). Global Changes in Diet and Activity Patterns as Drivers of the Nutrition Transition. IN: S. C Kalhan, A. M. Prentice, & C. S. Yajnik (Eds.), *Emerging Societies – Coexistence of Childhood Malnutrition and Obesity*. Nestlé Nutr Inst Workshop Ser Pediatr Program. 63, pp. 1–14.

Schmidhuber, J., & Tubiello, F. N. (2007). Global food security under climate change. *Proc Natl Acad Sci.* 104, 19703–19708.

Sen, A. (1981). *Poverty and famines: an essay on entitlement and deprivation*. Clarendon Press/Oxford University Press, Oxford, UK.

Sioen, I., Matthys, C., De Backer, G., Van Camp, J., & De Henauw, S. (2007). Importance of seafood as nutrient source in the diet of Belgian adolescents. *J. Hum. Nutr. Diet.* 20, 580–589.

Skouteris, H., Cox, R., Huang, T., Rutherford, L., Edwards, S., & Cutter-Mackenzie, A. (2013). Promoting obesity prevention together with environmental sustainability. *Health Promotion International*. doi:10.1093/heapro/dat007

Stein, A.D., Thompson, A.M., & Waters, A. (2005). Childhood growth and chronic disease: evidence from countries undergoing the nutrition transition. *Matern Child Nutr.* 1(3), 177–184.

Stuckler, D., McKee, M., Ebrahim, S., & Basu, S. (2012). Manufacturing Epidemics: The Role of Global Producers in Increased Consumption of Unhealthy Commodities Including Processed Foods, Alcohol, and Tobacco. *PLoS Med.* 9(6), e1001235. doi:10.1371/journal.pmed.1001235

Swinburn, B., & Egger, G. (2002). Preventive strategies against weight gain and obesity. *Obesity Reviews.* 3 (4), 289–301.

Sy, M.M., Feinberg M., Verger P., Barré T., Cléménçon S., & Crépet A. New approach for the assessment of cluster diets. *Food and Chemical Toxicology.* 52 (2013), 180–187.

Tacon, A.J., & Metian, M. (2013). Fish Matters: Importance of Aquatic Foods in Human Nutrition and Global Food Supply. *Reviews in Fisheries Science,* 21(1), 22-38. doi:10.1080/10641262.2012.753405

U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2010). *Dietary Guidelines for Americans 2010 (7th ed.)*. Washington: U.S. Government Printing Office.

UNICEF (2006a). Under five deaths by cause. Available at: <[http://www.unicef.org/media/files/Under\\_five\\_deaths\\_by\\_cause\\_2006\\_estimates3.doc](http://www.unicef.org/media/files/Under_five_deaths_by_cause_2006_estimates3.doc)> (accessed 15 May, 2013).

UNICEF (2006b). Progress for Children: A Report Card on Nutrition (No. 4). Available at: <[http://www.unicef.org/publications/index\\_33685.html](http://www.unicef.org/publications/index_33685.html)> (accessed 15 May, 2013).

UNICEF (2007). The State of the World's Children 2007: Women and Children - The double dividend of gender equality. Available at: <<http://www.unicef.org/sowc/>> (accessed 11 May, 2013).

UNSD (2013). Millennium Development Goals Indicators. Department of public information. Goal 1: eradicate extreme poverty and hunger. Available at: <<http://www.un.org/millenniumgoals>> (accessed 22 May, 2013).

Van Kernebeek, H.R J., Oosting, S.J., Feskens, E.J.M., Gerber, P.J., & De Boer, I.J.M. (2013). The effect of nutritional quality on comparing environmental impacts of human diets. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2013.11.028

Wahlqvist, M. L., McKay, J., Chang, Y. -, & Chiu, Y. -. (2012). Rethinking the food security debate in Asia: Some missing ecological and health dimensions and solutions. *Food Security*, 4(4), 657-670.

Webb, P., Coates, J., Frongillo, E.A., Rogers, B.L., Swindale, A., & Bilinsky, P. (2006). Measuring household food insecurity: Why it's so important and yet so difficult to do. *Journal of Nutrition*. 136 (5), 1404S-1408S.

WHO (2013). World Health Organization Database. Available at: <<http://www.who.int>> (accessed 01 February, 2013).

WHO (2014). Global Environment Monitoring System (GEMS)/Food Cluster Diets. Available at: <[http://www.who.int/nutrition/landscape\\_analysis/nlis\\_gem\\_food/en/](http://www.who.int/nutrition/landscape_analysis/nlis_gem_food/en/)> (accessed 30 March, 2014).

Wolfenden, L., Wyse, R., Britton, B., Campbell, K., Hodder, R., Stacey, F., McElduff, P., & James, E. (2012). Interventions for increasing fruit and vegetable consumption in children aged 5 years and under. *Cochrane Database of Systematic Reviews* (Online). 11CD008552. doi:10.1002/14651858.CD008552.pub2

World Bank (2013). The World Bank Database. Available at: <<http://www.worldbank.org/>> (accessed 22 May, 2013).

## **CAPÍTULO 4: FACING CO-OCCURRENCE OF UNDERWEIGHT AND OVERWEIGHT POPULATIONS WORLDWIDE<sup>4</sup>**

### **ABSTRACT**

**Purpose** – This study investigates the situation and trends regarding prevalence of underweight, overweight, and undernourished populations worldwide. Thus, we defend that the conditions of hunger, underweight, overweight, and obesity are seen as anomalies resulting from nutritional and dietary food insecurity related to the concept of malnutrition.

**Design/methodology/approach** – This investigation was conducted through an ecological study, using indicators related to undernourishment, underweight, and overweight. Data, obtained through the WHO and United Nations, were analyzed through scatter plots and angular coefficient from linear regression.

**Findings** - Evidence suggests that some nations have high levels of undernourished and overweight populations at the same time. Results showed a significant reduction in the prevalence of underweight children and a significant increase in the prevalence of overweight children worldwide. Western Pacific has shown declining trends in both overweight and underweight children. Southern Africa has shown a strong increase in its child overweight population and no downward trend in its underweight child population.

**Practical implications** – We defend that programs and actions better aligned to diagnoses of some countries that face problems related to both underweight and overweight/obesity conditions are needed. This investigation can help public and private efforts to combat underweight and overweight diagnoses worldwide.

**Originality/value** – We present evidence of the co-occurrence of underweight and overweight in child populations worldwide. Thus, we show alarming trends regarding to these diagnoses.

**KEYWORDS:** food security; undernourishment; obesogenic environments; ecological study; global health; developing countries.

---

<sup>4</sup> This paper is in evaluation process at Nutrition & Food Science (ISSN: 0034-6659). This version of the paper was submitted in 28-October-2014. (ANNEX 4, pp. 159).

## 1. INTRODUCTION

This study investigates the world situation of undernourishment and underweight and overweight populations, as these relate to the condition of ensuring sufficient and adequate food to meet human needs, thereby preventing malnutrition. We defend that the conditions of hunger, underweight, overweight, and obesity are seen as anomalies resulting from nutritional and dietary food insecurity related to the concept of malnutrition. Therefore, the aim of this ecological study was to perform a global analysis of the undernourishment, underweight, and overweight circumstances.

Food security is defined as a condition of acquiring enough food in terms of quantity and nutrition (Sen, 1981; FAO, 2013). As such, food security is related to the human condition whereby individuals acquire and ingest sufficient amounts of nutrients in order to meet their needs and not harm their health. Although food security is seen as a condition of ensuring an adequate supply of food so there is no hunger or undernourishment, ensuring food security also considers that an excessive supply of food and inadequate food and nutrient ingestion can lead to overweight and obesity diagnoses, along with diseases related to such obesogenic diagnoses. Thus, the concept of malnutrition is defined as an abnormal physiological condition caused by inadequate, unbalanced, or excessive consumption of macronutrients and/or micronutrients. Malnutrition includes undernourishment, underweight, and overweight/obesity, as well as micronutrient deficiencies (FAO, 2013).

Despite the fact that food insecure people are those whose food intake falls below their minimum energetic requirements caused by a wide range of factors (FIVIMS, 2003), this investigation aims to better understand the state of worldwide food insecurity using undernourishment, underweight, and overweight as proxies. These indicators are associated to the anthropometry method of measuring food insecurity (Cunningham, 2005) that uses indicators like percentage of underweight or stunted children and adults with low body mass index (BMI) (Maxwell and Frankenberger, 1992; FIVIMS, 2002; Cogill, 2003). Thus, this investigation uses overweight as an additional indicator to measure food insecurity at the anthropometric level. We defend the argument that food insecurity includes all degrees of malnutrition: undernourishment, underweight, overweight, and obesity, despite the standard measures of food insecurity that usually consider indicators associated to underweight or deficiencies of nutrients. Therefore, the focus of the paper is the investigation of underweight and overweight co-occurrence in populations worldwide.



## 2. METHODS

This investigation was conducted through an ecological study. The analytical units were the populations of the world's countries. Indicators related to undernourishment, underweight, and overweight were analyzed. The data for these indicators were obtained from the Global Health Observatory Data Repository of the World Health Organization (WHO, 2013) and the Millennium Development Goals Indicators of the United Nations (UNSD, 2013). The prevalence of overweight condition is the percentage of a defined population with a body mass index (BMI) of 25 kg/m<sup>2</sup> or higher, being based on age-standard estimates of people aged 20 years and over (WHO, 2013). The prevalence of undernourished or food-deprived people is defined as the proportion of the population below the minimum level of dietary energy consumption (UNSD, 2013). The minimum level of dietary energy requirement is derived from the FAO/WHO/UNU (2001). We also analyze data regarding underweight and overweight children. Details about the data and indicators are presented in Table 1.

Table 1 – Details and description about indicators

Indicator	Details	Description	Source
Undernourished population (%)	Average % calculated using available data from 2006 to 2011	Percentage of the population that is undernourished or food deprived. The undernourished or food deprived are those individuals whose food intake falls below the minimum level of dietary energy requirements that is derived from the FAO/WHO/UNU.	UNSD
Prevalence of overweight (%)	% of population ages 15+	Percentage of defined population with a body mass index (BMI) of 25 kg/m <sup>2</sup> or higher	WHO
Child overweight (%)	Children aged <5 years overweight (%). Data of main regions of the world.	Percentage of overweight (weight-for-height above +2 standard deviations of the WHO Child Growth Standards median) among children aged 0-5 years. Time series with data of 1995, 2000, 2005, 2010, and 2012.	WHO
Child underweight (%)	Children aged <5 years underweight (%). Data of main regions of the world.	Percentage of underweight (weight-for-age less than -2 standard deviations of the WHO Child Growth Standards median) among children aged 0-5 years. Time series with data of 1995, 2000, 2005, 2010, and 2012.	WHO
Child overweight trend	Angular coefficient based on time series of Child overweight	This coefficient indicates the annual trend based on available data from 1995 to 2012. Missing values were treated through interpolation.	Based on WHO
Child underweight trend	Angular coefficient based on time series of Child underweight.	This coefficient indicates the annual trend based on available data from 1995 to 2012. Missing values were treated through interpolation.	Based on WHO

Source: Adapted from WHO (2013) and UNSD (2013)

Data were analyzed through scatter plots, Pearson's correlation, and time series graphs. The first scatter plot correlated undernourished populations (average % between 2006-2011) and the prevalence of overweight populations (% of population ages 15+ in 2008). The second scatter plot presented the correlation between overweight and underweight child populations considering the trend index (angular coefficient) from 1990-2015. The third scatter plot correlated the percent of underweight and overweight child populations in 2012. Also, the time series graphs (1990-2012) consider the prevalence of data of overweight and underweight child populations in the main regions worldwide available at WHO (2013). We identified four groups of countries, taking into account their urgent situations regarding overweight and undernourished populations. Linear trend (angular coefficient [ $\alpha$ ]) values were calculated to measure the evolutionary behavior of the indicators that evaluate global underweight and overweight populations. We used the software Statistica 8.0 as the main statistical package for this investigation.

### 3. RESULTS

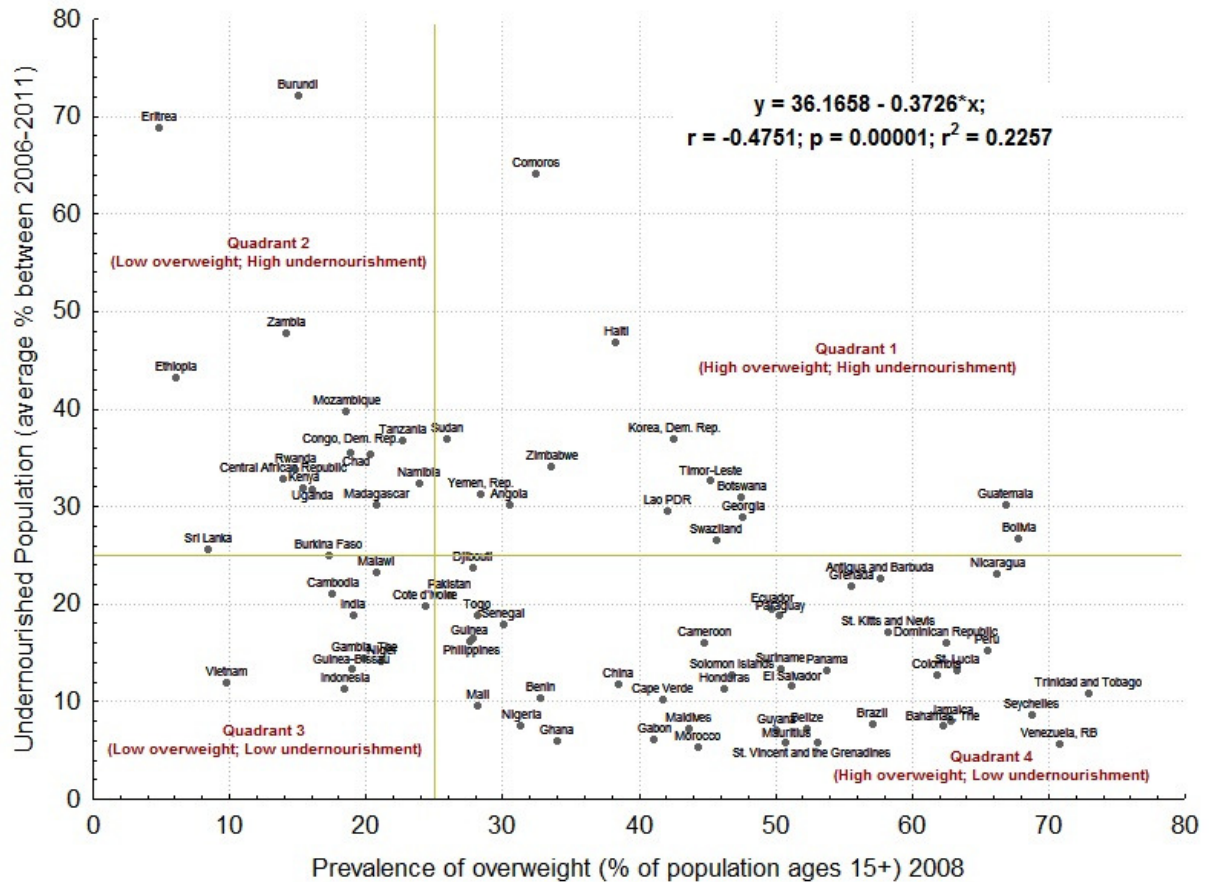
According to the definitions proposed by the World Food Summit (1996), food security represents "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Initially, it is appropriate to emphasize that this situation is linked to a temporal dimension where individuals should enjoy such status at any time, considering their access to adequate food consistent with their needs (Barrett, 2002). Furthermore, the concept of food security is strongly tied to the dimensions of availability, accessibility, and use (Barrett et al., 2010). However, availability is necessary but not sufficient to ensure security to access. Access is also necessary, but not sufficient, to ensure proper use (Webb et al., 2006).

Considering that food security refers to a situation of nutritional adequacy that allows individuals to have an active and healthy lifestyle, conditions of overweight, obesity, hunger, and underweight can be considered deviations from food security. Therefore, the degree of urgency of such deviations can be associated to food insecurity, being used as indicators. The situation of hunger refers to the condition of physical discomfort caused by lack of food, and it can be assessed and identified only at the individual level (Barrett, 2010). Hunger is the body's way of signaling that it is running short of food and needs to eat something (WFP, 2013).

The underweight condition is assessed through biometric measurement of the weight of the individual, with recorded values below the acceptable conditions for the person's sex, age, ethnicity, and body measurements (Barrett, 2010). Individuals at least two standard deviations below the reference value (Dietary Reference Intakes [DRI]) (FNB, 2005; UNICEF, 2013; WHO, 2013) are considered underweight. On the other hand, undernourishment refers to insufficient energy intake (calories) by internationally recommended standards (WHO, 2013). Malnutrition is related to undernourishment, obesity, and deficits in intake of specific micronutrients (Barrett, 2010). This last condition, therefore, is directly related to food insecurity, as it is associated with a deviation from the standard recommended to maintain a healthy human life condition. Food insecurity occurs when people lack secure access to sufficient quantities of safe and nutritious food; this lack of access may be caused by such factors as unavailability of food, insufficient purchasing power, inappropriate distribution, and inadequate use of food at the household level (FAO, 2013). So, food insecurity is a broader concept including malnutrition conditions like undernourishment, underweight and overweight. Thus, these last concepts are anthropometric measures that can be used as indicators for food insecurity.

Considering food insecurity is a condition associated with diagnoses of hunger, undernourishment, underweight, overweight, and obesity, this study analyzes the positions of the world's nations in terms of severity of food insecurity. This severity was evaluated through diagnoses of undernourishment, underweight, and overweight. In order to assess the severity of food insecurity in the various nations, scatter plots and time series graphs were drawn. First, nations were categorized by percentage of undernourished populations and percentage of overweight populations (Figure 1). Countries with an undernourished population of less than 5% were eliminated from the analysis.

Figure 1 – Relation between undernourished and overweight population worldwide



Source: Adapted from WHO (2013)

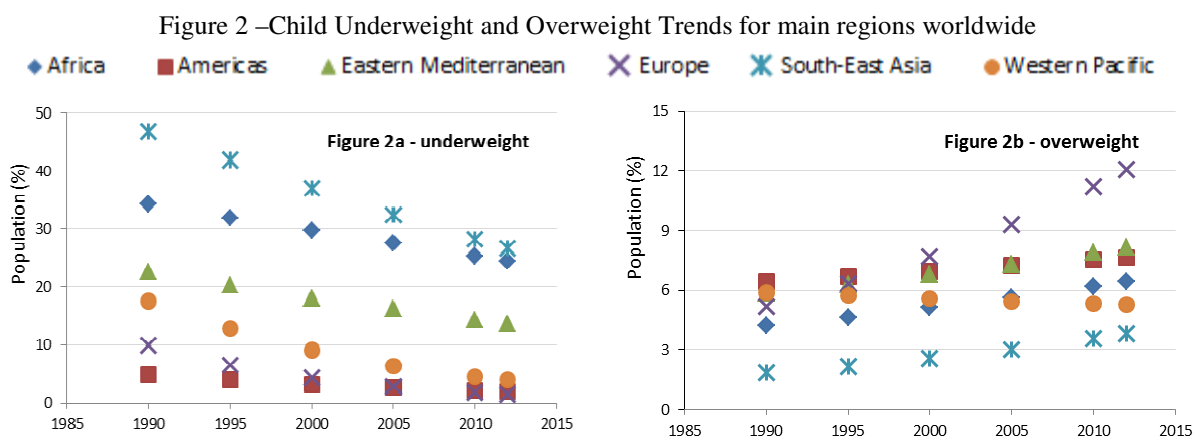
The initial evidence suggested the existence of a significant ( $p < 0.001$ ) and negative correlation ( $r = -0.4751$ ) between undernourished populations and overweight populations. Despite the fact that this was an expected result, the distribution of nations in the dispersion map reveals some important aspects to be considered. First, it should be noted that two lines were drawn to indicate the 25% line for each variable on the map. The map was divided into four quadrants, considering the urgency and severity of undernourishment and overweight diagnoses observed. Quadrant 1 was formed by nations with more than 50% of their respective populations with nutritional disorders, either overweight or undernourishment. The nations positioned in quadrant 1 (e.g., Haiti, Zimbabwe, Guatemala, Bolivia, Comoros, Angola, Swaziland, and Democratic Republic of Korea) face the greatest problems in terms of severity of food insecurity, as they need to combat salient problems related to undernourishment and overweight conditions.

Quadrant 2 was formed by countries with large undernourished populations ( $> 25\%$ ), but smaller overweight populations (e.g., Burundi, Eritrea, Zambia, Ethiopia, Mozambique,

and Tanzania). It should be noted that Eritrea and Burundi are African nations that have portions of undernourished population exceeding 50%, ranking them as nations with severe food insecurity problems arising from undernourishment.

Quadrant 3 was formed by nations with small percentages of overweight and undernourished populations (e.g., Vietnam, Cambodia, India, Indonesia, and Gambia) that still face serious problems related to food insecurity, as they have overweight and undernourishment rates higher than 10%. Finally, the nations positioned in the fourth quadrant are characterized by a moderate portion of its population classified as undernourished, but with a high proportion of overweight conditions. Such nations (e.g., Brazil, Maldives, Morocco, Colombia, and China) face serious problems of food insecurity strongly related to obesogenic conditions. It should be emphasized again that countries with controlled rates of undernourished population (<5%) were excluded from the analysis. Therefore, all of the identified countries face problems of moderate or severe food insecurity linked to undernourishment and/or overweight.

The evidence presented previously regarding the global scenario in terms of undernourishment and overweight nations reflects only a static point of view. However, in this study, it was considered highly relevant to analyze the evolution of societies considering their underweight and overweight child populations. Thus, we analyzed the historical development (from 1990 to 2012) of underweight and overweight child populations in the major regions of the world (Figure 2).



Source: Adapted from WHO (2013)

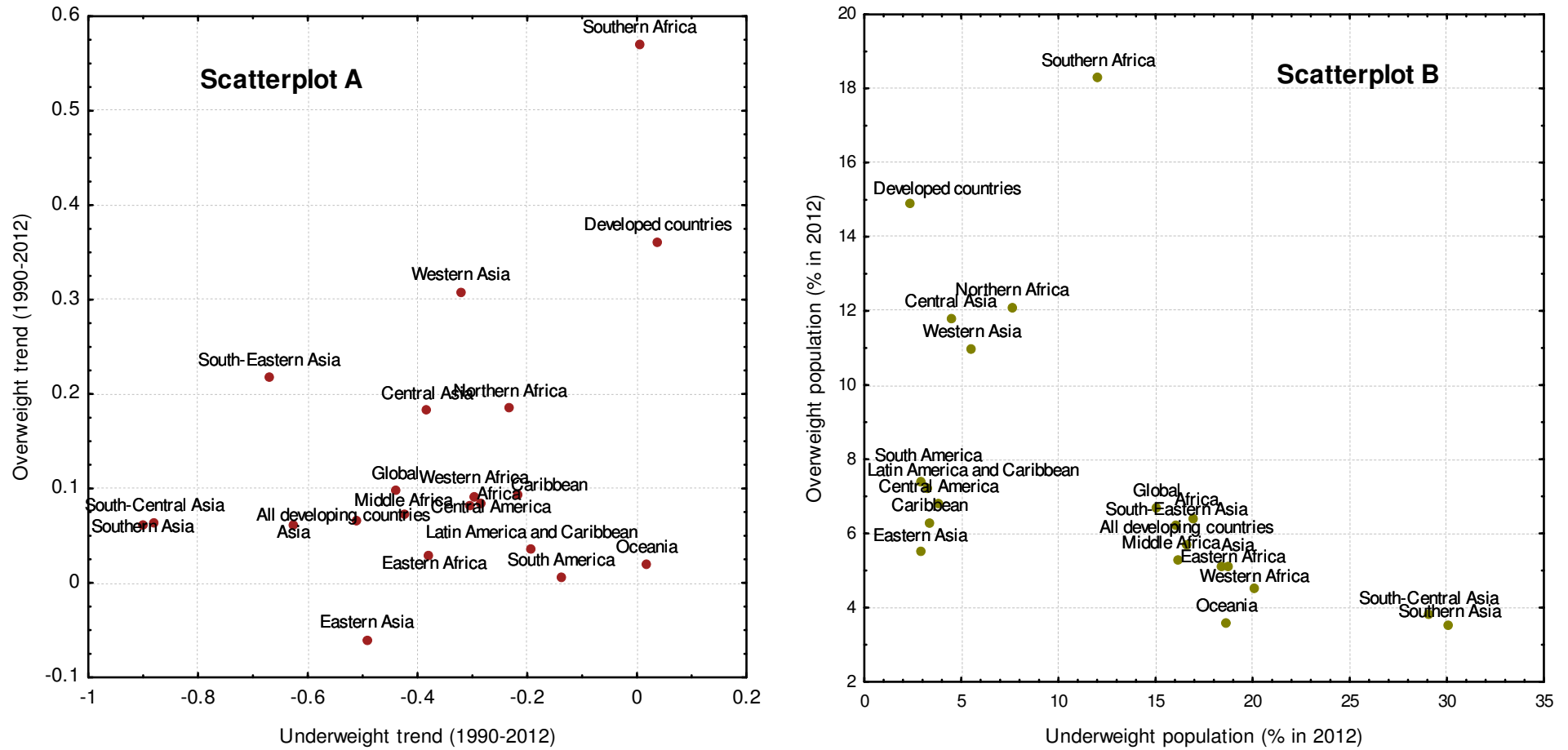
Evidence suggests that, in general, the main regions of the world are experiencing a significant reduction in their child underweight population percentages with some regions showing a sharper and more significant reduction than the others. The analysis of the angular

coefficient ( $\alpha$ ) obtained through simple regression suggests that Southeast Asia has the best performance in terms of reducing their child underweight population ( $\alpha=-0.921$ ,  $R^2=0.998$ ). However, this region still has the highest proportion of underweight children in the world. The second best performance is observed in the Western Pacific ( $\alpha=-0.601$ ,  $R^2=0.966$ ) which currently has underweight child population percentages similar to those of the Americas and Europe. The regions of Africa ( $\alpha=-0.443$ ,  $R^2=0.999$ ), Eastern Mediterranean ( $\alpha=-0.403$ ,  $R^2=0.997$ ), and Europe ( $\alpha=-0.363$ ,  $R^2=0.943$ ) showed a moderate performance in reducing their child underweight populations. However, it is noteworthy that Africa and the Eastern Mediterranean still have significant proportions of underweight children.

Regarding the historical evolution related to the overweight severity in the main regions of the world, the evidence indicates that, except for the Western Pacific ( $\alpha=-0.027$ ,  $R^2=0.999$ ), all the other regions have experienced an increase in the overweight child population. Europe ( $\alpha =0.314$ ,  $R^2=0.989$ ) is the region that recorded the largest increase in their share of overweight children; the European region currently has the largest child overweight portion. The regions of Africa ( $\alpha=0.100$ ,  $R^2=0.997$ ), Eastern Mediterranean ( $\alpha=0.105$ ,  $R^2=0.998$ ), and Southeast Asia ( $\alpha=0.090$ ,  $R^2=0.990$ ) showed a moderate increase in their overweight child population. Finally, the Americas region ( $\alpha=0.056$ ,  $R^2=0.999$ ), which had the largest percentage of overweight children in the 1990s, had the lowest increase in overweight children, which suggests that it is likely that these nations, along with the nations of the Western Pacific, are more engaged in practices and initiatives focused on the fight against the obesogenic situation.

In order to contribute to the empirical analyses and better understand global food insecurity based on the co-occurrence of underweight and overweight, we next present some empirical results that shows the global overview of the main regions of the world in terms of evolutionary trends of overweight and underweight child populations (Figure 3). The current (2012) overweight and underweight child percentages of the main regions of the world are also presented. This comparison is performed in order to compare the current situation to the performance trends of fighting the severity of food insecurity worldwide.

Figure 3 – Comparison between current child underweight / overweight situations and trends for food insecurity worldwide



Note: Scatterplot A presents the cross analysis of over/underweight trends (angular coefficient for annual time series from 1990 to 2012) for each main world cluster of countries; Scatterplot B presents the cross analysis of over/underweight prevalence in 2012 for each main world cluster of countries.

Source: Adapted from WHO (2013).

The trend values in scatter plot A mean the average increase (positive value) or decrease (negative value) per year in the prevalence of overweight or underweight children from 1990 to 2012. The evidence suggests that, in general, the world is showing a moderate reduction in its share of the underweight child population (-0.45), and a lowered increase in its share of the overweight child population (0.1). However, in 2012, a significant percentage of children in the world were underweight (15.08%), and a lower percentage of children were overweight (6.7%) (scatter plot B). Therefore, evidence suggests that the percentage of underweight children is being reduced more effectively than the percentage of overweight children is being increased. It can also be seen that the developed nations, which have no significant underweight child portions of their populations, have had a high increase in their overweight child populations, considering its observed trend value. Thus, these developed countries are already presenting a prominent portion of children with overweight diagnoses (14.9%), and it is reasonable to expect that their portions of overweight populations will increase significantly in the coming years. On the other hand, the developing nations have shown a moderate reduction in their underweight child populations (-0.5), but their overweight child populations (0.05) have not increased significantly. However, these nations still have a considerable percentage of underweight children (16.6%).

Of the main regions of the world, the evidence suggests that Southern Africa had the largest increase in child overweight population, and no reduction trend in the child underweight population. It is important to consider that a significant portion of children in Southern Africa are underweight (12.04% in 2012), which suggests that the performance of this region in combating malnutrition is highly unsatisfactory. Furthermore, Southern Africa has a high percentage of overweight children, suggesting that while this region still faces problems related to underweight and undernourishment, they also face problems related to obesogenic severity. These findings can be related to findings of malnutrition co-occurrence in South Africa (Kimani-Murage, 2013). The Western Asia, Central Asia, and Northern Africa regions had moderate increases in overweight child populations, as well as their performance in fighting the severities related to the child underweight population. Thus, these regions are already facing a significant obesogenic severity, considering their overweight population percentages. Thus, we argue that these regions will face severe problems related to the obesogenic situation in coming years.

Other regions formed by developing countries (e.g., Middle Africa, Central America, Eastern Africa, and Eastern Asia) showed a moderate reduction in the overweight and underweight percentages of their child populations, maintaining their situation, which is



considered highly positive. However, Middle Africa, Eastern Africa, and Eastern Asia are regions that still face severe problems regarding their significant portion of underweight children.

Eastern Asia is seen as a region that has shown a reduction in both child overweight and underweight levels. This region also has low percentages of overweight and underweight children. We can see that, considering our findings, Eastern Asia is the region with the best profile in terms of child overweight and underweight levels. Finally, the regions of South-Central Asia and Southern Asia showed the greatest reduction trends in child underweight populations, which is considered highly positive. However, South-Central Asia and Southern Asia still had child underweight rates of 29.06% and 30.03%, respectively, in 2012. Therefore, these regions still face serious problems linked to underweight populations.

#### **4. DISCUSSION**

It is noteworthy that food security is closely related to the availability of food for consumption, with the physical and economic conditions that individuals have to purchase food according to their needs, the proper use of food, and the stability, over time, to ensure basic nutritional needs. Thus, the causes that lead to food insecurity are varied and malnutrition is related to government and political issues (Mejía Acosta and Haddad, 2014), as well as to socio-economic inequality (Konttinen et al., 2013; Davey et al., 2013). Also, malnutrition is associated with higher public health costs (Lim et al., 2012). These nutritional problems are likely to be minimized through agricultural activities based on food systems focused on substantive equality by strengthening local production and defending biodiversity and dietary diversity (Frison et al., 2006; Friel et al., 2007).

Besides the recurring problems of hunger and undernourishment, the global problem of food insecurity is closely associated to the obesogenic pandemic, which has been established globally. This pandemic, initially alarmed by the conditions observed in the USA, currently affects not only developed countries (e.g., Europe and North America), but also developing countries, especially in urban areas (Prentice, 2006). Indeed, this study highlights this argument that the obesogenic severity is strongly observed in developing regions worldwide. The prevalence of obesity is increasing rapidly in developing countries, leading to increased morbidity and mortality from diabetes and cardiovascular disease (Misra and Khurana, 2008). This pandemic is facilitated by subsidized agriculture and multinational companies that provide cheap food rich in fats, oils, and carbohydrates. In addition,

mechanized devices that reduce physical labor, affordable motorized transportation, and sedentary entertainment activities (e.g., television and Internet) strongly contribute to the worsening of the obesogenic situation worldwide (Prentice, 2006).

The evidence presented in this study suggests that some nations are facing serious problems related to food insecurity, considering both undernourishment and overweight diagnoses. Such diagnoses, strongly associated with inadequate nutritional ingestion (among other factors), affect both developed and developing countries, assuming alarming global proportions. More specifically, it has been observed that countries such as Haiti, Zimbabwe, Guatemala, Bolivia, Comoros, Angola, Swaziland, and the Democratic Republic of Korea face serious problems arising from food insecurity related to undernourishment and overweight diagnoses.

The study also shows that the Western Pacific region performs best in terms of combating underweight and overweight child conditions. This group of nations was the only one that showed such dramatic results in reducing these indicators of malnutrition. It was also noted that Eastern Asia had reduced underweight and overweight population plots, and had low levels of such diagnoses in 2012. With a nutritional model heavily based on rice (Shams, 2007) and vegetables, we suggest that the Eastern Asia region has the best performance in the fight against food insecurity. We also point that high consumption levels of healthy foods (e.g., fish, milk, vegetables, and eggs) observed in nations such as Japan, the Democratic Republic of Korea, and China can significantly contribute to the promotion of food security in Eastern Asia. In particular, we consider that the consumption of fish and vegetables is highly positive to human health (Moore et al., 2010), contributing to the establishment of a condition of food security. In addition, initiatives and policies are aligned with the promotion of food security, strongly contributing to this performance (Lachat et al., 2013).

In contrast, highly significant portions of the population of Southern Africa are overweight and underweight, and the evolution indicator in the fight against these conditions is not positive. This region showed increasing trends in its share of the population that is overweight and stagnation in its share of the population that is underweight, suggesting that the nations of Southern Africa have severe problems related to food insecurity. Logically, intervention from government initiatives and the private sector are necessary to curb the growth of the overweight population as well as to combat circumstances of severe underweight and undernourishment.

We argue that underweight, overweight, and obesity diagnoses are strongly linked to food consumption habits (Rosenheck, 2008; Bowman et al., 2004; Ludwig et al., 2001).

Therefore, these habits, described as the dietary patterns (or dietary models) of populations, have an important role in these deviations from food security. Dietary patterns are changing and we are facing a significant nutrition transition worldwide in the last few decades (Drewnowski and Popkin, 2009); there are important implications regarding obesity (Popkin et al., 2012; Popkin and Gordon-Larsen, 2004) and consequently, food security and public health associated with this transition. Moreover, the negative impacts of food insecurity observed in many developing countries might be strongly associated with their development level. Studies have shown that severe malnutrition can lead to a significant, irreversible impairment of the cognitive abilities of individuals through alterations of the central nervous system (Dobbing, 1972). It is necessary to consider that undernourishment is a main cause of child mortality and an aggravation of the propensity for diseases such as anemia and infections, which affect child development (Ribas et al., 1999). The obesogenic environment tends to significantly increase the risk of type II diabetes, hypertension, stroke, and cardiovascular diseases (McTigue et al., 2006; Moghaddam et al., 2007; Mokdad et al., 2001; Must et al., 1999). Therefore, the public health infrastructure in obesogenic societies must be prepared to meet the growing demands of individuals who seek public medical services due to obesity.

Considering the evidence that some countries face problems related to both underweight and overweight/obesity conditions, programs designed to attenuate or eliminate hunger and undernourishment can possibly result in growth rates of overweight and obesity diagnoses (DeBono et al., 2012). Actions and initiatives to combat undernourishment are likely to trigger diagnoses of overweight and obesity. Related to this, evidence suggests that food stamps can be associated with obesity (Baum, 2011; Leung et al., 2013). Also, economic development can promote food security; however, some adverse effects regarding the nutrition transition include promoting an obesogenic environment (Drewnowski and Popkin, 2009). Furthermore, the emergence of big companies that supply processed foods to markets all over the world, providing high-calorie and fatty foods at a cheap price, can significantly impact the worsening global obesogenic situation (Sibbel, 2012). These companies probably do not contribute significantly to combating malnutrition, as their foods are often nutritionally poor or inadequate in micronutrients; rather, the massive consumption of these processed foods can lead to high levels of overweight and obese diagnoses in a population, but with ongoing symptoms of undernourishment. The increasing consumption of ultra-processed, inexpensive, ready-to-consume, energy-dense, fatty, sugary or salty food, is led by transnational food manufacturing, retailing and fast food service corporations (Monteiro et al.,

2013; Moodie et al., 2013). Despite the fact that some food companies are focusing on healthier options of processed food, these options are often expensive, or seen as expensive, and do not reach economically disadvantaged individuals (Grasso et al., 2014; Toldrá and Reig, 2011).

Some studies have highlighted the relationship between food insecurity and indicators of overweight conditions (Metallinos-Katsaras et al., 2009; Pan et al., 2012). Also, it is necessary to highlight that food insecurity is associated with obesity (Pan et al., 2012). Studies have reported their findings related to the co-occurrence of underweight and overweight diagnoses in specific communities (Salehi-Abargouei et al., 2013; Metallinos-Katsaras et al., 2012). Indeed, this investigation presents similar findings considering nations worldwide. Economically disadvantaged individuals gravitate toward cheap, unhealthy, high-calorie, and fat-rich foods, contributing to malnutrition. Thus, these individuals usually have a higher consumption of energy-dense foods, fatty meats, and fried foods (Miura et al., 2012; Thornton et al., 2011; Darmon and Drewnowski, 2008). Evidence suggests that socio-economically disadvantaged individuals are more influenced by price in their food choices (Konttinen et al., 2013) and have a less healthy diet (Giskes et al., 2009; Darmon and Drewnowski, 2008). On the other hand, higher income individuals give more importance to healthy choices (Konttinen et al., 2013; Darmon and Drewnowski, 2008). Recent studies have emphasized the growing role of large food industries, nicknamed “Big Food,” and their impact on global public health (Stuckler and Nestle, 2012), suggesting that such industries act as promoters of obesogenic environments (Brownell and Warner, 2009), possibly having a prominent impact on childhood obesity. The growth of such industries, which operate globally, can greatly aggravate the conditions of food insecurity, as they promote easy access to cheap and nutritionally inadequate food with high levels of fat, sodium, and other components, thereby promoting increased malnutrition rates.

## **5. CONCLUSIONS**

This study addresses an important issue that harms humans - the growing population plots of underweight and overweight conditions. Assuming that food insecurity is related to problems of inadequate nutritional intake, problems associated with concepts such as hunger, undernourishment, underweight, overweight, and obesity are part of this scope. Thus, recurring concerns related to hunger and undernourishment, and more recent concerns related to obesogenic severity, are addressed in this study in order to generate a better understanding

of how the nations of the world are positioned in terms of co-occurrence of underweight and overweight conditions.

Considering findings presented in this paper, and assuming that food security is a condition strongly associated to three hierarchical conditions - availability, access, and utilization (Barrett, 2010; Webb et al., 2006), further investigations regarding the main causes of the prevalence of undernourishment, underweight, and overweight situations is still necessary. Some obesogenic nations might face problems related to adequate utilization. On the other hand, undernourished and hunger populations might face food insecurity due to availability and access problems. Further studies regarding the main factors driving the co-occurrence of underweight and overweight situation in nations worldwide are still needed and encouraged.

The present study has some important limitations. Because it is a global analysis based on a study with an ecological approach, the evidence is somewhat superficial. Thus, the study provides an overview of the global situation regarding the problems of overweight, underweight, and undernourishment. We also intend to spur a discussion regarding food insecurity as a broad concept that includes obesogenic indicators like overweight and obese prevalence. However, this can generate some discomfort in some fields of the scientific community.

Considering the topic of this investigation, studies that are more specific and focus on certain societies are needed in order to understand the antecedents of some serious food insecurity diagnoses of certain nations, as well as certain areas that show a positive performance in promoting food security. Furthermore, it is suggested that studies be conducted focusing on public and private initiatives to promote global food security, with a focus on food patterns and related agribusiness activities (e.g., the importance of SFSCs and the use of agricultural production technologies in small farms).

## **REFERENCES**

- Barrett, C.B. (2010), "Measuring food insecurity", *Science*, Vol. 327, No. 5967, pp. 825-828.
- Barrett, C.B. (2002), "Food Assistance and Food Security Programs", in: Gardner B.L., Rausser, G.C. (Eds.), *Handbook of Agricultural Economics*, Elsevier Science, Amsterdam, Vol. 2B.

Baum, C.L. (2011), “The effects of food stamps on obesity”, *Southern Economic Journal*. Vol. 77, No. 3, pp. 623–651. doi:10.4284/sej.2011.77.3.623

Bleich, S., Cutler, D., Murray, C., and Adams, A. (2008), “Why is the developed world obese?” *Annual Review of Public Health*, Vol. 29, pp. 273-295.

Bovet, P., Paccaud, F., and Chiolero, A. (2012), “Socio-economic status and obesity in children in Africa”, *Obesity Reviews*, Vol. 13, No. 11, pp. 1080-1080.

Bowman, S.A., Gortmaker, S.L., Ebbeling, C.B., Pereira, M.A., and Ludwig, D.S. (2004), “Effects of Fast-Food Consumption on Energy Intake and Diet Quality Among Children in a National Household Survey”, *Pediatrics*, Vol. 113, No. 1, pp. 112–118. doi:10.1542/peds.113.1.112

Brownell, K.D., and Warner, K.E. (2009), “The Perils of Ignoring History: Big Tobacco Played Dirty and Millions Died. How Similar Is Big Food?” *Milbank Quarterly*, Vol. 87, pp. 259–294. doi: 10.1111/j.1468-0009.2009.00555.x

Cogill, B. (2003), “Anthropometric Indicators Measurement Guide”, Food and Nutrition Technical Assistance Project, Washington, DC.

Cunningham, L. (2005), “Assessing the contribution of aquaculture to food security: a survey of methodologies”. *FAO Fisheries Circular*. No. 1010. Rome, FAO.

Darmon, N., and Drewnowski, A. (2008), “Does social class predict diet quality?” *American Journal of Clinical Nutrition*. Vol. 87, No. 5, pp. 1107–1117.

Davey, T.M., Allotey, P., and Reidpath, D.D. (2013), “Is obesity an ineluctable consequence of development? A case study of Malaysia”, *Public Health*, Vol. 127, No. 12, pp. 1057–1062. doi:10.1016/j.puhe.2013.09.008

DeBono, N.L., Ross, N.A., and Berrang-Ford, L. (2012), “Does the food stamp program cause obesity? A realist review and a call for place-based research”, *Health and Place*, Vol. 18, No. 4, pp. 747-756.

Dobbing, J. (1972), “Vulnerable periods of brain development”, *Ciba/Lipids*, pp. 8–29. doi:10.1002/9780470719862.ch2

Drewnowski, A., and Popkin, B.M. (2009), “The Nutrition Transition: New Trends in the Global Diet”, *Nutrition Reviews*, Vol. 55, No. 2, pp. 31–43. doi:10.1111/j.1753-4887.1997.tb01593.x

FAO. (2010), “Progress towards millennium development goal 1: Hunger Target”, Available at: <http://www.fao.org/hunger> (accessed 18 May 2013).

FAO. (2013), “Food and Agriculture Organization of United Nations”, Available at: <http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en/> (accessed 05 February 2013).

FAO/WHO/UNU. (2001), “Human energy requirements”, *Food and Nutrition Technical Report Series. Report of a Joint FAO/WHO/UNU Expert Consultation*. Rome, 17–24.

FIVIMS, (2002), “Measurement and Assessment of Food Deprivation and Undernutrition”, FAO, Rome.

FIVIMS. (2003), “Food Insecurity and Vulnerability Information and Mapping Systems”, FAO, Rome.

FNB. (2005), “Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)”, Available at: <http://www.nap.edu/openbook.php?isbn=0309085373> (accessed 03 February 2013). The National Academies Press, Washington, DC.

Friel, S., Chopra, M., and Satcher, D. (2007), “Unequal weight: Equity oriented policy responses to the global obesity epidemic”, *British Medical Journal*, Vol. 335, No. 7632, pp. 1241-1243.

Frison, E.A., Smith, I.F., Johns, T., Cherfas, J., and Eyzaguirre, P.B. (2006), “Agricultural biodiversity, nutrition, and health: Making a difference to hunger and nutrition in the developing world”, *Food and Nutrition Bulletin*, Vol. 27, No. 2, pp. 167-179.

Gill, T. (1997), “Key issues in the prevention of obesity”, *Br Med Bull*, Vol. 53, No. 2, pp. 359–88.

Giskes, K., Avendaño, M., Brug, J., and Kunst, A.E. (2009), “A systematic review of studies on socioeconomic inequalities in dietary intakes associated with weight gain and overweight/obesity conducted among European adults”, *Obesity Reviews*, Vol. 11, No. 6, pp. 413–429. doi:10.1111/j.1467-789x.2009.00658.x

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M., and Toulmin, C. (2010), “Food security: the challenge of feeding 9 billion people”, *Science*, Vol. 327, No. 5967, pp. 812-818.

Grasso, S., Brunton, N.P., Lyng, J.G., Lalor, F., and Monahan, F.J. (2014), “Healthy processed meat products – Regulatory, reformulation and consumer challenges”, *Trends in Food Science & Technology*, Vol. 39, No. 1, pp. 4–17. doi:10.1016/j.tifs.2014.06.006

Kimani-Murage, E.W. (2013), “Exploring the paradox: double burden of malnutrition in rural South Africa”, *Global Health Action*, pp. 6193-205. doi:10.3402/gha.v6i0.19249

Konttinen, H., Sarlio-Lähteenkorva, S., Silventoinen, K., Männistö, S., and Haukkala, A. (2013), “Socio-economic disparities in the consumption of vegetables, fruit and energy-dense foods: the role of motive priorities”, *Public Health Nutrition*, Vol. 16, No. 5, pp. 873–882. doi:10.1017/s1368980012003540

Lachat, C., Otchere, S., Roberfroid, D., Abdulai, A., Seret, F., Milesevic, J., Xuereb, G., Candeias, V., and Kolsteren, P. (2013), “Diet and Physical Activity for the Prevention of Noncommunicable Diseases in Low- and Middle-Income Countries: A Systematic Policy Review”, *Plos Medicine*, Vol. 10, No. 6, pp. 1-19. doi:10.1371/journal.pmed.1001465



Leung, C.W., Blumenthal, S.J., Hoffnagle, E.E., Jensen, H.H., Foerster, S.B., Nestle, M., L. Cheung, W. Y., Mozaffarian, D., and Willett, W.C. (2013), “Associations of Food Stamp Participation with Dietary Quality and Obesity in Children”, *Pediatrics*, Vol. 131, No. 3, pp. 463–472. doi:10.1542/peds.2012-0889

Lim, S.L., Ong, K.C.B., Chan, Y.H., Loke, W.C., Ferguson, M., and Daniels, L. (2012), “Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality”, *Clinical Nutrition*, Vol. 31, No. 3, pp. 345–350. doi:10.1016/j.clnu.2011.11.001

Ludwig, D.S., Peterson, K.E., and Gortmaker, S.L. (2001), “Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis”, *The Lancet*, Vol. 357, No. 9255, pp. 505–508. doi:10.1016/s0140-6736(00)04041-1

Maxwell, S., and Frankenberger, T.R. (1992), “Household Food Security: Concepts, Indicators, Measurements”, UNICEF/IFAD, New York.

McTigue, K., Larson, J.C., Valoski, A., Burke, G., Kotchen, J., Lewis, C.E., Stefanick, M.L., Van Horn, L., and Kuller, L. (2006), “Mortality and Cardiac and Vascular Outcomes in Extremely Obese Women”, *Journal of the American Medical Association*, Vol. 296, No. 1, pp. 79–86.

Mejía Acosta, A., and Haddad, L. (2014), “The politics of success in the fight against malnutrition in Peru”, *Food Policy*, Vol. 44, pp. 26–35. doi:10.1016/j.foodpol.2013.10.009

Metallinos-Katsaras, E., Sherry, B., and Kallio, J. (2009), “Food Insecurity Is Associated with Overweight in Children Younger than 5 Years of Age”, *Journal of the American Dietetic Association*, Vol. 109, No. 10, pp. 1790–1794.

Metallinos-Katsaras, E., Must, A., and Gorman, K. (2012), “A Longitudinal Study of Food Insecurity on Obesity in Preschool Children”, *Journal of the Academy of Nutrition & Dietetics*, Vol. 112, No. 12, pp. 1949-1958. doi:10.1016/j.jand.2012.08.031

Misra, A., and Khurana, L. (2008), “Obesity and the Metabolic Syndrome in Developing Countries”, *Journal of Clinical Endocrinology & Metabolism*, Vol. 93, No. 11, pp. 9-30.

Miura, K., Giskes, K., and Turrell, G. (2012), “Socio-economic differences in takeaway food consumption among adults”, *Public Health Nutrition*, Vol. 15, No. 2, pp. 218–226. doi:10.1017/s136898001100139x

Moghaddam, A.A., Woodward, M., and Huxley, R. (2007), “Obesity and Risk of Colorectal Cancer: A Meta-Analysis of 31 Studies with 70,000 Events”, *Cancer Epidemiology Biomarkers and Prevention*, Vol. 16, No. 12, pp. 2533–2547.

Mokdad, A.H., Bowman, B.A., Ford, E.S., Vinicor, F., Marks, J.S., and Koplan, J.P. (2001), “The Continuing Epidemics of Obesity and Diabetes in the United States”, *Journal of the American Medical Association*, Vol. 286, No. 10, pp. 1195–1200.

Monteiro, C.A., Moubarac, J.-C., Cannon, G., Ng, S.W., and Popkin, B. (2013), “Ultra-processed products are becoming dominant in the global food system”, *Obesity Reviews*, Vol. 14, pp. 21–28. doi:10.1111/obr.12107

Moodie, R., Stuckler, D., Monteiro, C., Sheron, N., Neal, B., Thamarangsi, T., Lincoln, P., and Casswell, S. (2013), “Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries”, *The Lancet*, Vol. 381, No. 9867, pp. 670–679. doi:10.1016/s0140-6736(12)62089-3

Moore, C.S., Lindroos, A.K., Kreutzer, M., Larsen, T.M., Astrup, A., Van Baak, M.A., Handjieva-Darlenska, T., Hlavaty, P., Kafatos, A., Kohl, A., Martinez, J.A., Monsheimer, S., and Jebb, S.A. (2010), “Dietary strategy to manipulate ad libitum macronutrient intake, and glycaemic index, across eight European countries in the Diogenes Study”, *Obesity Reviews*, Vol. 11, pp. 67–75.

Must, A., Spadano, J., Coakley, E.H., Field, A.E., Colditz, G., and Dietz, W.H. (1999), “The Disease Burden Associated with Overweight and Obesity”, *Journal of the American Medical Association*, Vol. 282, No. 16, pp. 1523–1529.

Nederkoorn, C., Smulders, F.T.Y., Havermans, R.C., Roefs, A., and Jansen, A. (2006), “Impulsivity in obese women”, *Appetite*, Vol. 47, No. 2, pp. 253–256.

Pan, L., Sherry, B., Njai, R., and Blanck, H.M. (2012), “Food Insecurity Is Associated with Obesity among US Adults in 12 States”, *Journal of the Academy of Nutrition & Dietetics*, Vol. 112, No. 9, pp. 1403-1409. doi:10.1016/j.jand.2012.06.011

Popkin, B.M., Adair, L.S., and Ng, S.W. (2012), “Global nutrition transition and the pandemic of obesity in developing countries”, *Nutrition Reviews*, Vol. 70, No. 1, pp. 3-21.

Popkin, B.M., and Gordon-Larsen, P. (2004), “The nutrition transition: worldwide obesity dynamics and their determinants”, *International Journal of Obesity*, Vol. 28, pp. S2–S9. doi:10.1038/sj.ijo.0802804

Prentice, A.M. (2006), “The emerging epidemic of obesity in developing countries”, *International Journal of Epidemiology*, Vol. 35, No. 1, pp. 93-99.

Ribas, D.L.B., Philippi, S.T., Tanaka, A.C., and Zorzatto, J.R. (1999), “Saúde e estado nutricional infantil de uma população da região centro-oeste do Brasil”, *Rev Saúde Pública*, Vol. 33, No. 4, pp. 358-365.

Rosenheck, R. (2008), “Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk”, *Obesity Reviews*, Vol. 9, No. 6, pp.535–547. doi: 10.1111/j.1467-789x.2008.00477.x.

Salehi-Abargouei, A., Abdollahzad, H., Bameri, Z., and Esmailzadeh, A. (2013), “Underweight, overweight and obesity among zabolli adolescents: a comparison between international and iranians' national criteria”, *International Journal of Preventive Medicine*, Vol. 4, No. 5, pp. 523-530.

Sen, A. (1981), “Poverty and famines: an essay on entitlement and deprivation”, Clarendon Press/Oxford University Press, Oxford, UK.

Shams, N. (2007), “Contribution of Rice Field Ecosystems to Food Security Strategies in Northwest Cambodia”, *Journal of Sustainable Agriculture*, Vol. 29, No. 4, pp. 109-133. doi:10.1300/J064v29n0409

Sibbel, A. (2012), “Public nutrition and the role of the food industry”, *British Food Journal*, Vol. 114, No. 6, pp. 784-797.

Stuckler, D., and Nestle, M. (2012), “Big Food, Food Systems, and Global Health”, *PLoS Med*, Vol. 9, No. 6. e1001242. doi:10.1371/journal.pmed.1001242

Swinburn, B., and Egger, G. (2002), “Preventive strategies against weight gain and obesity”, *Obesity Reviews*, Vol. 3, No. 4, pp. 289–301.

Swinburn, B., Egger, G., and Raza, F. (1999), “Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interventions for obesity”, *Preventive Medicine*, Vol. 29, No. 6, pp. 563-570.

Thornton, L.E., Bentley, R.J., and Kavanagh, A.M. (2011), “Individual and area-level socioeconomic associations with fast food purchasing”, *Journal of Epidemiology & Community Health*, Vol. 65, No. 10, pp. 873–880. doi:10.1136/jech.2009.099614

Toldrá, F., and Reig, M. (2011), “Innovations for healthier processed meats”, *Trends in Food Science & Technology*, Vol. 22, No. 9, pp. 517–522. doi:10.1016/j.tifs.2011.08.007

UNICEF. (2006), “Progress for Children: A Report Card on Nutrition (No. 4)”, Available at: [http://www.unicef.org/publications/index\\_33685.html](http://www.unicef.org/publications/index_33685.html) (accessed 15 May 2013).

UNICEF. (2007), “The State of the World's Children 2007: Women and Children - The double dividend of gender equality”, Available at: <http://www.unicef.org/sowc/> (accessed 11 May, 2013).

UNICEF. (2013), “Information by country”, Available at: [http://www.unicef.org/infobycountry/stats\\_popup2.html](http://www.unicef.org/infobycountry/stats_popup2.html) (accessed 15 June, 2013).

United Nations. (2013), “Department of public information. Goal 1: eradicate extreme poverty and hunger”, Available at: <http://www.un.org/millenniumgoals> (accessed 05 May 2013).

UNSD. (2013), “United Nations Statistics Division”, Available at: <http://unstats.un.org/unsd/default.htm> (accessed 05 May 2013).

Webb, P., Coates, J., Frongillo, E.A., Rogers, B.L., Swindale, A., and Bilinsky, P. (2006), “Measuring household food insecurity: Why it's so important and yet so difficult to do”, *Journal of Nutrition*, Vol. 136, No. 5, pp. 1404S-1408S.

WFP. (2011), “World Food Programme”, Available at: <http://http://www.wfp.org> (accessed 22 May 2013).

WHO. (2013), “Global Health Observatory of the World Health Organization”, Available at: <http://www.who.int> (accessed 01 February, 2013).

**CAPÍTULO 5:**  
**BEHAVIORAL AND SOCIETAL DRIVERS OF AN OBESOGENIC**  
**ENVIRONMENT WORLDWIDE<sup>5</sup>**

**ABSTRACT**

**Purpose** - This ecological study aimed to analyze the impact of societal and behavioral factors on the obesogenic situation worldwide. The societal variables included urbanization, motorization, and educational and economic developments, while the behavioral variables consisted of nutritional intake and insufficient physical activity (IPA).

**Design/methodology/approach** - This investigation was based on official data concerning 99 countries, in the first part of the reference model, and 92 countries, in the second part. The constructs were measured through urban population (%), energy/protein/fat supply, expected years of schooling, GDP and GNI per capita, vehicles per 1,000 inhabitants, average Body Mass Index (BMI), and IPA level of the populations. Data, obtained through the FAO, WHO, World Bank, and United Nations, were analyzed mainly through descriptive, factor, and multiple regression analyses.

**Findings** - The results suggested that nutritional supply/intake, IPA, and educational level impact significantly and positively on the obesogenic situation ( $p < 0.01$ ,  $p < 0.001$  and  $p < 0.001$ , respectively). In addition, urbanization significantly affects the IPA ( $p < 0.01$ ). Evidence also suggested that economic development impacts negatively on obesogenic severity ( $p < 0.01$ ).

**Originality/value** – Developing economies might face severe obesogenic problems in the future, given their limited access to healthy food and their growing urbanization; thus, nutritional intake should not be seen as the main antecedent of the obesogenic environment. This paper provides comprehensive information to policy makers and researchers interested in the severity of the global obesogenic environment.

**KEYWORDS:** collective obesity; overweight; Body Mass Index; environmental issues; nutritional intake; public health.

---

<sup>5</sup> This paper has been approved to be published at Nutrition & Food Science (ISSN: 0034-6659) in 07-October-2014. (ANNEX 5, pp. 160).

## 1. INTRODUCTION

The obesogenic level of an environment can be defined as “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations” (Swinburn and Egger, 2002). The current global environment can be seen as obesogenic (Swinburn et al., 1999), and an alarming degree of the world population presents symptoms of overweight and obesity; the number of individuals diagnosed with obesity has increased dramatically over the last few years (WHO, 2013). The consequence of this obesogenic reality is serious for obese individuals and obesogenic societies (Nederkoorn et al., 2006). The pandemic of obesity, greatly observed in the United States, currently affects not only developed countries, but also developing countries, especially in their urban areas (Prentice, 2006). The prevalence of obesity is rapidly increasing in developing countries, leading to increased morbidity and mortality from diabetes and cardiovascular disease (McTigue et al., 2006; Moghaddam et al., 2007; Mokdad et al., 2001; Must et al., 1999; Misra and Khurana, 2008). It is strongly suggested that the obesogenic environment is a consequence of social, environmental, and behavioral aspects (Oliveira et al., 2013; Giskes et al., 2011; Hammond, 2010; Papas et al., 2007).

Obesity at an individual level strongly results from nutritional and physical conditions. However, it is necessary to build a better understanding of the causes of obesogenic environments in worldwide economies. The factors that cause and contribute to obesity in both developed and less developed countries are multifactorial and very complex. Environmental, social, and cultural drivers might interact with genetic susceptibilities to increase the obesogenic severity (Bouchard, 1995). Considering that the present investigation is concerned with the worldwide situation, behavioral and societal aspects are addressed to support the hypotheses. Societal aspects are focused on urbanization, development, and educational levels, while the behavioral aspects addressed are physical activities and nutritional intake.

This study aimed to investigate the possible impacts of environmental and behavioral factors on the obesogenic environment worldwide, considering developed and developing countries. The hypotheses related to environmental issues state that (H1) educational level significantly impacts obesogenic severity and (H2) economic development level significantly impacts obesogenic severity. The hypotheses related to behavioral issues state that (H3) insufficient physical activity impacts positively on the obesogenic environment and (H4) nutritional intake impacts positively on the obesogenic environment. Additionally, two other

hypotheses state that (H5) urbanization level increases the insufficient physical activity of a society and (H6) motorization level increases the insufficient physical activity of a society.

This study seeks to contribute to the construction of knowledge about the impacts of environmental and behavioral variables on obesogenic environments. Additionally, the evidence found and presented in this research can generate new insights for researchers, motivating them to conduct further investigations in order to build a better understanding about the causes and consequences of obesity worldwide. However, this study also has practical implications. The evidence presented here can be used to better articulate and support public policy and social actions in order to improve public health around the world, considering the obesogenic environment currently faced. Despite the limitations of this investigation, it presents important contributions to a better understanding about obesogenic environments.

## **2. METHOD**

This ecological study was based on data provided by official institutions, such as the Food and Agriculture Organization of the United Nations (FAO, 2013), the World Health Organization (WHO, 2013), the United Nations Statistics Division (UNSD, 2013), the World Bank (2013), and the United Nations Development Programme (UNDP, 2013). The IPA (Insufficient Physical Activity) level is the percentage of a population completing fewer than 5 sessions of 30 minutes of moderate activity per week, or fewer than 3 sessions of 20 minutes of vigorous activity per week, or the equivalent (WHO, 2013). Commonly, overweight and obesity situations are evaluated through the Body Mass Index (BMI), which is obtained by a simple calculation based on the individual's height and weight: the weight (in kilograms) is divided by the height (in meters) squared ( $\text{kg}/\text{m}^2$ ). The overweight population is the percentage of a population with a BMI of  $25 \text{ kg}/\text{m}^2$  or greater, while the obese population is the percentage of a population with a BMI of  $30 \text{ kg}/\text{m}^2$  or greater. We need to be aware that BMI does not address specific traits of body composition. Despite the fact that BMI is a widely accepted measure of obesity, researchers point out that it should not be the only measure of obesity, particularly as related to adiposity (Rothman, 2008; Cole et al., 2005). However, BMI is adequate to evaluate body fat of populations, as a public health tool for monitoring obesogenic severity (Hall and Cole, 2006).

The variables that composed this study, their operational indicators, their respective official sources, and the years for which data were collected are shown in Table 1 in the next



section. Although there is some time misalignment of the operational variables, we assume that this does not bias the statistical procedures and results. Additionally, this paper used nutritional supply as a proxy for nutritional intake, since a given population's real consumption is not available at a global level.

Table 1 – Variables, Indicators, Sources and Factorial Analysis

Variables	Operational Indicators	Year	Source	Factorial Loading	AVE
Urbanization	Urban population (%);	2010	World Bank	-	-
Nutritional Supply/Intake <sup>a</sup>	Energy Supply;	2008	FAO	0.957 *	0.897
	Protein Supply;	2008		0.952 *	
	Fat Supply;	2008		0.934 *	
Educational Level	Average school years;	2010	UNDP	0.934 *	0.927
	Expected years of schooling (men);	Mean (2006/2009)	World Bank	0.973 *	
	Expected years of schooling (women);	Mean (2006/2009)	World Bank	0.980 *	
Economic Development	GDP per capita;	2009	UNSD	0.996 *	0.991
	GNI per capita;	2009	UNSD	0.996 *	
Motorization	Motor vehicles / 1000 hab. <sup>b</sup> ;	(2007/2009)	World Bank	0.997 *	0.994
	Passenger cars / 1000 hab. <sup>c</sup> ;	(2007/2009)		0.997 *	
Obesogenic Situation	Obese population (%);	2008	WHO	0.976 *	0.931
	Overweight population (%);			0.932 *	
	Mean BMI of the population;			0.986 *	
Insufficient physical activity	Insufficient physical activity (men and women).	2008	WHO	-	-

Note: AVE (Average Variance Extracted); GDP (Gross Domestic Product); GNI (Gross National Income); \* p < 0.001; <sup>a</sup> Energy/Protein/Fat supply are proxies of nutritional intake; <sup>b</sup> include cars, buses, and freight vehicles but do not include two-wheelers; <sup>c</sup> refer to road motor vehicles, other than two-wheelers, intended for the carriage of passengers and designed to seat no more than nine people (including the driver).

Furthermore, this study was focused on the evaluation of a model divided into two stages. The first stage analyzed the impact of urbanization and motorization levels on IPA levels of populations worldwide (hypotheses H5 and H6 respectively). The second stage estimated the impact of dietary intake, IPA, educational level, and economic development on the obesogenic situation of countries worldwide (hypotheses H4, H3, H1, and H2 respectively).

Details regarding the procedures of the data analysis aiming to test the hypotheses and assumptions of this study are presented in the next section. Data were investigated for 99 countries for the first part of the model and 92 for the second part, since certain countries lacked data for some of the operational variables analyzed. Despite the missing data, both samples are composed of various profiles of nations regarding economic development, prevalence of overweight/obesity, urbanization, and educational level. Table 2 presents

information about the sample of 99 countries, with available data used to estimate the first part of the model.

Table 2 – Profile of the 99 countries with available data

	Mean (a)	Conf. Limits for means (95%)		Minimum	Maximum	Standard Deviation (b)	Coef. Var. (b/a) (%)
		-	+				
Urban population (%) <sup>a</sup>	57.7	53.5	61.9	15.1	98.4	20.9	36.2
Insufficiently active age standardized (both sex) <sup>b</sup>	33.9	30.7	37.0	4.7	71.9	16	47.1
Motor vehicles per 1000 people (mean 2007/2009) <sup>a</sup>	247	199	294	2.0	812	239	97
Passenger cars per 1000 people (mean 2007/2009) <sup>a</sup>	200	160	241	1.0	670	202	101
HDI (2010) <sup>a</sup>	0.7	0.6	0.7	0.3	0.9	0.2	26.5
Mean years of schooling of adults (2010) <sup>a</sup>	7.9	7.3	8.5	1.2	12.6	3.1	39.6
Per capita GNI (2009) <sup>c</sup>	13677	10145	17210	317	76218	17711	129
Per capita GDP (2009) <sup>c</sup>	14207	10374	18040	339	104384	19219	135

Note: <sup>a</sup> data obtained at World Bank (2013); <sup>b</sup> data obtained at World Health Organization [WHO] (2013); <sup>c</sup> data obtained at United Nations Statistics Division [UNSD] (2013).

Evidence regarding the profiles of these countries indicates that the sample is sufficiently heterogeneous considering the urbanization level, economic development, and HDI (Human Development Index). Of the 99 countries, 32 were classified as developed countries according to Gross National Income (GNI) per capita per year. Countries with a GNI per capita greater than U.S. \$11,905 in 2009 were defined as developed (World Bank, 2013).

The assessment of the constructs regarding behavioral and societal aspects was performed by Factor Analysis (FA) and the Average Variance Extracted (AVE) (Hair et al., 1998). Factor Analysis examines the correlation matrix of indicators, aiming to put together those highly correlated indicators (factors) that explain significant parts of the variations in the data. The main applications of FA are to reduce the number of variables and to detect structure in the relationships between variables. This study uses FA to reduce the number of indicators. The AVE, which assesses the convergent validity of latent variables, should provide values greater than 0.5 in order to explain more than half of the variance of the items that make up a common factor. The AVE is calculated through factor loadings and standard

errors of the indicators obtained in the factor analysis (Hair et al., 1998; Fornell and Larcker, 1982). This study uses the FA because it is clear that the reduction of some operational indicators to latent variables provides a better adjustment; educational level, economic development, and obesogenic level are complex variables, considering that they are related to populations, which justifies the use of the FA.

The reference model was evaluated through a standard multiple regression analysis. In order to assess the validity of the regression equations, the values of the adjusted  $R^2$  (coefficient of determination) and the significance of the equations (p-value) were calculated and analyzed. The  $R^2$  value is the index that indicates the percentage of total variance of the dependent variable, which is explained by the regression equation (Hair et al., 1998).

Considering the regression results, it is important to examine the linearity, homoscedasticity, and multicollinearity (Hair et al., 1998). For the assessment of linearity, the resulting residuals of the regressions performed were plotted in Q-Q plots and scatter plots; the results suggested that there was no problem of linearity. To elucidate the homoscedasticity situation, Levene's test was used, and the findings suggested that the dependent variable (obesogenic environment) had equal variances in explaining the error terms. Finally, in order to analyze the multicollinearity among independent variables, the values of tolerance and VIF (Variance Inflation Factor) were observed. Tolerance values lower than .90 and VIF values higher than 10 indicate multicollinearity problems among variables. Our results showed that the tolerance values were higher than .90 and the VIF values were lower than 10; therefore, we assumed that the regressions performed had no significant multicollinearity problems among variables.

### **3. RESULTS**

Evidence indicated that in 2004, the average BMI of the world's population surpassed the 25-point range, which represents an overweight situation (WHO, 2013). Moreover, the mean BMI worldwide is growing sharply and steadily. Considering the linear projection and linear equation ( $y = 0.076x - 127.304$ ;  $R^2=0.992$ ), it is expected that the global population will achieve a 30-point range of BMI (obesity) in 2070. This obesogenic environment that we are facing may be due to the abundant availability, easy accessibility and aggressive marketing of foods rich in calories and fats, associated with reduced physical activity in some locations (mostly in urban areas), which tends to cause weight gain, leading to a situation of collective obesity (Van Strien et al., 2009).

This paper showed earlier the values of factor loading obtained for the indicators through the FA, as well as the values of the AVEs of the study variables (Table 1). The factor loading points to the role, based on a correlation analysis, that each variable has in the definition of each factor (or latent variable) (Hair et al., 1998). All factor loadings obtained for the operational indicators of their respective variables are highly significant ( $p < 0.001$ ); in addition, the satisfactory values of AVE are those greater than 0.5 (Hair et al., 1998). Therefore, the values of the AVEs of all variables were highly acceptable, explaining a significant portion of their respective set of indicators. The variables relating to IPA and urbanization were obtained through simple algebraic procedures or based on just one indicator, having no values of factor loading and AVE.

Results obtained through the estimations, by multiple linear regressions, for the two stages of the reference model are presented next. Initially, we present the results for the two parts of the model, considering all countries with valid data (Table 3).

Table 3 – Regression results for the hypotheses

Dependent variable →	Part 1	Part 2
	Insufficient physical activity	Obesogenic situation
Intercept	$\beta = 16.589$ ( $p < 0.001$ ) **	$\beta = -0.628$ ( $p < 0.001$ ) ***
(H6) Motorization	$\beta = 0.128$ ( $p = 0.310$ )	-
(H5) Urbanization	$\beta = 0.385$ ( $p < 0.001$ ) **	-
(H4) Nutritional intake/supply	-	$\beta = 0.364$ ( $p < 0.01$ ) **
(H3) Insufficient Physical Activity	-	$\beta = 0.268$ ( $p < 0.001$ ) ***
(H1) Educational level	-	$\beta = 0.527$ ( $p < 0.001$ ) ***
(H2) Economic Development	-	$\beta = -0.335$ ( $p < 0.01$ ) **
R	0.483	0.773
R <sup>2</sup>	0.233	0.598
Adjusted R <sup>2</sup>	0.217 ( $p < 0.001$ ) ***	0.579 ( $p < 0.001$ ) ***
<i>n<sup>o.</sup> of valid cases</i>	99	92

Note:  $\beta$  is the estimated coefficient for each predictor (or independent variable); R is the Pearson's Correlation; R<sup>2</sup> is the Coefficient of Determination; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

The first part of the model evaluated the impacts of urbanization and motorization on the IPA levels of the respective populations. It is possible to assume that this first equation, inclusive of all 99 countries with valid data, is highly significant ( $p < 0.001$ ). Also, evidence suggests that the urbanization and motorization levels explain 21.7% of the IPA levels of the populations. It was also found that the impact of urbanization on the IPA levels of those 99 countries was positive and highly significant ( $p < 0.01$ ). As such, these findings corroborated hypothesis 5; however, the motorization level did not produce a significant impact on IPA levels. Consequently, hypothesis 6 was refuted. In general, we can assume that urbanization and IPA are strongly related, corroborating some previous evidence (Van Strien et al., 2009).

The urban lifestyle implies a lack of physical activity and severe sedentary behaviors. Also, it seems reasonable to think that technological devices enhance this sedentary behavior.

With regard to the second part of the model, which evaluated the impact of food/nutritional intake, insufficient physical activity, educational level, and economic development on obesogenic severity, evidence suggested that the equation incorporating all 92 countries with valid data presents statistical significance ( $p < 0.001$ ). Additionally, the four independent variables explained 57.9% of the obesogenic situation of those 92 countries. Evidence also suggested that food/nutritional intake, insufficient physical activity, and educational level impact significantly and positively on the obesogenic situation, corroborating hypotheses H4, H3, and H1 respectively. Special attention must be paid to evidence that suggested that educational level is positively associated with the obesogenic situation; however, such findings are contradictory to the theoretical presuppositions highlighted previously (Adler and Stewart, 2009). Indeed, hypothesis H1 was corroborated in its positive version.

Economic development impacted significantly and negatively on the obesogenic situation, suggesting that the economic development of societies reduces the severity of the obesogenic environment. This evidence corroborated hypothesis H2 in its negative form. Additionally, this evidence is aligned with findings already reported in studies conducted on individuals and specific communities (Adler and Stewart, 2009; Rhoades et al., 2004). We can assume, then, that educational progress might be associated with obesogenic severity, and that countries with worse economic development are facing alarming problems of obesity and overweight. Indirectly, evidence also suggested that the urbanization level impacts positively and significantly on obesogenic severity, corroborating previous studies (Neuman et al., 2013).

#### **4. DISCUSSION**

It is known that obesity is associated with significant social and individual costs given that obese people present a greater risk of disease and death. Although there are some controversies regarding the impacts of overweight and obesity in human mortality (Manson et al., 2007), studies suggest that being overweight is a significant risk factor that leads to type 2 diabetes, hypertension, cardiovascular disease, stroke and several types of cancer (McTigue et al., 2006; Moghaddam et al., 2007; Mokdad et al., 2001; Must et al., 1999). Therefore, the resources to be employed in the public health of obesogenic societies should be, logically,

higher. Obesity, in addition to causing higher risk rates of cardiovascular disease and diabetes, may also affect the psychological balance of the obese individual, damaging their social and educational life as well as employment opportunities and income (WHO, 2000).

An important point that deserves attention is the fact that obesity is not a unitary disease, in that its drivers may be associated with several factors, such as genetic, physiologic/metabolic, socio-behavioral and environmental causes (Bouchard, 1991; Bouchard, 1994; Weinsier et al., 1998; Blundell et al., 2005). An individual's genetic composition can strongly explain their excess weight. However, the increase in obesogenic severity observed in recent years must also be attributed to environmental factors that interact and aggravate human genetic susceptibility to weight gain (Ravussin and Bogardus, 2000).

Considering the drivers of an obesogenic environment, an ecological model was proposed, suggesting that biological and environmental factors influence human behavior (Egger and Swinburn, 1997). Furthermore, this behavior dictates the balance between energy in (food consumption) (Prentice, 1998) and energy out (mostly influenced by physical activities). At an individual level, equilibrium fat stores are influenced by physiological adjustments like changes in metabolic rates, energy expenditures of physical activities and nutrient partitioning (Ravussin and Swinburn, 1994). We can assume that obesity-promoting behaviors are enforced by certain factors beyond the individual level (Sallis and Owen, 1997). Therefore, considering that environmental factors have a significant impact on obesogenic severity, it seems logical that some obese individuals might not be able to control their impulsive behavior related to eating and weight gain in an environment that promotes this gain by reinforcing overeating and inactivity (Poston and Foreyt, 1999).

Obesogenic severity is an increasingly common reality in industrialized countries (National Institutes of Health [NIH] & National Heart, Lung, and Blood Institute [NHLBI], 1998). It is reasonable to consider that the industrialization process played a key role in the global evolution of obesity, and the human capacity for fat accumulation is an important adaptive trait. However, this capacity is increasingly misaligned with the modern lifestyle and the industrialized environment where productive activities rely heavily on mechanization, and not on human physical effort (Wells, 2006). The strong urbanization of societies can be seen as one of the possible environmental triggers that aggravate human susceptibility to weight gain. Evidence suggests that the mean BMI in less-developed countries is commonly higher within urban areas (Neuman et al., 2013). However, when comparing rural and urban individuals, evidence suggests that the prevalence of obesity is significantly higher among rural adults in the United States (Befort et al., 2012). Considering this empirical contradiction,

this study aims to present evidence that reinforces these arguments suggesting that urbanization is strongly associated with obesogenic severity.

The habits of urban lifestyle range from the extensive use of motor vehicles to the habit of eating out. This urban way of life possibly decreases the level of physical activities practiced by individuals. Urbanization and motorization levels of a given society can be faced as correlated indicators, but considering the use of motorized vehicles, evidence suggests that overweight and obesity are lower among men that use public transportation. Also, mechanized devices that reduce physical activity at work, affordable motorized transportation and sedentary entertainment activities (e.g., television and internet) strongly contribute to the worsening of pandemic obesity (Prentice, 2006). Thus, walking and bicycling to work are significantly negatively associated with overweight and obesity (Lindström, 2008). Our findings do not support the hypothesis 6 suggesting that motorization level is not significantly associated with the level of insufficient physical activity in a population. Also, there is insufficient evidence based on investigations regarding the impact of motorization level on obesogenic severity in countries worldwide.

Other factors that may promote collective obesity are the levels of income and education of a society; obesity is most often observed in socially disadvantaged groups with low income and less education (Adler and Stewart, 2009). It is also observed that some developing countries (e.g. Mexico and South American countries) face serious problems of collective obesity (Popkin et al., 2012; WHO, 2013). Evidence suggests that the improvement of the economic situations in developing countries can be associated with a growing increase of obesity in adults and children (Misra and Khurana, 2008). In a study conducted in the US, it was evident that, in 2001, 27% of adults with only a high school education or less were considered to be obese. It was also highlighted that 28.6% of people classified as poor were also classified as obese (Rhoades et al., 2004). Such evidence suggests that economically disadvantaged societies can be associated with severe obesogenic environments. Thus, our findings corroborate the second hypothesis (H2), arguing that countries with lower economic development are associated with obesogenic severity. Considering the economic profile of obese individuals, it is important to observe that the relationship between economic disadvantage and the overweight status of adult individuals can be faced as a recursive relationship. While situations of social disadvantage can encourage weight gain, prejudice and social disadvantage caused by obesity can impair job performance, educational assessment and social development of obese individuals (Adler and Stewart, 2009). Considering that obese individuals may suffer institutional and social discrimination, stronger

than those related to gender or race in some cases (Andreyeva et al., 2008), it is possible to assume that the consequences of obesity might achieve collective problems in terms of economic, social and psychological aspects.

The behavioral aspects that impact the obesogenic severity addressed in this study are insufficient physical activity and high food intake. This is an equation that considers the balance between energetic intake and expenditure. Considering physical activities, it is worth noting that aerobic fitness levels of men in industrial nations are significantly lower than those in men leading active lifestyles (Blair et al., 1991; Cordain et al., 1997). It seems reasonable to think that this lack of physical activity is influenced by the industrialization and urbanization processes; thus, it seems logical that this lack of physical activities of a population is affected by the motorization level of a given society. This argument is reinforced since we corroborate the hypothesis 5 suggesting that urbanization level is positively associated with the level of physical inactivity of populations. The high prevalence of sedentary behavior strongly contributes to obesogenic severity (Barlow et al., 1995). Considering nutritional intake, evidence indicates that food consumed outside the home, especially in fast food restaurants, is associated with weight gain and epidemic obesity (Rosenheck, 2008). Moreover, it is logical to think that new technologies (e.g. remote control, e-commerce, e-banking, etc.) reduce the physical activities of individuals in a given society, tending to exacerbate the obesity epidemic. Therefore, some of the main causes of an obesogenic environment are increasing urbanization, inadequate nutritional models and reduced physical activity.

Studies suggest that women have a higher tendency toward obesity than men (Drewnowski and Specter, 2004; Chang and Lauderdale, 2005; Ogden et al., 2007). Regarding to this, data available from the WHO shows that, in 2008, the average BMI of women over 20 years of age worldwide was 25.85, while the average BMI of men was 25.04 (WHO, 2013). Therefore, considering the worldwide levels, it is possible to assert that women are more overweight than men, which can be associated with the global average percentage of men and women with insufficient physical activity. While 32.09% of the male population had insufficient physical activity, 39.12% of the female population showed such a failure in 2008 (WHO, 2013). Obviously, we need to be aware of the gender differences in body composition, considering the ratio between fat and lean mass. Thus, this study considers that insufficient physical activity, along with eating habits, is one of the behavioral causes of an obesogenic environment.



Logically, we must assume that nutritional intake is one of the most important drivers of the obesogenic environment. This pandemic is strongly influenced by nutritional habits and the composition of nutritional models. The nutritional patterns of world populations present significant dietary changes, and nutritional models are being based on a diet dominated by the higher consumption of caloric sweeteners and animal foods (Popkin, 2006). Also, the growth and dominance of multinational food companies that offer cheap products rich in fat (Stuckler et al., 2012; Stuckler and Nestle, 2012) are factors that strongly contribute to nutritional changes of humanity in recent decades. These arguments are supported since our findings corroborate the fourth hypothesis.

## 5. CONCLUSIONS

Obviously, there are several drivers of the obesogenic environment. Aggressive government intervention programs to combat child malnutrition may also contribute to the increasing obesity (Misra and Khurana, 2008). Additionally, cultural and social aspects might impact nutritional habits and energy expenditures. Logically, the solving of the problem of the obesity pandemic is a highly complex task, because it is a reality caused by human behavior as well as macro-environmental variables (Swinburn and Egger, 2002; Swinburn et al., 1999; Egger and Swinburn, 1997). Moreover, the situation becomes even more complex when considering that cultural aspects, as well as physiological factors and individual behaviors, also influence the propensity of people to become obese. With this in mind, the theoretical implications of this study are directed toward a better understanding about the impacts of societal and behavioral variables on the obesogenic environment worldwide. Furthermore, evidence suggests that actions aimed to mitigate the obesogenic severity in the world should be aligned with those variables investigated related to the economic and social environment. Some actions well designed to the realities of each nation, such as the adequacy of a basic-needs grocery package, child nutritional programs and school meals, and the encouragement of the use of urban transportation which is more sustainable and healthy (e.g. the use of collective bicycles) can provide significant improvements in the obesogenic situation globally.

This study does have some important limitations. The absence of valid data for all countries significantly undermines the estimation of the reference model; moreover, considering that this study aims to provide a global overview, the findings are somewhat vague and the results presented here need further and more specific investigations. Also, the

country level data does not reflect the diversity found within a country for various influencing factors of the obesogenic environment; additional studies are still needed. Indeed, it is suggested to conduct a study that aims to analyze the relationships between different nutritional models of societies and the obesogenic environment. Some dietary habits enhanced by industrial societies, strongly associated with fast food and processed food, may aggravate the obesogenic situation worldwide. Thus, longitudinal investigations relating the severity of obesogenic environments and the infrastructure of public health are strongly necessary.

## REFERENCES

Adler, N.E. and Stewart, J. (2009), “Reducing Obesity: Motivating Action While Not Blaming the Victim”, *Milbank Quarterly*, Vol. 87, No. 1, pp. 49–70. doi:10.1111/j.1468-0009.2009.00547.x

Andreyeva, T., Puhl, R.M. and Brownell, K.D. (2008), “Changes in Perceived Weight Discrimination Among Americans, 1995–1996 Through 2004–2006”, *Obesity*, Vol. 16, No. 5, pp. 1129–1134. doi:10.1038/oby.2008.35

Barlow C.E., Kohl H.W., Gibbons L.W. and Blair S.N. (1995), “Physical fitness, mortality, and obesity”, *Int J Obes Relat Metab Disord*, Vol. 19, No. Suppl. 4, pp.S41–S44.

Befort, C.A., Nazir, N. and Perri, M.G. (2012), “Prevalence of Obesity Among Adults From Rural and Urban Areas of the United States: Findings From NHANES (2005-2008)”, *The Journal of Rural Health*, Vol. 28, No. 4, pp. 392–397. doi:10.1111/j.1748-0361.2012.00411.x

Blair S.N., Kohl H.W., Barlow C.E. and Gibbons L.W. (1991), “Physical fitness and all-cause mortality in hypertensive men”, *Ann Med*, Vol. 23, pp. 307–312.

Blundell J., Stubbs R.J., Golding C., Croden F., Alam R., Whybrow S., Le Nourya J. and Lawtona C.L. (2005), “Resistance and susceptibility to weight gain: individual variability in response to a high fat diet”, *Physiology & Behavior*, Vol. 86, No. 5, pp. 614–622. doi:10.1016/j.physbeh.2005.08.052

Bouchard C. (1991), “Current understanding of the etiology of obesity: Genetic and nongenetic factors”, *American Journal of Clinical Nutrition*, Vol. 53, No. 6, pp. 1561S–1565S.

Bouchard C. (1994), “Genetics of obesity: Overview and research direction”, in Bouchard C.B. (Ed.), *The Genetics of Obesity*, CRC Press, Boca Raton, FL, pp. 223–233.

Bouchard C. (1995), “Genetics and the metabolic syndrome”, *Int J Obes Relat Metab Disord*, Vol. 9, No. Suppl. 1, pp. S52–S59.

Chang, V.W. and Lauderdale, D.S. (2005), “Income Disparities in Body Mass Index and Obesity in the United States, 1971-2002”, *Archives of Internal Medicine*, Vol. 165, No. 18, pp. 2122-2126. doi:10.1001/archinte.165.18.2122

Cole, T.J., Faith, M.S., Pietrobelli, A., and Heo, M. (2005), “What is the best measure of adiposity change in growing children: BMI, BMI %, BMI z-score or BMI centile?”, *European Journal of Clinical Nutrition*, Vol. 59, No. 6, pp. 807–807. doi:10.1038/sj.ejcn.1602155

Cordain L., Gotshall R.W. and Eaton S.B. (1997), “Evolutionary aspects of exercise”, *World Rev Nutr Diet*. Vol. 81, pp. 49–60.

Drewnowski A. and Specter S.E. (2004), “Poverty and Obesity: The Role of Energy Density and Energy Costs”, *American Journal of Clinical Nutrition*, Vol. 79, No. 1, pp. 6–16.

Egger G. and Swinburn B. (1997), “An ecological approach to the obesity pandemic”, *BMJ*, Vol. 315, No. 7106, pp. 477–80.

Food and Agriculture Organization [FAO] (2013), “Food and Agriculture Organization of United Nations”, available at: <http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en/> (accessed 22 August 2013).

Fornell C. and Larcker D. (1982), “Evaluating structural equation models with unobservable variables and measurement error”, *Journal of Marketing Research*, Vol. 17, No. 1, pp. 39-50.

Giskes, K., van Lenthe, F., Avendano-Pabon, M., and Brug, J. (2011), “A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments?”, *Obesity Reviews*, Vol. 12, No. 5, pp. e95–e106. doi:10.1111/j.1467-789x.2010.00769.x

Hair J.F., Anderson R.E., Tatham R.L. and Black W.C. (1998), “Multivariate data analysis with readings”, Prentice-Hall, New Jersey, NY.

Hall, D.M.B., and Cole, T.J. (2006), “What use is the BMI?”, *Archives of Disease in Childhood*, Vol. 91, No. 4, pp. 283–286. doi:10.1136/adc.2005.077339

Hammond, R.A. (2010), “Social influence and obesity. *Current Opinion in Endocrinology, Diabetes and Obesity*, Vol. 17, No. 5, pp. 467–471. doi:10.1097/med.0b013e32833d4687

Lindström M. (2008), “Means of transportation to work and overweight and obesity: A population-based study in southern Sweden”, *Preventive Medicine*, Vol. 46, No. 1, pp. 22-28. doi:10.1016/j.jpmed.2007.07.012.

Manson J.E., Bassuk S.S., Hu F.B., Stampfer M.J., Colditz G.A. and Willett W.C. (2007), “Estimating The Number of Deaths Due to Obesity: Can The Divergent Findings Be Reconciled?”, *Journal of Women's Health*, Vol. 16, No. 2, pp. 168-176. doi:10.1089/jwh.2006.0080.

McTigue, K., Larson, J.C., Valoski, A., Burke, G., Kotchen, J., Lewis, C.E., Stefanick M.L., Van Horn L. and Kuller, L. (2006), “Mortality and Cardiac and Vascular Outcomes in Extremely Obese Women”, *Journal of the American Medical Association*, Vol. 296, No. 1, pp. 79-86. doi:10.1001/jama.296.1.79

Misra A. and Khurana L. (2008), “Obesity and the Metabolic Syndrome in Developing Countries”, *Journal of Clinical Endocrinology & Metabolism*, Vol. 93, No. 11, pp. 9-30.

Moghaddam, A.A., Woodward, M. and Huxley, R. (2007), “Obesity and Risk of Colorectal Cancer: A Meta-analysis of 31 Studies with 70,000 Events”, *Cancer Epidemiology*

*Biomarkers & Prevention*, Vol. 16, No, 12, pp. 2533–2547. doi:10.1158/1055-9965.epi-07-0708

Mokdad A.H., Bowman B.A., Ford E.S., Vinicor F., Marks J.S. and Koplan J.P. (2001), “The Continuing Epidemics of Obesity and Diabetes in the United States”, *Journal of the American Medical Association*, Vol. 286, No. 10, pp. 1195–1200.

Must A., Spadano J., Coakley E.H., Field A.E., Colditz G. and Dietz W.H. (1999), “The Disease Burden Associated with Overweight and Obesity”, *Journal of the American Medical Association*, Vol. 282, No. 16, pp. 1523–29.

National Institutes of Health [NIH], National Heart, Lung, and Blood Institute [NHLBI] (1998), “Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity: The evidence report”, Washington DC, US Government Press.

Nederkoorn, C., Smulders, F.T.Y., Havermans, R.C., Roefs, A. and Jansen, A. (2006), “Impulsivity in obese women”, *Appetite*, Vol. 47, No. 2, pp. 253–256. doi:10.1016/j.appet.2006.05.008

Neuman M., Kawachi I., Gortmaker S. and Subramanian S. (2013), “Urban-rural differences in BMI in low- and middle-income countries: the role of socioeconomic status”, *The American Journal of Clinical Nutrition*, Vol. 97, No. 2, pp. 428-436. doi:10.3945/ajcn.112.045997.

Ogden C.L., Yanovski S.Z., Carroll M.D. and Flegal K.M. (2007), “The epidemiology of obesity”, *Gastroenterology*, Vol. 132, No. 6, pp. 2087-2102.

Oliveira, A.J., Rostila, M., de Leon, A.P., and Lopes, C.S. (2013), “The influence of social relationships on obesity: Sex differences in a longitudinal study”, *Obesity*, Vol. 21, No. 8, pp. 1540–1547. doi:10.1002/oby.20286

Papas, M.A., Alberg, A.J., Ewing, R., Helzlsouer, K.J., Gary, T.L., and Klassen, A.C. (2007), “The Built Environment and Obesity”, *Epidemiol. Rev.*, Vol. 29, No. 1, pp. 129-143. doi: 10.1093/epirev/mxm009

Popkin B.M. (2006), “Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases”, *Am J Clin Nutr*, Vol. 84, pp. 289–298.

Popkin, B.M., Adair, L.S., and Ng, S.W. (2012), “Global nutrition transition and the pandemic of obesity in developing countries”, *Nutrition Reviews*, Vol. 70, No. 1, pp. 3–21. doi:10.1111/j.1753-4887.2011.00456.x

Poston W.S.C. and Foreyt J.P. (1999), “Obesity is an environmental issue”, *Atherosclerosis*, Vol. 146, pp. 201–209.

Prentice A.M. (1998), “Manipulation of dietary fat and energy density and subsequent effects on substrate flux and food intake”, *Am J Clin Nutr*, Vol. 67, pp. 535S–541S.

Prentice, A.M. (2006), “The emerging epidemic of obesity in developing countries”, *International Journal of Epidemiology*, Vol. 35, No. 1, pp. 93–99. doi:10.1093/ije/dyi272

Ravussin E. and Swinburn B.A. (1994), “Metabolic predictors of obesity: cross-sectional versus longitudinal data”, *Int J Obes*, Vol. 17, No. 3suppl, pp. S28–S31.

Ravussin, E. and Bogardus, C. (2000), “Energy balance and weight regulation: genetics versus environment”, *British Journal of Nutrition*, Vol. 83, No. S1, pp. S17–S20. doi:10.1017/s0007114500000908

Rhoades J.A., Altman B.M. and Cornelius L.J. (2004), “Trends in Adult Obesity in the United States, 1987 and 2001: Estimates for the Non-Institutionalized Population, Age 20 to 64”, Statistical Brief no. 37. available at: [http://www.meps.ahrq.gov/mepsweb/data\\_files/publications/st37/stat37.pdf](http://www.meps.ahrq.gov/mepsweb/data_files/publications/st37/stat37.pdf) (accessed 25 August 2012).

Rosenheck, R. (2008), “Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk”, *Obesity Reviews*, Vol. 9, No. 6, pp. 535–547. doi:10.1111/j.1467-789x.2008.00477.x

Rothman, K.J. (2008), “BMI-related errors in the measurement of obesity”, *International Journal of Obesity*, Vol. 32, pp. S56–S59. doi:10.1038/ijo.2008.87

Sallis J.F. and Owen N. (1997), “Ecological models”, in Glanz K., Lewis F.M. and Rimer B.K. (Eds.), *Health behavior and health education: Theory, research, and practice*, Jossey-Bass, San Francisco, CA, pp. 403–424.

Stuckler D., McKee M., Ebrahim S. and Basu S. (2012), “Manufacturing Epidemics: The Role of Global Producers in Increased Consumption of Unhealthy Commodities Including Processed Foods, Alcohol, and Tobacco”, *PLoS Med*, Vol. 9, No. 6, pp. e1001235. doi:10.1371/journal.pmed.1001235.

Stuckler, D. and Nestle, M. (2012), “Big Food, Food Systems, and Global Health”, *PLoS Med*, Vol. 9, No. 6. e1001242. doi:10.1371/journal.pmed.1001242

Swinburn, B. and Egger, G. (2002), “Preventive strategies against weight gain and obesity”, *Obesity Reviews*, Vol. 3, No. 4, pp. 289–301. doi:10.1046/j.1467-789x.2002.00082.x

Swinburn, B., Egger, G. and Raza, F. (1999), “Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity”, *Preventive Medicine*, Vol. 29, No. 6, pp. 563–570. doi:10.1006/pmed.1999.0585

United Nations Development Programme [UNDP] (2013), “International Human Development Indicators”, available at: <http://hdrstats.undp.org/en/tables/> (accessed 23 August 2013).

United Nations Statistics Division [UNSD] (2013), “National Accounts Main Aggregates Database”, available at: <http://unstats.un.org/unsd/snaama/selbasicFast.asp> (accessed 21 August 2013).

Van Strien, T., Herman, C.P. and Verheijden, M.W. (2009), “Eating style, overeating, and overweight in a representative Dutch sample. Does external eating play a role?”, *Appetite*, Vol. 52, No. 2, pp. 380–387. doi:10.1016/j.appet.2008.11.010

Weinsier R.L., Hunter G.R., Heine A.F., Goran M.I. and Sell S.M. (1998), “The etiology of obesity: Relative contribution of metabolic factors, diet, and physical activity”, *American Journal of Medicine*, Vol. 105, No. 2, pp. 145–50.

Wells, J.C.K. (2006), “The evolution of human fatness and susceptibility to obesity: an ethological approach”, *Biological Reviews*, Vol. 81, No. 2, pp. 183-205. doi:10.1017/s1464793105006974

World Bank (2013), “The World Bank”, available at: <http://www.worldbank.org/> (accessed 22 August 2013).

World Health Organization [WHO] (2013), “World Health Organization Database”, available at: <http://www.who.int> (accessed 22 August 2013).

World Health Organization [WHO] (2000), “Obesity: Preventing and managing the global epidemic”. Report of a WHO consultation on obesity, Geneva, Switzerland. available at: [http://libdoc.who.int/trs/WHO\\_TRS\\_894.pdf](http://libdoc.who.int/trs/WHO_TRS_894.pdf) (accessed 18 August 2013).



## CONSIDERAÇÕES FINAIS

Este trabalho consiste em um conjunto de estudos relacionados à temática da insegurança alimentar mundial, que paradoxalmente coexiste com indicadores de obesidade pandêmica. Tal proposta objetivou apresentar contribuições pertinentes com o intuito de proporcionar um melhor entendimento da situação mundial de segurança alimentar, considerando os indicadores antropométricos. Além disso, essa proposta busca também enfatizar a importância do papel do agronegócio brasileiro como potencial atenuador da gravidade de insegurança alimentar em nível mundial, principalmente com relação às nações menos favorecidas do continente africano.

Considerando o panorama mundial de insegurança alimentar, observamos que tal realidade é agravada tanto por diagnósticos de fome e desnutrição, como por diagnósticos de sobre peso e obesidade. Além disso, é evidenciado que algumas nações enfrentam a co-ocorrência de tais realidades, o que indica que essas nações enfrentam os dois lados da insegurança alimentar, precisando de uma atenção diferenciada para tal problemática. Considerando essa co-ocorrência, observa-se que as nações do sul da África enfrentam problemas acentuados de desnutrição e sobrepeso. Além disso, essas mesmas nações apresentam tendências de aumento para ambos os indicadores de baixo peso e sobrepeso para sua população infantil. Em contra partida, o leste asiático apresenta indicadores reduzidos para as proporções e tendências de crianças abaixo do peso e com situação de sobrepeso.

Analisando os padrões mundiais de suprimento alimentar, que podem ser utilizados como *proxy* para modelos alimentares, podemos constatar que determinados padrões estão mais associados com urgências de segurança alimentar. Os modelos alimentares fortemente presentes no continente africano, onde o suprimento é fortemente baseado em um grupo alimentar, estão associados com elevados índices de desnutrição e baixo peso infantil. Além disso, os modelos alimentares do leste asiático são mais balanceados, com suprimento elevado de vegetais, frutas e peixe. Logo, podemos sugerir que o suprimento alimentar do leste asiático pode ser um importante antecedente para os índices reduzidos de sobrepeso e baixo peso infantil. Tais resultados podem servir de base para o desenvolvimento de políticas públicas que fomentem um suprimento alimentar mais adequado tendo em vista as urgências alimentares de cada região. Além disso, esse esforço no suprimento alimentar mais adequado deve também considerar as limitações e fragilidades de cada região em termos de disponibilidade, acesso e uso de alimentos.

Como as populações africanas são as que apresentam maior urgência por segurança alimentar em termos de desnutrição e baixo peso infantil, a parceria estabelecida com o Brasil poderá vir a aliviar algumas deficiências importantes. No entanto, a constatação de que os projetos atualmente em andamento apresentam uma fraca sinergia e estão pouco alinhados com as maiores urgências africanas, podemos considerar que um melhor alinhamento de tais iniciativas colaborativas poderão auxiliar de forma significativa na promoção de segurança alimentar no continente africano. Além disso, a instabilidade política e os conflitos armados nas regiões mais fragilizadas são barreiras para o estabelecimento de iniciativas de combate à insegurança alimentar. Por fim, ao considerarmos que a desnutrição infantil é fator que compromete o desenvolvimento cognitivo humano de forma irreversível dos indivíduos, enquanto não for possível proporcionar segurança alimentar para os países mais desfavorecidos, o desenvolvimento de tais regiões permanecerá comprometido.

Estudos adicionais que busquem aliviar a gravidade de insegurança alimentar em nível mundial ainda são de grande urgência. Além disso, temáticas emergentes podem ser relacionadas com a temática da segurança alimentar, proporcionando um melhor entendimento dos antecedentes e conseqüências de tal situação. Como sugestão de estudos adicionais, salienta-se a necessidade por investigações relacionando os padrões de suprimento alimentar com os impactos ambientais atrelados ao consumo nutricional de populações. Além disso, também considera-se uma oportunidade de pesquisa pertinente a investigação acerca da associação existente entre as condições de infraestrutura logística das nações com suas situações de insegurança alimentar atrelada à disponibilidade, acesso e uso de alimentos.

Outra oportunidade de estudo considerada pertinente é analisar a associação entre a presença de cadeias curtas de suprimento de alimentos com condições reduzidas de insegurança alimentar, principalmente no que tange aos traços de obesogenia de populações. Podemos considerar que tais cadeias curtas, por estarem associadas a alimentos mais naturais, pouco ou não processados, podem proporcionar um auxílio importante e significativo no combate ao ambiente obesogênico. Além disso, a análise das cadeias produtivas e cadeias de suprimento ligadas ao Agronegócio, e suas particularidades estratégicas e operacionais, tem relação íntima com as potencialidades de empresas e agentes econômicos ligados à produção e distribuição de alimentos com potencial de aliviar a urgência por segurança alimentar em nível global. Outra temática associada ao suprimento de alimentos mais adequados e saudáveis é a produção e suprimento de alimentos orgânicos, que também pode ser encarada como uma oportunidade de pesquisa vinculada à temática da segurança alimentar.

Os estudos relacionados à temática da segurança alimentar mundial apresentados nesta tese de doutoramento apresentam limitações importantes. Além das limitações específicas apontadas em cada um dos artigos, é necessário atentar para o fato de que os estudos são baseados em dados de nível mundial obtidos em instituições e organizações renomadas. No entanto, tais dados são obtidos por tais instituições de formas diversas, por meio de procedimentos metodológicos diversos. Logo, tais dados apresentam uma fragilidade inerente a sua própria natureza. Além disso, como os estudos apresentados consideram as nações mundiais, seus resultados são vagos, não representando realidades populacionais mais específicas. Ademais, a investigação concernente ao conceito de segurança alimentar é baseada em indicadores antropométricos, o que também é considerada uma limitação importante, já que os indicadores da segurança alimentar contemplam outras perspectivas analíticas. Por fim, por se tratar de uma temática de urgência mundial, estudos adicionais que busquem suprir tomadores de decisão do âmbito público e privado com informações pertinentes ao desenvolvimento de melhores iniciativas de combate à insegurança alimentar mundial são fortemente encorajados.

O cenário mundial concernente à insegurança alimentar e obesogenia coletiva é tema de amplo debate no setor público e privado mundial. De fato, tais urgências abordadas nesta tese são temas de preocupação em nível de governos mundiais. No entanto, cabe também aos *stakeholders* ligados ao agronegócio mundial assumirem uma postura ativa frente aos problemas mundiais relacionados à insegurança alimentar e obesogenia, alinhando práticas e estratégias desde a pré-produção de alimentos (ex. pesquisas genéticas e novas formas de plantio e manejo produtivo) até atividades de distribuição e comercialização de produtos alimentícios, permeando todo processo de cadeias de suprimento alimentares. Com isso, este estudo finaliza com uma provocação de que agentes e organizações ligadas ao agronegócio em âmbito mundial devem incluir e destacar em suas pautas de discussão as problemáticas abordadas nesta tese. A insegurança alimentar tem implicações diretas em questões de saúde pública e problemas sociais, mas suas causas estão fortemente calcadas em elementos contemplados pelo campo de estudos do agronegócio.

Tal urgência mundial de promoção de segurança alimentar, incluindo como atores ativos os *stakeholders* do campo do agronegócio nesse cenário, oportuniza inovações altamente necessárias relacionadas à alimentação. Tais inovações são oportunizadas desde o desenvolvimento de inovações genéticas e formas produtivas inovadoras, como também inovações no processamento de alimentos tecnologicamente mais complexos e alinhados às urgências alimentares mundiais. Dessa forma, a inovação alimentar deve proporcionar

condições de garantir a segurança alimentar, garantindo a produção de quantidades e qualidades suficientes de alimentos para atender às necessidades mundiais, garantindo ainda condições de acesso físico e econômico de tais alimentos. Também podemos considerar inovações no âmbito do comportamento dos consumidores, que são o elo final das cadeias produtivas e de suprimento de alimentos, e que são o público-alvo da promoção da segurança alimentar. Cabe destacar, portanto, que a inovação em todos os agentes produtivos e de suprimento alimentar no campo do agronegócio, assim como agentes de políticas públicas e governos, possuem um papel fundamental na promoção da segurança alimentar mundial. Incorpora-se, portanto, enfaticamente, o agronegócio na pauta de discussão mundial sobre a promoção da segurança alimentar.

## REFERÊNCIAS

- ASSIS, A. M. O.; BARRETO, M. L. **Condições de vida, saúde e nutrição na infância em Salvador**. Salvador: UFBA, 2000.
- BARRETT, C. B. Measuring food insecurity. **Science**, Washington, v. 327, n. 5967, p. 825-828, 2010.
- DOAK, C.; ADAIR, L. S.; BENTLEY, M. The dual burden household and nutrition transition paradox. **International Journal of Obesity**, London, v. 29, n. 1, p. 129–136, 2005.
- DOBBING, J. Nutrition, the nervous system and behavior. **OPAS**, n. 251, 1972.
- FAO. Food and Agriculture Organization of United Nations, 2013. **Faostat**. Disponível em: <<http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en/>>. Acesso em: 27 maio 2013.
- FAO. Global hunger declining, but still unacceptably high: International hunger targets difficult to reach. **Economic and Social Development Department**, 2010a. Disponível em: <<http://www.fao.org/docrep/012/a1390e/a1390e00.pdf>>. Acesso em: 18 maio 2013.
- FAO. **Progress towards millennium development goal 1: hunger Target**, 2010b. Disponível em: <<http://www.fao.org/hunger>>. Acesso em: 18 maio 2013.
- FAO. Rome Declaration on World Food Security and World Food Summit Plan of Action. In: WORLD FOOD SUMMIT, 13-17 November, 1996, Rome. **Proceedings...** Rome: [FAO], 1996.
- FAO. **The State of Food Insecurity in the World 2013**, 2013. Disponível em: <<http://www.fao.org/publications/sofi/en/>>. Acesso em: 31 Mar. 2014.
- FAO. **The State of Food Insecurity in the World 2001**. Rome: FAO, 2002. p. 4-7.
- GODFRAY, H. C. J. et al. Food security: the challenge of feeding 9 billion people. **Science**, Washington, v. 327, n. 5967, p. 812-818, 2010.
- HAIR J. F. Et al. **Multivariate data analysis with readings**. New Jersey, NY: Prentice-Hall, 1998.
- IBGE. Instituto Brasileiro de Geografia e Estatística, 2013. **Banco de dados agregados**. Disponível em: <<http://www.ibge.gov.br>>. Acesso em: 10 abr. 2013.
- MCTIGUE, K. et al. Mortality and cardiac and vascular outcomes in extremely obese women. **Journal of the American Medical Association**, Chicago, v. 296, n. 1, p. 79–86, 2006.
- MISRA, A.; KHURANA, L. Obesity and the metabolic syndrome in developing countries. **Journal of Clinical Endocrinology & Metabolism**, Chevy Chase, v. 93, n. 11, p. 9-30, 2008.

MOGHADDAM, A. A.; WOODWARD, M.; HUXLEY, R. Obesity and risk of colorectal cancer: a meta-analysis of 31 studies with 70,000 events. **Cancer Epidemiology, Biomarkers and Prevention**, Philadelphia, v. 16, n. 12, p. 2533–2547, 2007.

MOKDAD, A. H. et al. The continuing epidemics of obesity and diabetes in the United States. **Journal of the American Medical Association**, Chicago, v. 286, n. 10, p. 1195–1200, 2001.

MUST, A. et al. The disease burden associated with overweight and obesity. **Journal of the American Medical Association**, Chicago, v. 282, n. 16, p. 1523–1529, 1999.

NEDERKOORN, C. et al. Impulsivity in obese women. **Appetite**, London, v. 47, n. 2, p. 253–256, 2006.

PATEL, R. **Stuffed and Starved**: the hidden battle for the world food system. Brooklyn: Melville House, 2008.

RIBAS, D. L. B. et al. Saúde e estado nutricional infantil de uma população da região centro-oeste do Brasil. **Revista de Saúde Pública**, São Paulo, v. 33, n. 4, p. 358-365, 1999

SEN, A. **Poverty and famines**: an essay on entitlement and deprivation. Clarendon Press/Oxford University Press: Oxford, UK, 1981.

STEIN, A. D.; THOMPSON, A. M.; WATERS, A. Childhood growth and chronic disease: evidence from countries undergoing the nutrition transition. **Maternal and Child Nutrition**, Oxford, v. 1, n. 3, p. 177–184, 2005.

SWINBURN, B.; EGGER, G.; RAZA, F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. **Preventive Medicine**, New York, v. 29, n. 6, p. 563-570, 1999.

UNDP - United Nations Development Programme. **International Human Development Indicators**, 2013. Disponível em: <<http://hdrstats.undp.org/en/tables>>. Acesso em: 23 ago. 2013.

UNICEF - United Nations Children's Fund. **Progress for Children**: A Report Card on Nutrition. (No. 4), 2006b. Disponível em: <[http://www.unicef.org/publications/index\\_33685.html](http://www.unicef.org/publications/index_33685.html)>. Acesso em: 15 maio 2013.

UNICEF - United Nations Children's Fund. **The State of the World's Children 2007**: Women and Children - The double dividend of gender equality, 2007. Disponível em: <<http://www.unicef.org/sowc/>>. Acesso em: 15 Maio 2013.

UNICEF - United Nations Children's Fund. **Under five deaths by cause**, 2006a. Disponível em: <[http://www.unicef.org/media/files/Under\\_five\\_deaths\\_by\\_cause\\_2006\\_estimates3.doc](http://www.unicef.org/media/files/Under_five_deaths_by_cause_2006_estimates3.doc)>. Acesso em: 15 maio 2013.

UNITED NATIONS. Department of public information. **Goal 1**: eradicate extreme poverty and hunger, 2013. Disponível em: <<http://www.un.org/millenniumgoals>>. Acesso em: 05 maio 2013.

UNSD - United Nations Statistic Division. Millennium Development Goals Indicators. Department of public information. **Goal 1**: eradicate extreme poverty and hunger, 2013. Disponível em: <<http://www.un.org/millenniumgoals>>. Acesso em: 22 maio 2013.

WEBB, P. et al. Measuring household food insecurity: Why it's so important and yet so difficult to do. **Journal of Nutrition**, Bethesda, v. 136, n. 5, p. 1404S-1408S, 2006.

WHO - World Health Organization. **Global Health Observatory Data Repository**, 2013. Disponível em: <<http://www.who.int/en/>>. Acesso em: 05 jan. 2013.

WHO - World Health Organization. **Micronutrients deficiencies**, 2013. Disponível em: <<http://www.who.int/nutrition/topics/ida/en/>>. Acesso em: 18 maio 2013.

WORLD BANK. **The World Bank Database**, 2013. Disponível em: <<http://www.worldbank.org/>>. Acesso em: 22 maio 2013.

**ANEXOS (ANNEXES)**





## Journal of Agribusiness in Developing and Emerging Economies

Brazilian Dry-Beans and Food Security in Developing Countries:

Eduardo Botti Abbade Homero Dewes

### Article information:

To cite this document:

Eduardo Botti Abbade Homero Dewes , (2014), "Brazilian Dry-Beans and Food Security in Developing Countries", Journal of Agribusiness in Developing and Emerging Economies, Vol. 4 Iss 2 pp. -

Permanent link to this document:

<http://dx.doi.org/10.1108/JADEE-06-2012-0015>

Downloaded on: 15 October 2014, At: 04:24 (PT)

References: this document contains references to 0 other documents.

To copy this document: [permissions@emeraldinsight.com](mailto:permissions@emeraldinsight.com)

### Users who downloaded this article also downloaded:

Josefa Salete Barbosa Cavalcanti, (2006), "The Dynamics of Local Development: From Hunger to Quality Food Cases from Northeastern Brazil", Research in Rural Sociology and Development, Vol. 12 pp. 175-201

Olaf Ploetner, (2006), "ESCRA", Journal of Business & Industrial Marketing, Vol. 21 Iss 3 pp. 189-194

Olímpio J. de Arroxelas Galvão, (1999), "Unequal federalism and regional inequalities: the case of the coffee policies in Brazil", International Journal of Social Economics, Vol. 26 Iss 7/8/9 pp. 1162-1185

Access to this document was granted through an Emerald subscription provided by 216607 []

### For Authors

If you would like to write for this, or any other Emerald publication, then please use our Emerald for Authors service information about how to choose which publication to write for and submission guidelines are available for all. Please visit [www.emeraldinsight.com/authors](http://www.emeraldinsight.com/authors) for more information.

### About Emerald [www.emeraldinsight.com](http://www.emeraldinsight.com)

Emerald is a global publisher linking research and practice to the benefit of society. The company manages a portfolio of more than 290 journals and over 2,350 books and book series volumes, as well as providing an extensive range of online products and additional customer resources and services.

Emerald is both COUNTER 4 and TRANSFER compliant. The organization is a partner of the Committee on Publication Ethics (COPE) and also works with Portico and the LOCKSS initiative for digital archive preservation.

\*Related content and download information correct at time of download.

---

## **Journal of Agribusiness in Developing and Emerging Economies - Manuscript ID JADEE-01-2014-0004.R1**

---

De: **onbehalfof+EDITORJADEE+syr.edu@manuscriptcentral.com** em nome de **EDITORJADEE@syr.edu**

Enviada: sexta-feira, 29 de agosto de 2014 16:30:19

Para: edabbade@hotmail.com

29-Aug-2014

Dear Mr. Abbade:

Your manuscript entitled "Brazilian Agribusiness facing African Food Insecurity" has been successfully submitted online and is presently being given full consideration for publication in the Journal of Agribusiness in Developing and Emerging Economies.

Your manuscript ID is JADEE-01-2014-0004.R1.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to Manuscript Central at <http://mc.manuscriptcentral.com/jadee> and edit your user information as appropriate.

You can also view the status of your manuscript at any time by checking your Author Centre after logging in to <http://mc.manuscriptcentral.com/jadee>.

Please note that Emerald requires you to clear permission to re-use any material not created by you. If there are permissions outstanding, please upload these when you submit your revision or send directly to Emerald if your paper is accepted immediately. Emerald is unable to publish your paper with permissions outstanding.

Thank you for submitting your manuscript to the Journal of Agribusiness in Developing and Emerging Economies.

Sincerely,

Journal of Agribusiness in Developing and Emerging Economies Editorial Office

# Food insecurity worldwide derived from food supply patterns

Eduardo Botti Abbade · Homero Dewes

Received: 15 May 2014 / Accepted: 12 November 2014  
© Springer Science+Business Media Dordrecht and International Society for Plant Pathology 2014

**Abstract** Worldwide, humanity is facing severe nutritional imbalances, which are dependent on access to food and the dietary habits of particular populations that can make them susceptible to malnutrition. This study aims to identify and analyze the main food supply patterns (FSPs) of populations worldwide, and then to relate them to their respective malnutrition conditions. The hypothesis is that there are specific, geographically identifiable FSPs that are associated with the nutritional misalignment of certain populations to a greater degree than others. This investigation is based on data regarding the supply of the main food groups worldwide, as well as the metrics associated with malnutrition. Data analyses were performed using descriptive statistics, cluster analysis, ANOVA, and correlation analysis. The results suggest the existence of nine clusters of countries with specific FSPs that differ significantly regarding their supplies of macronutrients and their malnutrition traits. Furthermore, using Pearson's coefficient of variation (CV) to assess the balance level (or symmetry) of each FSP, reflecting the average supply of food groups, the results suggest the existence of a positive and significant correlation ( $r=0.6364$ ;  $p=0.000$ ) between the imbalance level of particular FSPs and the prevalence of underweight children in their respective populations. Also, FSPs 1, 3, and 4 are strongly associated with obesogenic traits, with FSP 3 being the most strongly associated with the prevalence

of overweight. According to our analyses, the FSPs of Southern Africa (with a strong prevalence of child overweight) and Southern Asia (with a strong prevalence of child underweight) lead to the worst conditions observed, while the populations with the best nutritional status are based on the FSP of Eastern Asia.

**Keywords** Food security · World development · Dietary models · Nutritional composition · Obesogenic environment · Malnutrition

## Introduction

According to the United Nations Food and Agriculture Organization (FAO), food security refers to a situation where “all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences, for an active and healthy life” (FAO 1996; FAO 2002). Thus, food security is related to the availability, accessibility, and use of adequate food (Barrett 2002; Barrett 2010; Webb et al. 2006). Therefore, assuming that the provision of food security involves ensuring the conditions under which individuals can purchase/acquire enough food and nutrients to meet their needs (Sen 1981), it has become necessary to conduct an investigation based on identifying the main global food supply patterns (FSPs).

Food security is a complex concept that encompasses several indicators and diagnoses. The present investigation uses the anthropometric perspective of measuring food insecurity (Cunningham 2005) using specific indicators as proxies, such as prevalence of underweight and overweight children, undernourished population, and average body mass index (BMI) (Maxwell and Frankenberger 1992; FIVIMS 2002; Cogill 2003). It is also important to emphasize that overweight and obesity are considered serious nutritional disorders arising

---

E. B. Abbade (✉) · H. Dewes  
Federal University of Rio Grande do Sul (UFRGS), Bento Gonçalves  
Av. 7712, 91540-000 Porto Alegre, RS, Brazil  
e-mail: edabbade@hotmail.com

H. Dewes  
e-mail: hdewes@ufrgs.br

*Present Address:*  
E. B. Abbade  
Amélia Rodrigues St., 255, apt. 605, 97010-020 Santa Maria, RS,  
Brazil

---

## Nutrition and Food Science - Manuscript ID NFS-10-2014-0093

---

De: **onbehalf+vganji+gsu.edu@manuscriptcentral.com** em nome de **vganji@gsu.edu**  
Enviada: terça-feira, 28 de outubro de 2014 10:50:36  
Para: **edabbade@hotmail.com; ed\_abbade2000@yahoo.com.br**

28-Oct-2014

Dear Dr. Abbade:

Your manuscript entitled "Facing Co-occurrence of Underweight and Overweight Populations Worldwide" has been successfully submitted online. Your manuscript ID is NFS-10-2014-0093.

Many thanks for your submission to Nutrition and Food Science, at present, due to positive changes being made to ensure the effective running of the title, there is a delay progressing submissions through the system. All submitted papers will be held within a an organised section of the system until regular service resumes. We apologise for the delay but please be assured your paper will be addressed and not forgotten.

Thank you for submitting your manuscript to Nutrition and Food Science.

Kindest regards,

Cheers

Nikki Chapman  
Managing Editor | Emerald Group Publishing Limited

Tel +44 (0) 1274 515660 | Fax: +44 (0)1274 785200  
nchapman@emeraldinsight.com | [www.emeraldinsight.com](http://www.emeraldinsight.com)

P.S. Don't forget, you can read the journal online at <http://www.emeraldinsight.com/0034-6659.htm>

---

## Nutrition and Food Science - Decision on Manuscript ID NFS-04-2014-0036.R3

---

De: **onbehalf+vganji+gsu.edu@manuscriptcentral.com** em nome de **vganji@gsu.edu**

Enviada: terça-feira, 7 de outubro de 2014 15:23:29

Para: **edabbade@hotmail.com; ed\_abbade2000@yahoo.com.br; hdewes@ufrgs.br**

07-Oct-2014

Dear Dr. Abbade:

It is a pleasure to accept your manuscript entitled "Behavioral and Societal Drivers of an Obesogenic Environment Worldwide" in its current form for publication in Nutrition and Food Science. The comments of the reviewer(s) who reviewed your manuscript are included at the foot of this letter.

Please go to your Author Centre on Manuscript Central (Manuscripts with Decisions/Manuscripts I have co-authored) to complete the copyright assignment form. We cannot publish your paper without the copyright form. All authors are requested to complete the form and to input their full contact details, to ensure that a complimentary journal copy can be despatched upon publication. If you have provided full contact information in the completed copyright form your journal copy should arrive within 8 weeks of print publication.

If any of the contact information is incorrect you can update it by logging onto your author account and go to Edit Details at the top right of the screen. You cannot edit the copyright form directly. If the information on the article title page is incorrect you must contact the journal Publisher immediately.

If you would like more information about Emerald's copyright policy please visit the Information & Forms section in the Resources section of your Author Centre.

By publishing in this journal, your work will benefit from Emerald EarlyCite. This is a pre-publication service which allows your paper to be published online earlier, and so read by users and, potentially, be cited earlier. Please note, EarlyCite is not a proofing service. Emerald operates a 'right first time' policy, which means that the final version of the article which has been accepted by the Editor will be the published version. We cannot allow further changes to the article once it has been accepted.

Thank you for your contribution. We look forward to your continued contributions to the Journal.

Sincerely,  
Dr. Vijay Ganji  
Editor, Nutrition and Food Science  
vganji@gsu.edu

Reviewer(s)' Comments to Author: