NOTES

[1] Keys A. et al., 1986

[2] UNESCO, 2010. Representative List of the Intangible Cultural Heritage of Humanity (www.unesco.org/culture/ich/en/RL/00394)

[3] Bach-Faig A. et al., 2011

[4] Ros E. et al., 2014

[5] Haas P. et al., 2009
Barclay A.W. et al., 2008

[6] Bos M.B. et al., 2010

[7] Bartram H.P. et al., 1994

[8] Phillips S.M. et al., 2015

[9] Jakobsen M.U., 2009

[10] Grosso G. et al., 2014

[11] Bibbins-Domingo K. et al., 2010

[12] www.sapermangiare.mobi/;
www.nut.entecra.it/649/Introduzione.html

[13] Del Chierico F. et al., 2014

[14] Willcox D.C. et al., 2014

[15] Crous-Bou M. et al., 2014

[16] Sureda A. et al., 2018

[17] Tosti V. et al., 2018

[18] Schwingshackl L. et al., 2015

[19] Ros E. et al., 2014

[20] Del Chierico F. et al., 2014

[21] Martinez-Gonzalez M.A. et al., 2008
Esposito K. et al., 2009

[22] Benton D., 2015

[23] SINU. LARN, 2014

[24] Pereira P.M., Vicente A.F., 2013

[25] Nitti F.S., 1958, p. 180

[26] Perlès C., 2007, pp. 12-25

[27] Grottanelli C., Parise N.F., 1993

[28] Scarpi P., 2005

[29] Regola di Leandro (580 d. C.)

[30] Regola di Aureliano Pre Le Vergini (VI secolo)

[31] Flandrin J.L., 1992

[32] Regola di Abelardo (1140)

[33] Zamagni V., 1998, pp. 175-182

[34] Biondi G. et al., 2006, p. 243

[35] Ungar P.S. et al., 2008

[36] Wrangham R., 2009, p. 312

[37] Cordain L. et al., 2002

[38] Pereira P.M., Vicente A.F., 2013

[39] Mele M. et al., 2015, p. 400

[40] LARN: Livelli di Assunzione di Riferimento di Nutrienti ed energia per la popolazione italiana

[41] Miller V. et al., 2017

[42] World Health Organization, WHO 2011a

[43] McNeill S.H. et al., 2012

[44] McAfee A.J. et al., 2010

[45] DIRETTIVA 2008/100/CE

[46] Regulation (CE) n. 1924/2006 of the European Parliament and Council of December 20th, 2006 on nutrition and health claims provided on food products

[47] Provisional Maximum Tolerable Daily Intake (PMTDI): value for iron equal to 0.6 mg/kg of weight body/day (e.g.: 50mg per day for a weight body of 60 kg) as proposed by the JECFA (Joint FAO/WHO Expert Committee on Food Additives)

[48] Schmid A., 2009

[49] Dilzer A., Park Y., 2012
Tanaka T. et al., 2011

[50] Ha V., de Souza R.J. 2015

[51] Creig W.J., 2010

[52] McEvoy C.T. et al., 2012

[53] Moughan P.J., 2012

[54] SINU. LARN, 2012

[55] Bauer J. et al., 2013

[56] Phillips S.M., 2012

[57] Protein Summit 2.0: Evaluating the role of protein on public health. Am J Clin Nutr., 2015, 101(Suppl), pp.1317S–58S.

[58] Phillips S.M., 2015

[59] Nicklas T.A. et al., 2012

[60] Position paper SIPPS FIMP SIMA SIMP 2017 Vegetarian diets in developmental pregnancy (www.sinu.it)

[61] Monk C. et al., 2015

[62] Arner P., Spalding K.L. 2010

[63] Hermoso M. et al., 2011

[64] Nyaradi A. et al., 2013

[65] Dror D.K., Allen L.H., 2008

[66] Louwman M.W. et al., 2000

[67] Gibson R., Heath A.L., 2011

[68-69] Nyaradi A. et al., 2013

[70-71] Jáuregui-Lobera I., 2014

[72] Beard J.L., 2008

[73] Krebs N.F. et al., 2006

[74] World Health Organization, WHO, 2009b

[75] Scott S.P., Murray-Kolb L.E., 2016

[76] Rodriguez N.R. et al., 2009

[77] Van Staveren W., de Groot L., Horwath C., 2012

[78] Kouvari M. et al., 2016

[79] Landi F. et al., 2016

[80] Strasser B. et al., 2018

[81] Landi F. et al., 2012

[82] Landi F. et al., 2013

[83] Leong D.P. et al., 2015

[84] Nowson C, O'Connell S., 2015

[85] McNeill S, Van Elswyk M.E., 2012

[86] Neumann C.G. et al., 2007
Neumann C.G. et al., 2013

[87] Wang X. et al., 2016
Kappeler R. et al., 2013

[88] Lippi G. et al., 2015

[89] Roussell M.A. et al., 2012

[90] Micha R. et al., 2010

[91] In Italy less than 25 grams per day of processed meat is consumed (EPIC: 2003)

[92] Stewart B., Wild C.P., 2014.

[93] World Cancer Research Fund, 2007

[94] Bishop K.S., Ferguson L.R., 2015

[95] Lippi G. et al., 2016

[96] Red Meat and Processed Meat - volume 114 - IARC monographs on the evaluation of carcinogenic risks to humans - International Agency for Research on Cancer, 2018

[97] Bouvard V. et al., 2015

[98] Links between processed meat and colorectal cancer. World Health Organization website.

[99] Mele M. et al., 2015, p. 400

[100] Ho V. et al., 2014

[101] Lombardi-Boccia G. et al., 2004

[102] Mele M. et al., 2015, p. 400

[103-104] Jakszyn P. et al., 2004

[105] Song M. et al., 2015

[106] De Smet S., Vossen E., 2016

[107] Russo V. et al., 2017, p. 290

[108] Givens D.I., 2018

[109] www.doxa.it/news/cibo-di-oggi-cibo-di-domani-coop-doxa-expo2015/

[110] ISMEA, Sector Plan, Consumption Study of beef in Italy

[111] CSPO: Center for Oncology Study and Prevention; Pala V. et al., 2003

[112] EPIC: European Prospective Investigation into Cancer and Nutrition; Linseisen J. et al., 2002

[113] INRAN (now CREA Alimentation and Nutrition): The Research Centre for food and nutrition
Turrini A. et al., 2001
Leclercq C. et al., 2008

[114] www.aspa2.unitus.it/index.php/it/commissioni-aspa.html

[115] Russo V. et al., 2016

[116] ISMEA data

 ISBN 9788891793324

BIBLIOGRAPHY

- Allen J.S., 2009. The Lives of the Brain: Human Evolution and the Organ of Mind. Harvard University Press, p. 338
- Arner P., Spalding K.L., 2010. Fat cell turnover in humans. Biochem Biophys Res Commun. May 21;396(1) pp. 101-4
- Bach-Faig A., Berry E.M., Lairon D., Reguant J., Trichopoulou A., Dernini S., Medina F.X., Battino M., Belahsen R., Miranda G., Serra-Majem L.; Mediterranean Diet Foundation Expert Group, 2011 Dec. Mediterranean diet pyramid today. Science and cultural updates. Public Health Nutr, 14(12A), pp.2274-84
- Barclay A.W., Petocz P., McMillan-Price J., Flood V.M., Prvan T., Mitchell P., Brand-Miller J.C., 2008. Glycemic index, glycemic load, and chronic disease risk—A meta-analysis of observational studies. Am. J. Clin. Nutr., 87, pp. 627–637
- Bartram H.P., Scheppach W., Gerlach S., Ruckdeschel G., Kelber E., Kasper H., 1994. Does yogurt enriched with Bifidobacterium longum affect colonic microbiology and fecal metabolites in health subjects? Am. J. Clin. Nutr., 59, pp. 428–432
- Bauer J., Biolo G., Cederholm T., Cesari M., Cruz-Jentoft A.J., Morley J.E., Phillips S., Sieber C., Stehle P., Teta D., Visvanathan R., Volpi E., Boirie Y., 2013. Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group. J Am Med Dir Assoc. 14 pp. 542–59
- Benton D., 2015. Portion size: what we know and what we need to know. Crit. Rev. Food Sci. Nutr. 55(7), pp.988-1004
- Beard J.L., 2008. Why iron deficiency is important in infant development. J. Nutr., 138, pp. 2534–2536
- Bernardi E., 2015. Oggi cosa mangio. Giunti, Milano
- Bianchi E. (a cura di), 2001. Regole monastiche d'occidente. Einaudi, Torino
- Bibbins-Domingo K., Chertow G.M., Coxson P.G.,Moran A., Lightwood J.M., Pletcher M.J., Goldman L., 2010. Projected effect of dietary salt reductions on future cardiovascular disease. N. Engl. J. Med., 362, pp. 590–599
- Biondi G., Martini F., Rickards O., Rotilio G., 2006. In carne e ossa. DNA, cibo e culture dell'uomo preistorico, Laterza, Bari, p. 243
- Bishop K.S., Ferguson L.R., 2015. The Interaction between epigenetics, nutrition and the development of cancer. Nutrients, 7, pp. 922–947
- Bos M.B., de Vries J.H.M., Feskens E.J.M., van Dijk,S.J., Hoelen D.W.M., Siebelink E., Heijligenberg R., de Groot L.C.P.G.M., 2010. Effect of a high monounsaturated fatty acids diet and a Mediterranean diet on serum lipids and insulin sensitivity in adults with mild abdominal obesity. Nutr. Metab. Cardiovasc. Dis., 20, pp. 591–598
- Bouvard V., Loomis D., Guyton K.Z., Grosse Y., Ghissassi F.E., Benbrahim-Tallaa L., Guha N, Mattock H., Straif K.; International Agency for Research on CancerMonograph Working Group., 2015 Dec. Carcinogenicity of consumption of red and processedmeat. Lancet Oncol., 16(16), pp. 1599-600
- Buccioni A., Mele M., Pulina G., 2011. Il consumo dì proteine animali: la co-evoluzione dell'uomo e della sua dieta. ADI Magazine, 15 (3), pp. 191- 195
- Capatti A., De Bernardi A., Varni A. (a cura di). 1998. Storia d'Italia. Annali 13. L'Alimentazione. Einaudi, Torino
- Cordain L., Eaton S.B., Brand-Miller J., Mann N., Hill K., 2002. The paradoxical nature of hunter-gatherer diets: meat-based, yet non-atherogenic. European Journal of Clinical Nutrition. 56, Suppl. 1, pp. 542–552
- Cordain L., Eaton S.B., Sebastian A., Mann N., LIndeberg s., Watkins B.A., O'Keefe J.H., Brand-Miller J., 2005. Origins and evolution of the western diet: health implication for the 21st century. Am. J. Clin. Nutr., 81, pp. 341-354
- Corti P., 1998. Emigrazione e consuetudini alimentari, in saggio in Storia d'Italia. Annali 13. L'Alimentazione. Einaudi, Torino
- CREA - Alimenti e Nutrizione (Consiglio per la ricerca e l'analisi in economia agraria – Centro di ricerca per gli alimenti e la nutrizione). 2003. Linee Guida per una Sana Alimentazione Italiana. Available online: nut.entecra.it/648/linee_guida.html
- Creig W.J., 2010 Dec. Nutrition concerns and health effects of vegetarian diets. Nutr Clin Pract., 25(6), pp.613-20
- Cremaschi L., 2003. Regole monastiche femminili. Einaudi, Torino
- Crous-Bou M., Fung T.T., Prescott J., Julin B., Du M., Sun Q., Rexrode K.M., Hu F.B., De, Vivo I., 2014 Dec 2. Mediterranean diet and telomere length in Nurses' Health Study:population based cohort study. BMJ., 349:g6674

 ISBN 9788891793324

- CSConfagricoltura, 2015. Produzione, commercio con l'estero e consumo delle principali carni rosse in Italia (www.confagricolturapiemonte.it/wp-content/uploads/2015/11/produzione_commercio_con_l_estero_e_consumo_delle_principali_carni_rosse_in_italia.pdf)
- De Smet S., Vossen E., 2016 Oct. Meat: The balance between nutrition and health. A review. Meat Sci., 120, pp. 145-156
- Del Chierico F., Vernocchi P., Dallapiccola B., Putignani L., 2014 Jul 1. Mediterranean diet and health: food effects on gut microbiota and disease control. Int J Mol Sci., 15(7), pp.11678-99
- Dilzer A., Park Y., 2012. Implication of conjugated linoleic acid (CLA) in human health. Crit Rev Food Sci Nutr. 52(6), pp. 488-513
- Dror D.K., Allen L.H., 2008. Effect of vitamin B12 deficiency on neurodevelopment in infants: current knowledge and possible mechanisms. Nutr., 66, pp. 250–255
- Eaton S.B., 2006. The ancestral human diet: what was it and should it be a paradigm for contemporary nutrition? Proc. Nutr. Soc. 65(1), pp. 1-6
- Esposito K., Maiorino M.I., di Palo C., Giugliano D., 2009. Adherence to a Mediterranean diet and glycaemic control in Type 2 diabetes mellitus. Diabet. Med. J. Br. Diabet. Assoc., 26, pp. 900–907
- EUFIC European food information Council, 2015. How to talk about food risk
- FAO/WHO Expert Committee on Food Additives, 1983. Evaluation of certain additives and contaminants. 27th report. WHO Techn. Report Series, N. 696
- FAOSTAT. Food Balance, Food Supply – Livestock Primary Equivalent. Gross availability of
- beef consumption), pork meat, poultry meat. Last access: May 2016. faostat3. fao.org/faostat-gateway/go/to/download/FB/CL/E
- Finch C.E., 2010. Evolution of the human lifespan and diseases of aging: roles of infection, inflammation and nutrition. PNAS, doi 10.1073
- Flandrin J.L., 1992. Chronique de Platine. Pour une gastronomie historique. Odile Jacob, Parigi
- Flandrin J.L., Montanari M., 2007. Storia dell'alimentazione. Laterza, Roma-Bari
- Franzina E. 1979. Merica! Merica! Emigrazione e colonizzazione nelle lettere dei contadini veneti in America Latina (1876-1902). Feltrinelli, Milano
- Gibson R., Heath A.L., 2011. Population groups at risk of zinc deficiency in Australia and New Zealand. Nutr. Diet., 68, pp. 97–108
- Givens D.I., 2018 Aug. Review: Dairy foods, red meat and processed meat in the diet: implications for health at key life stages. Animal., 12(8), pp. 1709-1721
- Grosso G., Pajak A., Marventano S., Castellano S., Galvano F., Bucolo C., Drago F., Caraci F., 2014. Role of ω-3 fatty acids in the treatment of depressive disorders: A comprehensive meta-analysis of randomized clinical trials. PLoS One, 9, e96905
- Grottanelli C., 2007. La carne e i suoi riti, saggio in Flandrin-Montanari, Storia dell'alimentazione vol 1. Laterza, Bari
- Grottanelli C., Parise N.F., 1993. Sacrificio e società nel mondo antico. Laterza, Roma-Bari
- Ha V., de Souza R.J. 2015 Oct 27. "Fleshing Out" the Benefits of Adopting a Vegetarian Diet. J Am Heart Assoc., 4(10)
- Haas P., Machado M.J., Anton A.A., Silva A.S.S., De Francisco A., 2009. Effectiveness of whole grain consumption in the prevention of colorectal cancer: Meta-analysis of cohort studies. Int. J. Food Sci. Nutr., 60(6), pp.1-13
- Hermoso M., Vucic V., Vollhardt C., Arsic A., Roman-Viñas B., Iglesia-Altaba I., Gurinovic M., Koletzko B., 2011. The effect of iron on cognitive development and function in infants, children and adolescents: a systematic review. Ann Nutr Metab., 59(2-4), pp. 154-65
- Ho V., Peacock S., Massey T.E., Ashbury J.E., Vanner S.J., King W.D., 2014 Nov. Meat-derived-carcinogens, genetic susceptibility and colorectal adenoma risk. Genes Nutr., 9(6), p. 430
- ISIT, IVSI, INSRAN, SSICA, 2013. Salumi Italiani: Nuovi Valori, Nuovo Valore - Aggiornamento dei dati nutrizionali e ruolo dei salumi italiani nell'alimentazione moderna. Sprim Italia srl, Milano. Available online: www.salumi-italiani.it/area-salute-benessere/it/pagina/approfondimenti/area-download.php
- ISMEA, 2014. Piano di Settore, Studio sui consumi di carne bovina in Italia
- Jakobsen M.U., O'Reilly E.J., Heitmann B.L., Pereira M.A., Balter K., Fraser G.E., Goldbourt U., Hallmans G., Knekt P., Liu S. et al., 2009. Major types of dietary fat and risk of coronary heart disease: A pooled analysis of 11 cohort studies. Am. J. Clin. Nutr., 89, pp. 1425–1432
- Jakszyn P., Agudo A., Ibáñez R., García-Closas R., Pera G., Amiano P., González C.A., 2004 Aug. Development of a food database of nitrosamines, heterocyclic amines, and polycyclic aromatic hydrocarbons. J Nutr., 134(8), pp. 2011-4
- Jáuregui-Lobera I., 2014 Nov 10. Iron deficiency and cognitive functions. Neuropsychiatr Dis Treat., 10, pp. 2087-95
- Kappeler R., Eichholzer M., Rohrmann S., 2013.

Meat consumption and diet quality and mortality in NHANES III. Eur J Clin Nutr.,67(6), pp. 598-606

- Keys A., Menotti A., Karvonen M.J., Aravanis C., Blackburn H., Buzina R., Djordjevic B.S., Dontas A.S., Fidanza F., Keys M.H., et al., 1986. The diet and 15-year death rate in the Seven Countries Study. Am J Epidemiol, 124(6), pp. 903–915
- Kouvari M., Tyrovolas S., Panagiotakos D.B., 2016 Feb. Red meat consumption and healthy ageing: A review. Maturitas, 84, pp. 17-24
- Krebs N.F., Westcott J.E., Butler N., Robinson C., Bell M., Hambidge K.M.,2006. Meat as a first complementary food for breastfed infants: Feasibility and impact on zinc intake and status. Journal of Pediatric Gastroenterology and Nutrition, 42 pp.207-214
- Landi F., Calvani R., Tosato M., Martone A.M., Ortolani E., Savera G., D'Angelo E., Sisto A., Marzetti E., 2016 May 14. Protein Intake and Muscle Health in Old Age: From Biological Plausibility to Clinical Evidence. Nutrients, 8(5)
- Landi F., Cruz-Jentoft A.J., Liperoti R., Russo A., Giovannini S., Tosato M., Capoluongo E., Bernabei R., Onder G., 2013 Mar. Sarcopenia and mortality risk in frail older persons aged 80 years and older: results from ilSIRENTE study. Age Ageing., 42(2), pp. 203-9
- Landi F., Liperoti R., Russo A., Giovannini S., Tosato M., Capoluongo E., Bernabei R., Onder G., 2012 Oct. Sarcopenia as a risk factor for falls in elderly individuals: results from the ilSIRENTE study. Clin Nutr., 31(5), pp. 652-8
- Leclercq C., Arcella S., Piccinelli R., Sette S. Le Donne C., Turrini A., 2009. "The Italian National Food Consumption Survey INRAN-SCAI 2005–06: main results in terms of food consumption". Public Health Nutrition, 12(12), pp. 2504– 2532
- Leong D.P., et al.; Prospective Urban Rural Epidemiology (PURE), 2015 Jul 18. Study investigators (2015). Prognostic value of grip strength: findings from the prospective urban rural epidemiology study. Lancet, 386(9990), pp. 266-73
- Linseisen J., Kesse E., Silmani N., Bueno- De MEsquita HB., Ockè MC., et al., 2002. "Meat consumption in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohorts: results from 24-hour dietary recalls". Public Health Nutrition, 5(6B), pp. 1243–1258
- Lippi G., Mattiuzzi C., Cervellin G., 2016 Jan. Meat consumption and cancer risk: a critical review of published meta-analyses. Crit Rev OncolHematol., 97, pp. 1-14
- Lippi G., Mattiuzzi C., Sanchis-Gomar F., 2015. Red meat consumption and ischemic heart disease. A systematic literature review. Meat Sci., 108, pp. 32-36
- Lombardi-Boccia G., Lanzi S., Lucarini M., Di Lullo G., 2004 Jul. Meat and meat products consumption in Italy: contribution to trace elements, heme iron and selected B vitamins supply. Int J Vitam Nutr Res., 74(4), pp. 247-51
- Louwman M.W., et al., 2000. Signs of impaired cognitive function in adolescents with marginal cobalamin status. Am. J. Clin. Nutr., 72, pp. 762–769
- Martinez-Gonzalez M.A., de la Fuente-Arrillaga C., Nunez-Cordoba J.M., Basterra-Gortari F.J., Beunza J.J., Vazquez Z., Benito S., Tortosa A., Bes-Rastrollo M., 2008. Adherence to Mediterranean diet and risk of developing diabetes: Prospective cohort study. Br. Med. J., 336, pp. 1348–1351
- McAfee A.J., McSorley E.M., Cuskelly G.J., Moss B.W., Wallace J.M., Bonham M.P., Fearon A.M., 2010 Jan. Red meat consumption: an overview of the risks and benefits. Meat Sci., 84(1), pp. 1-13
- McEvoy C.T., Temple N., Woodside J.V., 2012 Dec. Vegetarian diets, low-meat diets and health: a review. Public Health Nutr., 15(12), pp. 2287-94
- McNeill S.H., Harris K.B., Field T.G., Van Elswyk M.E., 2012 Jan. The evolution of lean beef: identifying lean beef in today's U.S. marketplace. Meat Sci., 90(1), pp. 1-8
- McNeill S., Van Elswyk M.E., 2012 Nov. Red meat in global nutrition. Meat Sci., 92(3), pp.166-73
- Mele M., Nudda A., Pauselli M., Roscini V., Casarosa L., Secchiari P., Pulina G., 2015. Consumo di Carne e salute umana. In: Alimenti di Origine Animale e Salute. FrancoAngeli, Milano
- Micha R., Wallace S.K., Mozaffarian D., 2010. Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus. A systematic review and meta-analysis. Circulation, 121 pp. 2271 – 2283
- Miller V. et al., 2017. Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study. Lancet, 390(10107), pp. 2037-2049
- Monk C., Georgieff M.K., Xu D., Hao X., Bansal R., Gustafsson H., Spicer J., Peterson B.S., 2015 Nov 24. Maternal prenatal iron status and tissue organization in the neonatal brain. Pediatr Res.
- Moughan P.J., 2012. Dietary protein for human health. Br J Nutr., 108 (Suppl 2):S1–2
- Neumann C.G., Jiang L., Weiss R.E., Grillenberger M., Gewa C.A., Siekmann J.H., Murphy S.P., Bwibo N.O., 2013 Apr 14. Meat supplementation increases arm muscle area in Kenyanschoolchildren. Br J Nutr., 109(7), pp. 1230-40
- Neumann C.G., Murphy S.P., Gewa C., Grillen-

berger M., Bwibo N.O., 2007 Apr. Meat supplementation improves growth, cognitive, and behavioral outcomes in Kenyan children. J Nutr., 137(4), pp. 1119-23

- Nicklas T.A., O'Neil C.E., Zanovec M., Keast D.R., Fulgoni V.L. III, 2012. Contribution of beef consumption to nutrient intake, diet quality, and food patterns in the diets of the US population. Meat Sci., 90 pp. 152–8
- Nitti F.S., 1958. Scritti sulla questione meridionale, vol II. Laterza, Bari
- Nowson C., O'Connell S., 2015 Aug 14. Protein Requirements and Recommendations for Older People: A Review. Nutrients., 7(8), pp. 6874-99
- Nyaradi A., Li J., Hickling S., Foster J., Oddy W.H., 2013 Mar 26. The role of nutrition in children's neurocognitive development, from pregnancy through childhood. Front Hum Neurosci., 7, p. 97
- Pala V. et al., 2003. "Diet in the Italian epic cohorts: presentation of data and methodological issues". Tumori, 89(6), pp.594-607
- Pereira P.M., Vicente A.F., 2013 Mar. Meat nutritional composition and nutritive role in the human diet. Meat Sci., 93(3), pp. 586-92
- Perlès C., 2007. Le strategie alimentari nell'età preistorica, saggio in Flandrin-Montanari, Storia dell'alimentazione, vol 1. Laterza, Bari
- Phillips S.M., 2012. Dietary protein requirements and adaptive advantages in athletes. Br J Nutr., 108(Suppl 2):S158–67
- Phillips S.M., Fulgoni V.L. III, Heaney R.P., Nicklas T.A., Slavin J.L., Weaver C.M., 2015 Apr 29. Commonly consumed protein foods contribute to nutrient intake, diet quality, and nutrient adequacy. Am J Clin Nutr.
- Rodriguez N.R., DiMarco N.M., Langley S., American Dietetic Association, Dietitiansof Canada, American College of Sports Medicine: Nutrition and Athletic Performance, 2009 Mar. Position of the American Dietetic Association, Dietitians of Canada,and the American College of Sports Medicine: Nutrition and athletic performance. J Am Diet Assoc., 109(3), pp. 509-27
- Ros E., Martínez-González M.A., Estruch R., Salas-Salvadó J., Fitó M., Martínez J.A., Corella D., 2014 May 14. Mediterranean diet and cardiovascular health: Teachings of the PREDIMED study. Adv Nutr., 5(3), pp. 330S-6S
- Roussell M.A., Hill A.M., Gaugler T.L., West S.G., Heuvel J.P., Alaupovic P., Gillies P.J., Kris-Etherton P.M., 2012 Jan. Beef in an Optimal Lean Diet study: effects on lipids, lipoproteins, and apolipoproteins. Am J ClinNutr., 95(1), pp. 9-16
- Ruff C.B., 2000. Body mass prediction from skeletal frame size in elite athletes. Am J Phys Anthropol. 113(4), pp. 507-517
- Russo V., De Angelis A., Danieli P.P., 2017. Consumo reale di carne e di pesce in Italia. Dal consumo apparente al consumo reale con il metodo della Detrazione Preventiva delle Perdite. FrancoAngeli, Milano
- Russo V., Sermoneta C., 8/06/2015. Indicatori statistici per la filiera agro-alimentare. Il consumo di carne: importanza, limiti, incertezze e possibilità di miglioramento delle stime. Convegno ISTAT, Milano
- Scarpi P., 2005. Il senso del cibo. Sellerio, Palermo
- Schmid A., 2009. Bioactive substances in meat and meat products. Fleischwirtschaft,89(7) pp. 83-90
- Schwingshackl L., Hoffmann G., 2015 Dec. Adherence to Mediterranean diet and risk of cancer: an updated systematic review and meta-analysis of observational studies. Cancer Med., 4(12), pp.1933-47
- Scott S.P., Murray-Kolb L.E., 2016 Jan. Iron Status Is Associated with Performance on Executive Functioning Tasks in Nonanemic Young Women. J Nutr., 146(1), pp. 30-7
- SINU, 2012. Società Italiana di Nutrizione Umana. LARN - Livelli di Assunzione di Riferimento di Nutrienti ed energia per la popolazione italiana. Revisione 2012. SICS, Milano
- SINU, 2014. Società Italiana di Nutrizione Umana. LARN - Livelli di Assunzione di Riferimento di Nutrienti ed energia per la popolazione italiana. IV Revisione. SICS, Milano
- Song M., Garrett W.S., Chan A.T., 2015 May. Nutrients, foods, and colorectal cancer prevention. Gastroenterology, 148(6), pp. 1244-60.e16
- Sprim Italia srl, 2013. "Il Ruolo della Carne in un'alimentazione equilibrata e sostenibile". Supplemento a NUTRIMI – La rivista di Nutrizione pratica, edizione aprile 2013
- Stewart B., Wild C.P., 2014. World Cancer Report. IARC Press, Lyon
- Strasser B., Volaklis K., Fuchs D., Burtscher M., 2018 Feb 1. Role of Dietary Protein and Muscular Fitness on Longevity and Aging. Aging Dis., 9(1), pp. 119-132
- Sureda A., Bibiloni M.D.M., Julibert A., Bouzas C., Argelich E., Llompart I., Pons A.., Tur J.A., 2018 Jan 10. Adherence to the Mediterranean Diet and Inflammatory Markers. Nutrients., 10(1)
- Teleki G., 1981. The omnivorous diet and eclectic feeding habits of chimpanzees in Gombe National Park, Tanzania. In: Omnivorous Primates: Gathering and Hunting in Human Evolution,

R.S.O. Harding & G. Teleki (eds.), pp. 303-343, Columbia Univ. Press, N.Y.

- Tanaka T., Hosokawa M., Yasui Y., Ishigamori R., Miyashita K., 2011. Cancer chemopreventive ability of conjugated linolenic acids. Int J Mol Sci., 12(11), pp. 7495-509
- Tosti V., Bertozzi B., Fontana L., 2018 Mar 2. Health Benefits of the Mediterranean Diet: Metabolic and Molecular Mechanisms. J Gerontol A Biol Sci Med Sci., 73(3), pp. 318-326
- Turrini A., Saba A. Perrone D., Cialda E. D'Amicis A., 2001. "Food consumption patterns in Italy: the INN-CA Study 1994-1996." European Journal of Clinical Nutrition, 55(7), pp. 571-588
- Ungar P.S., Grine F.E., Teaford M.F., Petraglia M., 2008. Dental Microwear and Diet of the Plio-Pleistocene Hominin Paranthropus boisei. PLoS ONE, 3(4), e2044
- Van Staveren W., de Groot L., Horwath C., 2012. Nutrition and ageing. In J. Mann & A.S. Truswell (eds). Essentials of human nutrition, 4th edn. Oxford University Press, New York
- Wang X., Lin X., Ouyang Y.Y., Liu J., Zhao G., Pan A., Hu F.B., 2016 Apr. Red and processed meat consumption and mortality: dose-response meta-analysis of prospective cohort studies. Public Health Nutr. 19(5), pp. 893-905
- Willcox D.C., Scapagnini G., Willcox B.J., 2014 Mar-Apr. Healthy aging diets other than the Mediterranean: a focus on the Okinawan diet. Mech Ageing Dev., 136-137, pp.148-62
- World Cancer Research Fund, 2007. American Institute for Cancer Research: Food, Nutrition and the Prevention of Cancer: A Global Perspective. The Institute, Washington, DC, USA
- WHO 2011a. Global status report on non-communicable diseases 2010. World Health Organization, Geneva
- WHO 2009b. Infant and Young Child Feeding: Model Chapter for Textbooks for Medical Students and Allied Health Professionals. World Health Organization, Geneva
- Wrangham R., 2009. Catching Fire: How Cooking Made Us Human. Basic Books,Perseus Group, Cambridge, Massachusset, p. 312
- Zamagni V., 1998. L'evoluzione dei consumi tra tradizione e innovazione, saggio in Storia d'Italia. Annali 13. L'Alimentazione. Einaudi, Torino
- Association for Science and Animal Production: www.aspa2.unitus.it
- Confagrigoltura Piemonte: www.confagricolturapiemonte.it
- Council for agricultural research and analysis of the agrarian economy: nut.entecra.it
- Doxa - Research and Analysis: www.doxa.it
- Eufic - European Food information Council www.eufic.org
- Food and Agriculture Organization of the United Nations: faostat3.fao.org
- Institute for Health Metrics and Evaluation: www.healthdata.org
- Institute for the Valorisation of Italian Cured Meats: www.salumi-italiani.it
- Ministry or Health: www.salute.gov.it
- Knowing how to eat, promotion of food culture: sapermangiare.mobi
- Italian Society of Human Nutrition: www.sinu.it
- United Nations Educational, Scientific and Cultural Organization: www.unesco.org

MEAT AND THE ENVIRONMENT

- WHAT ARE THE IMPACTS OF MEAT?
- HOW TO CALCULATE THE ENVIRONMENTAL SUSTAINABILITY OF FOOD
- THE ENVIRONMENTAL IMPACTS OF THE DIET: THE ENVIRONMENTAL HOURGLASS

 ISBN 9788891793324

Introduction

THE LIFE CYCLE ASSESSMENT METHODOLOGY (LCA) PERMITS THE CALCULATION OF THE ENVIRONMENTAL IMPACTS OF THE ENTIRE AGRI-FOOD CHAIN

THE EUROPEAN PRODUCTION SYSTEM HAS THE LOWEST ENVIRONMENTAL IMPACT PER KG OF PROTEIN

IF CONSUMED ACCORDING TO THE MEDITERRANEAN DIET MODEL, MEAT HAS AN ENVIRONMENTAL IMPACT SIMILAR TO THAT OF OTHER FOODS

The debate on the impacts of food often leads to the timely comparison of environmental indicators related to the production of 1 kg of various foods. Whilst providing useful information for the improvement of supply chains, these classifications are not very significant for a few reasons. The first is nutritional: it is very clear, for example, that ***the comparison between salad, rice and meat is wrong regardless because these foods have different "functions" and contribute to human health in a complementary way****. This was discussed in the nutrition chapter. In merit to the environmental reason, the classification of foods according to their impact can lead to the conclusion that the most impactful ones, such as meat, are to be eliminated so as to reduce the pressure on the environment. Even this consideration is not particularly consistent with reality because it suggests that some agricultural or livestock chains be cancelled.*

On the other hand, those who know how agri-food production works have a clear mind about ***the constant integrations between the various productions,*** *to the point that talking about different products is (almost) incorrect. Instead, it would be much more coherent to imagine food production as one big system, characterised by many products with as many by-products, that almost always find a use in the same sector* ***following the principles of the circular economy,*** *today very popular in the processing industry, but known to farmers and breeders for centuries. Entering the question of animal husbandry and the production of meat and cured meats, the debate should therefore not be regarding "if", but on "how", pushing the producers (agricultural and industrial) to constantly improve performances by reducing impacts. In this context, the calculation of impacts becomes a useful reference, facilitating comparisons with oneself or similar processes, provided that the indicators are interpreted correctly, avoiding misleading considerations such as those done by treating the overall consumption of water without referring to its availability in places of consumption.*

Lastly, further attention must be placed concerning the using of kg as a reference unit. There is no doubt that meats and cold cuts are among the foods characterised by the greatest environmental impact when the analysis is carried out per kg of product. Considering that a correct diet involves the balanced consumption of all foods, a correct analysis should take into consideration ***the frequency of consumption and portions suggested by nutritionists:*** *the multiplication of impacts and quantities is the basis of the* ***Environmental Hourglass,*** *icon of the Sustainable Meat project. According to this representation,* ***eating meat in the right quantity does not result in a significant increase in an individual's environmental impact.***

 ISBN 9788891793324

1 WHAT ARE **THE IMPACTS OF MEAT**

1.1 Animals and plants: a circular system

Respect to other industrial sectors, the agri-food sector is certainly the most complex, because it is conditioned by **the many interactions between the various production chains** that are substantially integrated into a model defined as **circular**. This term, used not offhand, has become "trandy" again in recent years. One of the main challenges for the sustainability of industrial systems is that of modifying the linear growth model (extraction of raw materials, transformation and disposal of waste) to circular, thus maximising the reuse and recovery of waste. One of the most current definitions of circular economy is from the Ellen MacArthur Foundation[1] which defines it as "**an economy designed to regenerate itself**" specifying that "in a circular economy the flows of materials are of two types: the biological ones, capable of being reintegrated in the biosphere, and the technical ones, destined to be revalorised without entering the biosphere".

The **circular economy is an approach that farmers and breeders know very well** because, for example, one of the characteristics that regulates the proper functioning of a farm is the integration between the many activities: the straw that remains from the cultivation of cereals is often used for animals (as food or litter), while manure is a valuable aid in fertilising land. The meat and cured meats sector certainly contributes to this circularity: many by-products generated during food production, both in the field and in the transformation processes, have animal feed as their main destiny. Entering even more in detail, we can see how **the breeding of cattle is one of the most articulated and circular** that exists since the so-called cow-calf supply chain produces meat, milk, skin and many of the by-products generated during the slaughter phase are destined for the most varied of uses.

In this last field, research and industrial innovation are certainly important in maximising the possibility of reuse. One of the most famous examples is that of the veal slaughterhouse which is used for the production of natural rennet, still considered the best from a qualitative point of view for the production of all PDO cheeses.
These characteristics of integration and circularity must also be taken into consideration when calculating environmental impacts. The correct attribution of the impacts must in fact follow appropriate "allocation rules" that allow the relative environmental loads to be distributed to the various products.

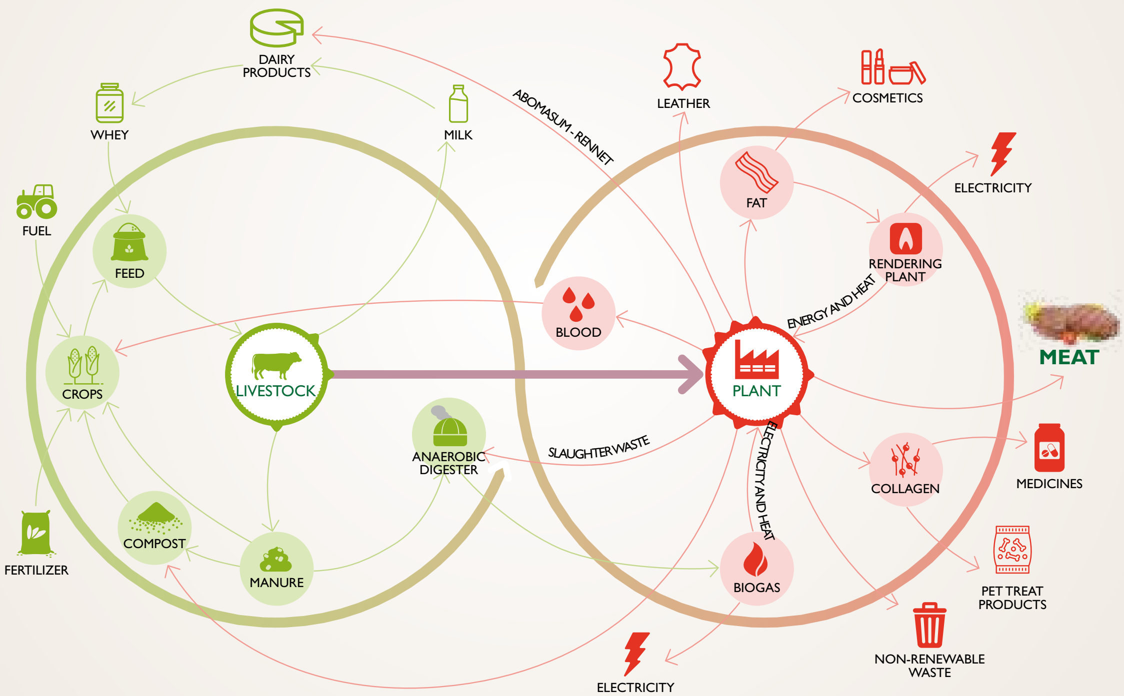
In other words, taking 100 as the impact score of breeding a cow, how much should be attributed to the cow's meat? How much to the calves generated throughout life? And to that of milk? And to the manure used as fertiliser? It is therefore clear that the analysis cannot be trivialised by evaluating a single process, but trying as much as possible to analyse systems in their entirety. This is undertaken following common conventional rules decided after international public consultations as will be described later.

1.2 Reduce impacts looking for efficiency

The calculation of impacts can be finalised both for "informative" purposes and the desire to reduce the pressure of the supply chains for the environment. This second aspect is normally the result of an efficiency research process known as the measure of the resources used to reach an objective. While from an economic point of view the question is quite intuitive (reduce costs equal to revenue), when you deal with the topic in the analysis of an agricultural supply chain, and even more from a livestock prospective, the matter does not start to become so immediate. There are two main aspects.

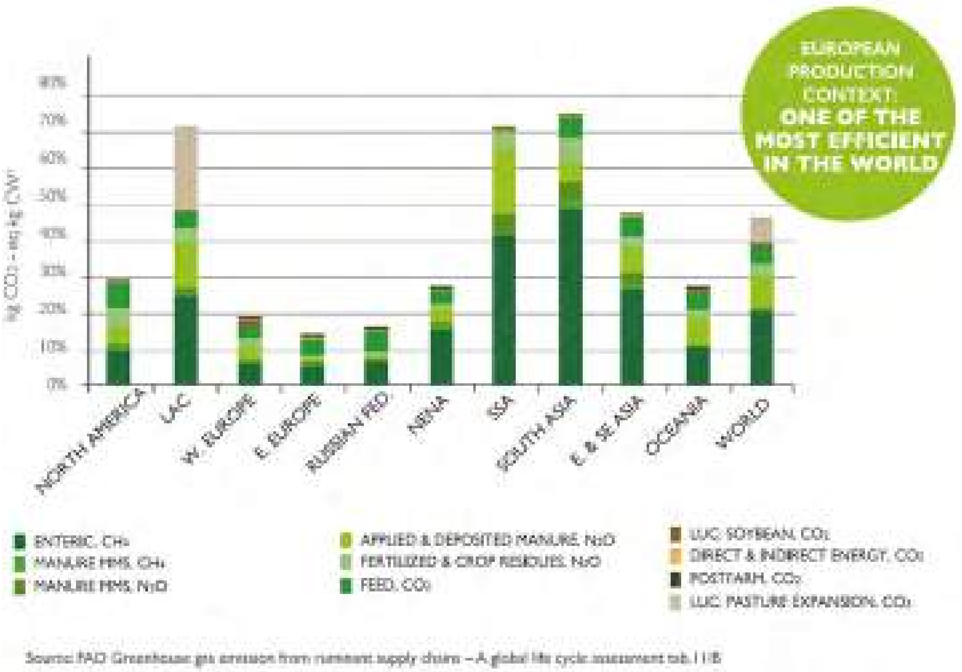
On the one hand, dealing with living beings opens the discussion to many aspects of an ethical nature (smaller spaces

THE CIRCULARITY OF THE COW-CALF CHAIN



for animals results in lower environmental impacts). On the other hand, the fact that the profound integration of agri-food chains creates a balance of relationships and flows that must be taken into consideration every time a decision is taken: the fact of sending the manure generated by a cattle farm to bio-digestion also has consequences on farms that receive it (or should have received it). So the questions are many; one of the most frequent is whether a barn or pasture is better (more sustainable). Since there are good reasons in both cases, the answer must be sought after defining the values and taking different points of view into account: animal welfare, safety, quality and meat taste, environmental impacts.

In order to be able to talk about sustainability, therefore, we cannot take into account only environmental aspects, but an overall equilibrium in production. This is what many scholars have tried, and try, to do in many projects throughout the world.



Emissions of carbon dioxide in cattle breeding in the world.
Source: extract from INALCA Sustainability Report, 2016

 ISBN 9788891793324

MAIN USES OF SLAUGHTER BY-PRODUCTS

BONES

are used for producing pet food, animal fodder, fertilisers and gelatine used for food and pharmaceuticals

CATTLE AND PIG SKIN

are used for producing leather products: veal leather is used for luxury articles (shoes, handbags, belts etc.), steer leather is used in the automotive sector (car seats), cow leather is used for making sofas and leather goods while pig leather is used to line shoes internally

FAT

is used in the cosmetic and chemical industries (soaps) as well as in the livestock sector (to produce animal fodder)

PORK RIND AND CARTILAGE

are used for producing food thickening agents as well as pet food

PORK RIND AND OTHER SINUOUS PARTS

are used for producing gelatine, both for food preparation (mainly pork) and pharmaceuticals (mainly bovine) for preparing films required for encapsulating medicines

BLOOD AND ENTRAILS

pig entrails are used for producing cured meats, while bovine blood is used for producing fertilisers and animal proteins, while chicken blood is used for pet food

PERICARDIUM

taken from both bovine and pork, are used for making medical devices (heart valves)

FAT LIQUIDS AND RUMEN CONTENT

along with other wastes are used for producing green energy (biogas cogeneration)

ABOMASUM

(the last cavity of the four stomach chambers of ruminants) is used for making rennet (for example it is the only coagulant that can be used for making PDO cheeses such as Grana Padano or Parmigiano Reggiano)

PORK BRISTLES

once used for making paintbrushes and brushes, today they are mainly used for making flours for livestock use

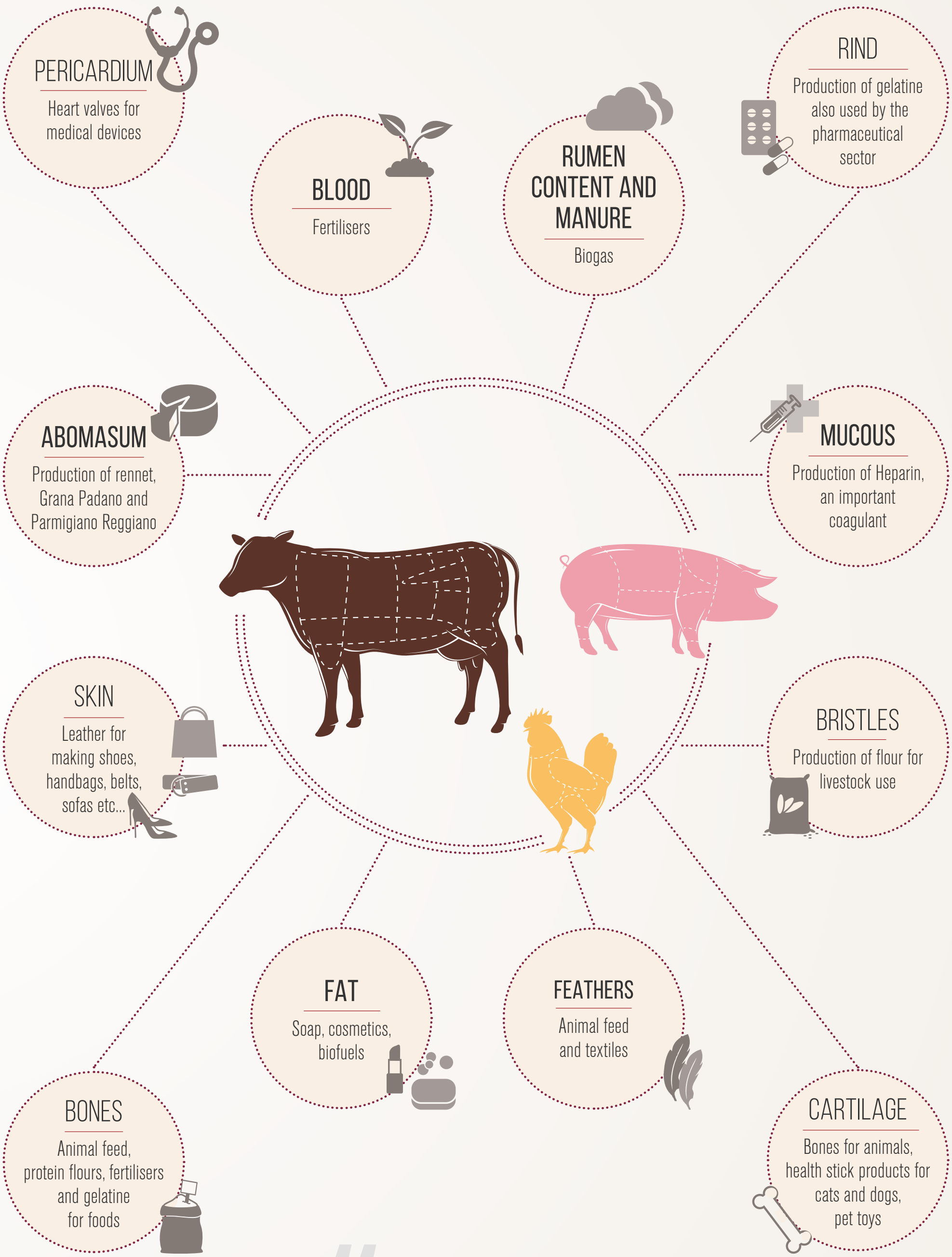
PORK MUCOUS

(extracted during the preparation of pork entails) is used by pharmaceutical companies for making Heparin, which is an important coagulant medicine

THE FEATHERS

are used in the production of animal feed and in the textile industry

 ISBN 9788891793324



"NOT ONLY MEAT IS OBTAINED FROM AN ANIMAL"

 ISBN 9788891793324

LIFE+ PROJECT
CLIMATE CHANGE-R

The LIFE+ Climate change-R was a LIFE project promoted and coordinated by the Emilia Romagna Region in 2013-2016, which focused on the theoretical and practical study of cultivation and breeding techniques that, with equal production yields and same product quality, allow the reduction of greenhouse gas emissions. The project was attended by some of the most important national and international agri-food groups and Italian large-scale retail traders.

The project was based on an integrated approach between the agricultural, industrial and distributive parts as well as the circularity induced by dialogue and exchange between the world of plant and animal productions.
The starting point was the approach of the integrated struggle, a long-established practice in Emilia-Romagna, to which research and application was added to develop new agricultural and livestock production disciplines that foresee the most advanced techniques identified internationally. Among the main results of these approaches are certainly the reduction of the use of fertilisers and plant protection products, a more rational management of water resources, lighter land processing techniques, different ways of handling manure and new types of animal feed. An important point was experimentation in a sample of farms that allowed confirmation of the validity, or the settings corrections, of the protocols being defined.

Regarding livestock production chains, the results obtained with the application of the ***Good Practices studied*** *in the project are to be evaluated in a positive way,* ***with percentages of carbon footprint reduction ranging from a few percentage points up to over 30%*** *compared to the average impact of the individual supply chains, which in particular has been calculated in 1.2 kg CO_2eq/kg milk for drinking milk, 1.3 kg CO_2eq/kg milk for milk destined for the production of Parmigiano Reggiano and 11.1 kg CO_2eq/kg of live weight for beef. The most effective interventions are those related to* ***improving the digestibility of the ration****, which is capable of reducing enteric emissions and methane emissions from effluents, to which is added the introduction of renewable energy, such as biogas and photovoltaics.*

The results of the project, which have been considered by the Region for the preparation and updating of agricultural and rural planning, are available at ***www.agricoltura.regione.emilia-romagna.it/climatechanger****.*

THE ROLE OF FAO IN THE BREEDING OF SUSTAINABLE CATTLE[2]

edited by Susanna Bramante[3]

Livestock breeding is essential for the sustenance of a large part of the world's population, especially in areas where people still live in poverty. The global demand for products of animal origin is increasing, especially in developing countries, thanks to the progressive urbanisation, the population growth and the increase in income of the population: it is estimated that the demand will grow by 70%, to feed a world population that will reach the threshold of 9.6 billion people by 2050.

In this context, global meat production is expected to increase more than double, from 229 million tons in 1999/2001 to 465 million tons in 2050, and that of milk from 580 to over 1,000 million tons.

The increase in demand for these products represents a great opportunity for around 1 billion people who depend on livestock breeding, as a source of livelihood and income. The growing demand for animal products is satisfied above all thanks to the rapid expansion of modern "intensive" farming methods linked to traditional systems.

This reality needs to be positioned in the context of limited natural resources, given that the livestock sector exerts an important pressure on many ecosystems, on biodiversity, water and soil quality and the global environmental impact. Livestock breeding contributes to ***greenhouse gas emissions less than 2% in developed countries and more than 30% in developing ones****, significantly affecting the problem of climate change. So, while on one hand the exploitation of resources is considered high, on the other* ***this sector provides food with high nutritional value with important and positive economic and social implications contributing to food security and reduction in poverty****.*

The livestock sector is the world's largest user of agricultural land, through pasture and the use of food crops. The natural resources that support agriculture, such as water and land, are becoming increasingly scarce and become ever more threatened by pollution and climate change.

In this context, the United Nations Food and Agriculture Organisation (FAO) supports the sustainable development of breeding livestock, with the aim of reducing its environmental impact and use of resources, while increasing production efficiency. This need is increasingly recognised among producers, society and governments and concrete initiatives have been put in place to effectively improve the use of natural resources.

In particular, two partnerships have been established, in which the FAO is actively involved, bringing together many stakeholders (governments, public and private sectors, producers, civil society, international community organisations, research and academic world, the donators who are committed to funding the various FAO projects).

The Global Agenda for Sustainable Breeding aims to catalyse the action of stakeholders, with the aim of:

1) Increasing production efficiency*: in the dairy sector, for example, through the improvement of health and nutrition of animals, it is possible to increase production by reducing the resources used, protecting the environment and ensuring food security.*

2) Revitalize the grasslands: *in the extensive breeding system, for example, the correct management of pasture allows the increase in production, storage of carbon in*

 ISBN 9788891793324

the soil and the protection of biodiversity and water quality. Resizing the number of animals bred and the use of fertilisers, it is possible to increase the quantity and quality of the forage.

3) Improve the management of manure: *in the intensive farming system, for example, the appropriate manure management allows to reduce air and water pollution, thanks to the production of biogas and the use of the effluents as fertiliser. The energy and nutrients recovered can replace the fuel and synthetic fertilisers.*

4) The Partnership on Environmental Assessment and Performance of the Farm (LEAP*), founded in 2012, focuses on the* ***development of specific industry guidelines****, to quantify and monitor the environmental impact and performance of the livestock sector. The initiative is the result of a consultation process started in 2010, between the Animal Production and Health Department of FAO and a group of representatives from food and agriculture sectors. Thanks to a continuous dialogue between stakeholders (governments, private sector and civil society), focused on the identification of objectives and on the consensus to work together, it was possible to develop the project, with the aim of creating a collaboration between the different parties interested in the purposes of the comparative analysis, monitoring and improvement of the environmental performance of the entire livestock chain, taking into consideration the positive social and economic consequences.*

Thanks to the technical, analytical and research skills, through the exchange of data and information organised in specific databases, this collective action will allow a better understanding and management of the key factors that influence the performance of the livestock sector and its environmental impact.
FAO is committed to providing comprehensive and reliable assessments of environmental impacts for the livestock sector, the potential for decreases and the concomitant effects on food security and poverty reduction. This is essential for stimulating political dialogue and taking the right strategic direction to follow.

GLOBAL LIVESTOCK ENVIRONMENTAL ASSESSMENT MODEL: THE FAO PROJECT

Among the many activities of the FAO, the GLEAM (Global Livestock Environmental Assessment Model) project is certainly worthy of note, which aims to evaluate, through the analysis of the life cycle, the environmental impacts of meat production worldwide and identify possible improvement actions. Indications for further in-depth information to the official documents are available on the project's website, where the relevant data and conclusions, especially in terms of greenhouse gas emissions, are reported.
The first data concerns the total emissions of the livestock sector, estimated at around 7,000 million tons per year (7 Gt), which correspond to

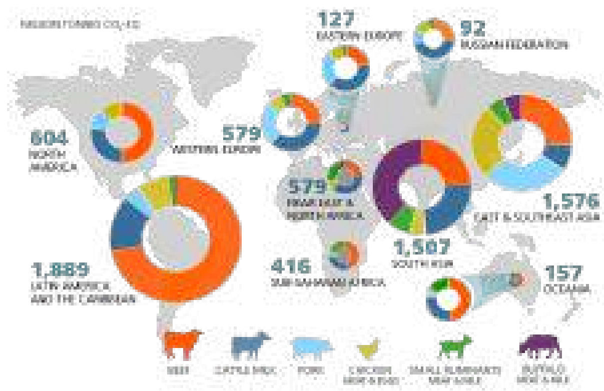
 ISBN 9788891793324

about 14% of the green-house gas emissions of all human activities. *In this value also fall the emissions associated with the change in land use, which occurs as a result of the replacement of forests with pastures or fields for the cultivation of raw materials for animal feed. Going specifically to individual meat, the most impacting species remains the bovine (from meat and milk), due to the enteric emissions that account for about 6-7%. The most important areas in terms of emissions are South America and Southeast Asia, followed by Europe and North America.*

An important aspect concerns the differences in production between the various areas, both in terms of species raised and of breeding patterns: in South America beef cattle breeding prevails, with systems mostly of an extensive type; in Asia, production is rather focused on dairy cattle and pigs; North America is a large producer of beef cattle in "industrial" systems, while production in Europe is semi-intensive, with a fairly balanced distribution among species, with a slight prevalence of pigs.

To these variations of production correspond obviously also differences of emissions. In the following figure it is possible to see how ***in the countries where the extensive breeding prevails, the emissions per production unit are higher than in those regions where the system is more industrialised***. *It should be remembered, however, that the excessive search for production efficiency can put product safety to risk, or the respect for animal welfare.*

A political-strategic type conclusion that can be reached is that the actions to improve the sustainability of the livestock sector must be calibrated on the peculiarities and needs of the regions to which it refers. For example, a reduction in per capita consumption would be desirable in regions where they are very high (for example North America); where instead the environmental impacts are very low and the consumption quite aligned to the nutritional suggestions, as for example in Europe, probably the most critical aspect could be that of animal welfare, upon which improvement interventions are certainly possible.



Greenhouse gas emissions by geographic areas
Source: www.fao.org/fileadmin/user_upload/gleam/images/fig5.png

 ISBN 9788891793324

DEVELOPMENT POLICIES
THE SUSTAINABILITY OF THE AGRI-FOOD SECTOR

EUROPEAN CONTEXT

Development guidelines for the definition of the new Common Agricultural Policy (CAP) post 2020

Although there are no references to the sustainability assessment, Member States will have the burden of submitting annual reports on the achievement of defined objectives for the protection of the environment and climate (for example, reports on biodiversity, use of resources and soil quality).

***On a voluntary basis**: it will be possible to finance rural development plans or support schemes, incentives and the granting of subsidies to operators engaged in the use of agricultural practices considered "sustainable" according to the application of mandatory parameters to be defined. Minimum 30% of rural development funds will have to be spent for the definition of measures to protect the environment and the climate.*

INTERNATIONAL CONTEST

Agenda 2030 United Nations

***17 Sustainable Development Goals (SDGs)** have been identified, articulated in 169 Targets to be achieved by 2030 in the environmental, economic, social and institutional sectors. The objectives regard, among others: environmental impact, employment and economic growth, workers' rights and communities. The EC is a promoter of Agenda 2030 (UN); on whose basis are defined the 10 priorities of the Commission in matters such as: employment, energy and climate, trade policy. The SDGs were defined between 2000 and 2015 and constitute the development of the objectives initially defined within the "Millennium Development Goals" (MDGs). They certainly represent one of the most effective results of the inclusive and synthesising work carried out by the United Nations which has actively involved moreover 1,500 companies.*
The SDGs are universally applicable in developed and developing countries and constitute the basis for operational plans, legislative actions and other policy initiatives. The SDGs have placed the economic activities of companies at the centre, as a necessary condition for their pursuing.

> **"BUSINESS ACTIVITY IS A VITAL ELEMENT IN ACHIEVING THE OBJECTIVES OF SUSTAINABLE DEVELOPMENT. COMPANIES CAN CONTRIBUTE THROUGH THEIR ACTIVITIES AND WE ASK THEM EVERYWHERE TO VALIDATE THEIR IMPACTS, SET AMBITIOUS GOALS AND COMMUNICATE RESULTS CLEARLY."**
>
> *Ban Ki-moon Secretary General of the United Nations*

1 - **NO POVERTY** - *End poverty in all its forms everywhere*

2 - **ZERO HUNGER** - *End hunger, achieve food security and improved nutrition and promote sustainable agriculture*

3 - **GOOD HEALTH AND WELL-BEING** - *Ensure healthy lives and promote well-being for all at all ages*

4 - **QUALITY EDUCATION** - *Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*

5 - **GENDER EQUALITY** - *Achieve gender equality and empower all women and girls*

6 - **CLEAN WATER AND SANITATION** - *Ensure availability and sustainable management of water and sanitation for all*

7 - **AFFORDABLE AND CLEAN ENERGY** - *Ensure access to affordable, reliable, sustainable and modern energy for all*

8 - **DECENT WORK AND ECONOMIC GROWTH** - *Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*

9 - **INDUSTRY, INNOVATION AND INFRASTRUCTURE** - *Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*

10 - **REDUCED INEQUALITIES** - *Reduce inequality within and among countries*

11 - **SUSTAINABLE CITIES AND COMMUNITIES** - *Make cities and human settlements inclusive, safe, resilient and sustainable*

12 - **RESPONSIBLE CONSUMPTION AND PRODUCTION** - *Ensure sustainable consumption and production patterns*

13 - **CLIMATE ACTION** - *Take urgent action to combat climate change and its impacts*

14 - **LIFE BELOW WATER** - *Conserve and sustainably use the oceans, seas and marine resources for sustainable development*

15 - **LIFE ON LAND** - *Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*

16 - **PEACE, JUSTICE AND STRONG INSTITUTIONS** - *Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels*

17 - **PARTNERSHIPS FOR THE GOALS** - *Strengthen the means of implementation and revitalize the global partnership for sustainable development*

The 17 global sustainability challenges (SDGs). Source: https://sustainabledevelopment.un.org/

IMPACTS
ALONG THE SUPPLY CHAIN

Like people have, animals have dieticians as well. They establish the appropriate rations for the various animal species during the various phases of their lives.
Soy, corn, sunflowers, alfalfa and hay are the main raw materials grown for making feed for livestock.

Breeding farms can be managed according to different production models according to both where they are located and the type of animals bred.

PRODUCTION OF FEED

- use of fertilisers and agrochemicals
- use of diesel fuel
- land occupation
- use of water

BREEDING FARMS

- the management of animal excrement
- energy consumption
- use of water

 ISBN 9788891793324

Although it is often believed that the most significant phases are those related to industrial processing or distribution, **more than half the overall impact derives from farm management and feed cultivation.** Agricultural and livestock farms are therefore the places where it is necessary to work to control and reduce, where possible, the factors of environmental impact.

The transformation phase begins with the slaughtering of the animals and includes, when foreseen, the production of more elaborate products such as cured meats.

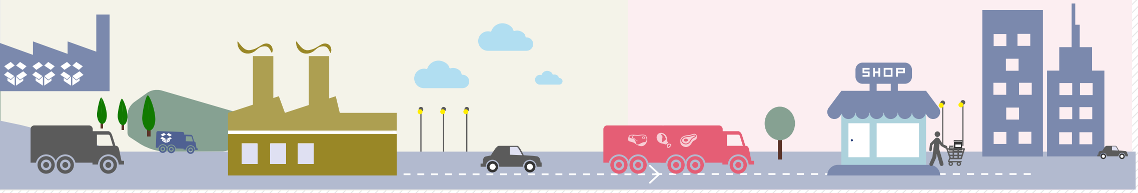
Distribution involves all of the production phases up until the retail stores or the meat's consumption.

TRANSFORMATION

- energy consumption
- waste production
- use of water

DISTRIBUTION

- transportation
- energy for conservation
- use of packaging



1.3 Feed production

The first phase of a livestock production chain coincides with that of feed production. The first step is therefore to understand how the feeds are composed, what are the main raw materials needed to produce them and how the impacts vary in the various supply chains. The relevant impacts of this phase are attributable to the agricultural phase: for poultry and pig meat, this item can constitute up to 60-80% of the emissions of the entire production system (farm to gate); in the case of beef, the agricultural contribution is a little lower, about 35-45%, because for ruminants, a large part of the emissions are linked to enteric fermentation[4].

It is therefore clear that the challenge of sustainability in livestock production can only be won by involving in a systematic and farsighted way all the players of the supply chain, including farms. The feed intended for farm animals is mainly composed of a mixture that includes cereals (corn, wheat, barley), legumes (such as soy), vitamins and trace elements according to a diet that is established on the basis of needs related to the type of breeding and to its productive specialisation.

In Italy there are farms that self-produce a large part of livestock feeds and **are part of integrated supply chains**. This practice, which is an indisputable strong point for breeding, is applied **above all in the case of ruminants** as they are capable of enhancing the biomasses of the pastures. This type of management allows the adaptation of agricultural production to specific nutritional strategies adopted by breeding, as well as a strong control capacity and good local application of agricultural practices, including the tech-

BREEDING FARM	BEEF	DAIRY COW	CHICKEN MEAT	PORK
TOTAL RATION	15-20 KG/DAY	25-30 KG/DAY	0,15 KG/DAY	1,35 KG/DAY
CORN OF VARIOUS TYPE	65-70%	60%	25-30%	45-50%
SUNFLOWER	8-10%	< 5%	–	-
SUGAR BEETS	5-10%	< 5%	–	-
WHEAT AND OTHER CEREALS	5-10%	10%	20%	30-35%
SOY	< 5%	< 5%	40%	15-20%
GRASS AND HAY	< 5%	20%	15%	-
SUPPLEMENTS	< 5%	< 5%	-	< 5%

Average rations (same quantity) of some species raised in barns in Italy

 ISBN 9788891793324

niques of "**Precision farming**", which can substantially affect the overall sustainability of agricultural production.

In the case of pig and poultry livestock production, the correlation between self-production of raw materials and livestock production is less strict. In these cases, we develop integrated supply chains that include livestock and feed mills, able to specialise the feed production to the specific type of livestock production. With respect to the free marketing between producer and feed user, **the integrated supply chain allows a greater consistency in production quality and above all greater control capacity**, both in terms of food safety and sustainability aspects. In general, vegetable raw materials for feed processing are bought on domestic and foreign markets. Depending on the type of agricultural raw material, the **degree of national self-sufficiency production is variable**.
In the case of soy, for example, Italy cannot be self-sufficient and must necessarily import from the most suitable territories, such as some areas of the South American continent. In such cases, the Community legislation provides for a complex system of rules concerning health safety and traceability throughout the food chain. It must be remembered that, from the point of view of safety, **feeds are equated with food for humans and are placed within the same rules provided in this sector**. Although in the context of international trade it is more complex to implement projects to improve sustainability, it is important to clarify that, even in the case of the globalised markets of agricultural commodities, voluntary circuits for the control and certification of sustainable production are available. An example in this sense is represented by the sustainable soy production and certification systems, the most important of which is represented by RTRS - Round Table on Responsible Soy (www.responsiblesoy.org).

With the aim of reducing the dependence on plant production from other continents, **the European Union promotes and**

BOVINE: THE HERBIVORES THAT TRANSFORM CELLULOSE INTO PROTEINS

The complexity of the metabolism of cattle and the specific characteristics of the emissions are the expression of a complex work of conversion. In fact, ruminants have a real natural bio-fermentation system consisting of rumen and large intestine. These organs allow the transformation of the cellulose contained in the vegetables, that is the non-digestible fraction for humans. The digestion of cellulose in ruminants is carried out by a complex and partly still unknown microbial flora that develops in these bovine organs. It is only thanks to this system that the animal is able to **convert vegetable products (otherwise indigestible) into noble proteins, such as milk and meat**. In fact, the biological process of rumination determines the transition from the plant to the animal world. This is the reason why ruminants were the first animals since prehistoric times that have coexisted with the human species, guaranteeing the supply of high biological value proteins, starting from poor vegetables without bioavailability for humans.

 ISBN 9788891793324

supports the use of waste and by-products deriving from agri-food supply chains for livestock production according to the principles of the circular economy. On this theme, numerous research paths are in fact aimed at expanding the technologies and the portfolio of livestock food obtained from food waste, suitable for the production of feed.

The animal diet has in fact always been completed by **residues or by-products of the various phases of industrial processing of food products**, such as fruit and vegetables not usable for sale, by-products of grinding cereals, non-compliant pasta and bakery products, residues from milk, beer, tomato industries or even the used panels from the extraction of soybean oil, sunflower and colza, excellent source of protein. The environmental advantage in the use of these materials is multiple: it reduces the dependence from abroad of feed materials, it saves agricultural land used for the **reduce waste by recovering resources that would otherwise be disposed of**; in addition, the use of former food products to be used as an ingredient for animal feeds, is in fact an efficient system to eliminate, or at least reduce, the waste of food resources[8].

The crucial point is the relationship between the quantity of edible proteins for humans intended for animal feed and the amount of (edible) protein obtainable from the breeding of animals.
To increase efficiency and decrease, as far as possible, the use of edible proteins for humans as livestock food, it is impor-

GFLI, WORLD PROJECT TO MEASURE THE ENVIRONMENTAL IMPACT OF FEED

The purpose of the Global Feed LCA Institute (Gfli) is to measure the environmental impact of feed production. This is a project launched in the United States in 2015 and promoted by various international associations such as Fefac (European federation of feed manufacturers), Ifif (International federation of feed manufacturers), Afia (American feed industry association) and the Anac (Animal Nutrition Association of Canada), in addition to a consortium of international companies.

The goal of the Gfli [10] is:
- adopt a standard method for assessing and analysing impact on an international environmental scale related to the production of feed;
- guarantee the creation and use of a free and transparent database that collects all the information on the life cycle of ingredients used in food production for animals;
- create a method of comparative analysis of the effects that feed production has on the environment.

Gfli has also established a partnership with the FAO and the Livestock Environmental Assessment and Performance Partnership to ensure that its activities are compatible with the methodological requirements defined by the two organisations. The technical program of the Gfli has been designed to also comply with the Pef (Product environmental footprint) project, to detect the environmental footprint of products and coordinated by the European Commission.

tant that animal husbandry and feed are increasingly optimising the use of crop residues and by-products, trying new combinations that keep conversion efficiency and animal welfare equally high[9]. Since the world population continues to grow along with the demand for food, **farm animals will play an essential role in the conversion of foods that are not edible by humans into quality proteins**.

FOOD	EXAMPLES	EDIBLE BY HUMANS?
CROPS FORAGE	Pasture grass, alfalfa, clovers, hay, silage.	No
CEREALS	Grain corn, wheat, barley, millet, sorghum, triticale, oat	Widely
VEGETABLE PROTEINS	Soy (paste and flour), cotton (seeds and flour), colza and peanut flour	Partially
CEREAL BY-PRODUCTS	Distillation industry cereals, corn gluten, wheat bran, straw, crop residues	Partially
VEGETAL BY-PRODUCTS	Apple peel, citrus pulp, almond shells, fruit/vegetable scraps.	Partially
EX FOOD PRODUCTS	Products not usable as food, packaged or not, deriving from both the production and distribution process	Partially
BY-PRODUCTS OF SUGAR FACTORIES	Molasses and beetroot pulp	Partially
ANIMAL BY-PRODUCTS	Waste meat and bones, tallow, feathers, blood and flour, usable as pet food.	Partially
DAIRY BY-PRODUCTS	Milk, whey, casein.	Partially
FISHING BY-PRODUCTS	Fish waste, fish oil, algae.	Partially
OTHER	Vitamins, minerals, probiotics, yeasts, enzymes, preservatives.	Partially

Examples of foods commonly used in animal production systems

 ISBN 9788891793324

CIRCULAR FEEDING:
THE CASE OF EX-FOOD PRODUCTS

edited by Valentina Massa - Dalma Mangimi

Animal nutrition is a cornerstone for food security, animal welfare and sustainability. A fundamental link in the chain, which has improved over the years in terms of production efficiency, playing a key role in reducing environmental impacts thanks to the increasing use of ***by-products, co-products and ex-food products****.*

The starting point has always been tradition: the use of by-products among feed ingredients has always been intertwined with agricultural and food production. To this has been added an increasing technical-scientific competence in the management of "precision" formulations for each type of animal and in the specific breeding phase.

*By-products are talked about a lot; a classic example is wheat bran, resulting from the decortication of wheat for flour production. An ingredient of which little is spoken, at least for now, and which is still an excellent example of circularity, is that of the former food products defined by the European Commission as those "****food products, other than the residues of catering, generated, in full compliance with Community legislation on food, which are no longer intended for human consumption for practical reasons, logistics or related to manufacturing defects, packaging or other, without presenting any risk to health if used as feed****" (REG. UE 68/2013).*

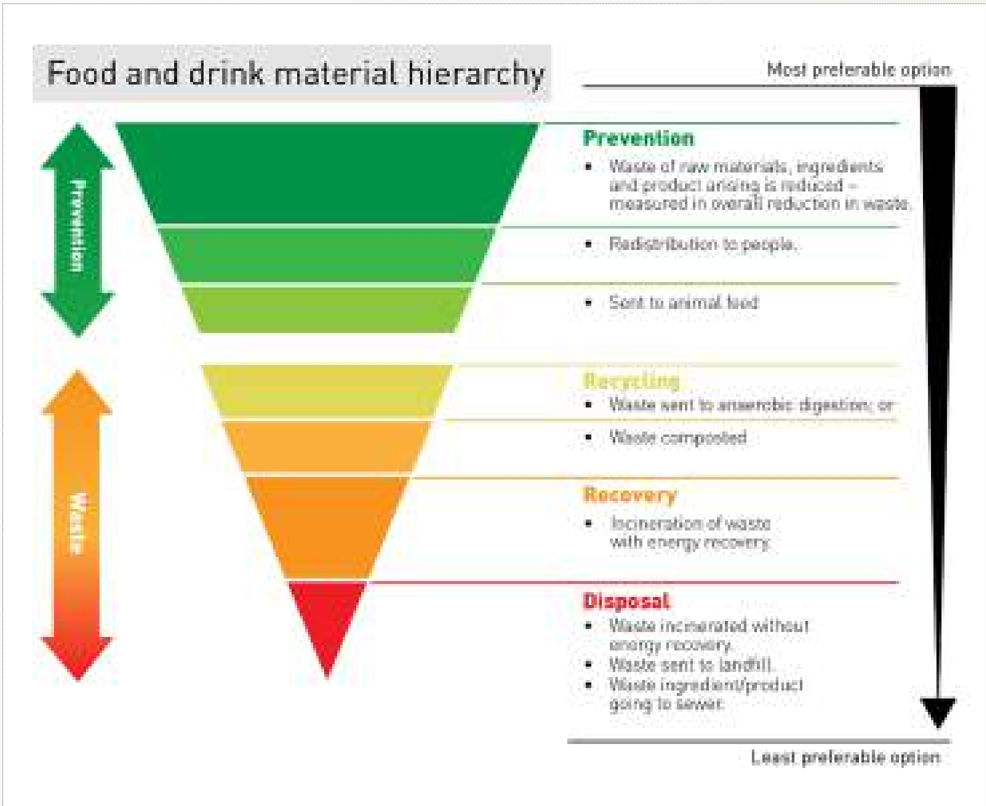
There can be various types of ex-food products, the most common are products derived from the process of transformation and selling of food (such as biscuits, pasta, snacks, bread, snacks, sweets), packaged or in bulk and, following appropriate processing as unwrapping and mixing, become excellent raw materials that replace cereals, sugars and fats in animal diets. It is not a question of waste but of feed materials that have passed from the status of "food" to that of animal feed. This procedure ensures maximum safety and traceability, thanks to the HACCP management plan.

Most of these former food products have already undergone a cooking process, which greatly improves the digestibility of starches and increases the digestible energy of the ration. The inclusion in feed of ingredients based on ex-food products was strongly promoted by the European Commission for two reasons: on the one hand we could reduce "a food waste" unintentional and unpredictable, while on the other, enhancing the use of nutritive resources selected for feed (characterised by high quality lipids, more digestible starches due to cooking, important sources of sugar as well as a reduced risk of contamination from mycotoxins), the need is reduced to use traditional raw materials that require for their production soil, energy, water, fertilisers and sometimes even plant pesticides. For these reasons, the European Commission has published a series of provisions to reduce food waste[5], as part of communications on the circular economy[6]. One of the initiatives consists in enhancing the nutrients of foods that, for commercial reasons or due to manufacturing problems or certain defects, are no longer destined for human consumption, through their safe use in animal feed. ***This recovery does***

 ISBN 9788891793324

not in any way compete with the supply of food banks because it allows the recovery of surpluses in addition to those foodstuffs otherwise treated as waste and therefore composted, transformed into biogas, disposed of in landfill or incinerated. The re-use of ex-product foodstuff as feed material is finally to be preferred over energy reuse or landfill disposal, as also suggested by the hierarchies of reuse of waste food products[7], promoted by EPA (US Environmental Protection Agency) and WRAP (the Waste and Resource Action Program) also endorsed by the EU Commission.

Today, therefore, it is possible to produce high quality meat with a reduced environmental impact thanks to a careful and attentive use of feed ingredients that are more sustainable and no less good or not safe, in line with the principles of the circular economy which provides safe recovery processes leaning towards a 0 level of waste.



Waste hierarchy for food products
Source: www.wrap.org.uk/content/why-take-action-legalpolicy-case

 ISBN 9788891793324

The impacts of agriculture

Use of fertilisers, irrigation and processing of land, use of crop protection products: in most cases the agricultural phase is the one in which the greatest impacts of the entire food production chain are found.

Fertilisers are substances that provide the soil with nitrogen, phosphorus and potassium, the nutrients necessary for the growth of plants: however, they are also **one of the first sources of environmental impacts in agricultural production**, both in terms of use and production processes, especially for those in synthesis. Amongst all, the greatest impact comes from nitrogen, due to the generation of protoxide that significantly affects the greenhouse effect. Moreover, when the fertiliser is supplied in excess, the residues not consumed by the plants can reach surface water courses, or the first underground water tables, causing an abnormal increase in the concentration of nitrogen which favours an exaggerated growth of flora: the so-called eutrophication phenomenon.

Natural fertilisers, widely used in organic farming, can lead to a reduction in impacts, especially due to the lower load in the production phase, but once placed in the field the effects are the same: indeed, in some cases the use of natural fertilisers (for example manure) makes "evolved" cultivation techniques difficult, which aim at reducing impacts thanks to the use of innovative techniques and technologies. In addition to nutrients, plants need to be **protected from diseases**, insects and weeds. These have in fact a negative implication both for the health of the plant itself, and therefore on production yields, as well as for food safety in case the plant or its products are used in food production.

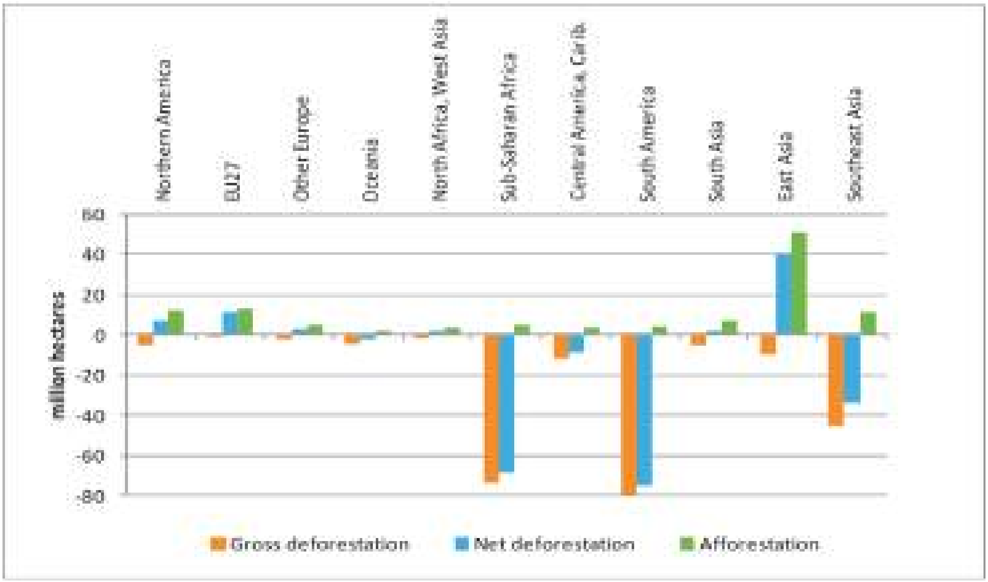
A defence can be made by administering to the plants (curative or preventive) the chemical substances (or natural, if avail-

able) during the various stages of growth, but also through an "intelligent" field management: for example, the fusarium infection, one of the diseases of wheat, more frequent when corn has previously been cultivated in the same soil. If the farmer takes this information into account when planning crop changes, he can reduce the use of chemicals and consequently reduce costs for the year.
Then there are operational choices, which require a decision in a very short time, based also on contingent situations: the weather, the risks of infection, etc. As they can have important environmental and economic impacts, these choices require ever more tools and information which the "traditional" farmer often does not have. For this reason, decision support systems (DSS, Decision Support Systems) that gather, organise, automatically interpret and integrate the information necessary to decide the most appropriate actions to respond to the most diverse cultural needs, be they long-term strategies or operational decisions to be taken quickly.

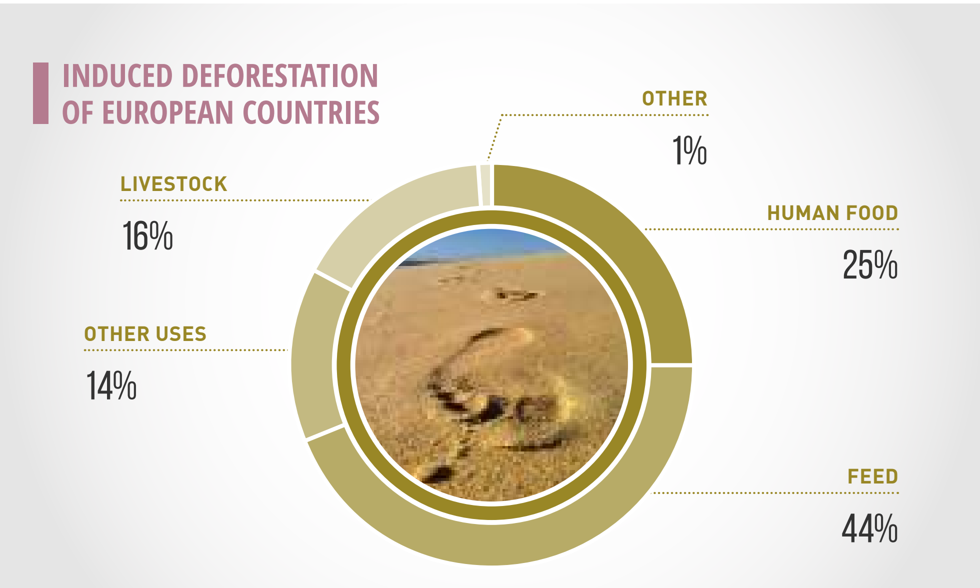
Abandonment and deforestation, two sides of the same coin

When we talk about territory, one of the most debated environmental aspects is the **use of the soil** that leads, paradoxically, to opposite problems depending on the regions of the world to which we refer: sometimes the main risk is the **abandonment** of the agricultural territories, in other cases the problem is the excessive aggression of anthropic activities to the natural environment (**deforestation**).
In Italy, for example, the main problem is represented by the conspicuous change from agricultural land to urbanised land, resulting in a general abandonment of territories by farmers. According to the most recent data published by ISPRA[11], at national level, land consumption has risen from 2.7% estimated during the 50s, to 7.6% in 2016, equal to over 23,000 km^2. To this is added the incentive for renewable energy, which often pushed farmers **to convert land into "photovoltaic power plants"**, or to convert "food" crops to the production of resources used for energy purposes (the so-called bioenergy). This phenomenon involves various impacts, both economic and social, productivity is lost with the consequent need to purchase raw materials from abroad, and environmental.

The presence of farms is in fact extremely useful for the protection of the territory, because the continuous maintenance allows to reduce, for example, the risk of landslides and earth-falls, especially in those areas characterised by high hydrogeological risk. The support, also economic, to agriculture and animal husbandry is therefore essential to avoid the progressive impoverishment of the "countryside". In other countries, however, the problem concerns an agriculture that looks for territorial space to the detriment of other habitats. Just think of the uncontrolled **deforestation** of tropical forests in favour of plantations for the production of agricultural raw materials (mainly palm oil and/or soy) for food or energy, or pasture for cattle livestock. All these transitions, besides determining the loss (sometimes permanent and irreversible) of fertile soil, cause further negative impacts, such as the fragmentation of the territory, a reduction in biodiversity, an alteration of the hydrogeological cycle and microclimate modifications. Although Europe is not directly affected by the phenomenon of deforestation and indeed the wooded areas are expanding, there is an



Changes in the areas covered by forests between 1990 and 2008 in different areas of the world. Europe (EU27) is characterised by an expansion of forest areas (afforestation), but indirectly contributes to the phenomenon of deforestation.
Source: EC Study, Technical Report 2013-063.



Deforestation induced by European countries in the period 1990-2008.
Source: EC Study, Technical Report 2013-063.

 ISBN 9788891793324

induced phenomenon (embodied) by the continuous and growing demand for raw materials. In all areas of the world there are phenomena of forest reduction and increase: those in which the net balance is strongly negative, however, are South America (33% of global gross deforestation), sub-Saharan Africa (31%) and Southeast Asia (19%).
In the period 1990-2008, **global gross deforestation** was estimated at **239 million hectares** (Mha). The **agricultural** sector has been responsible for the deforestation of about **128 Mha**: 49% is land destined for the production of feed, 8% is related to the cultivation of plant products for rations of pigs and poultry, 43% to the production of food of vegetable origin, bio-fuels and textile fibres. The top five crops that contributed to deforestation during the reporting period were soy (19%), maize (11%), palm oil (8%), rice (6%) and sugar cane (5%).
As for **Europe**, an **induced deforestation** of approximately **8.7 Mha** (7% of the total) has been estimated, with the greatest contribution being the demand for animal feed, followed by that of raw materials for human food (soy and palm oil).

These data show a very articulated phenomenon, the management of which is extremely complex, and must necessarily take into account the world population's growing demand for food. The containment of meat consumption can be a solution only where these are very high; a global vision must however also aim at the efficiency of production. As seen for the emissions of greenhouse gases, for example, it is clear that pasture is not always the most sustainable solution, as regards also deforestation. One of the intervention aspects is represented by the adoption of specific policies for the acquisition of raw materials by the producers, in order to allow a control of the supply chain and complete raw material traceability.

GMO
YES, OR NO?

One of the most controversial and recurrent aspects is certainly the one on GMOs (Genetically Modified Organism). These often end up in the dock accused of representing a danger to human health and the environment and, even more so, representing the very symbol of a highly mechanised agri-food model focused on monocultures. Although there are many works and many points of view on the topic, not always scientifically reliable, that of GMOs remains a sensitive issue that does not fail to trigger diatribes between supporters and detractors of this form of innovation. Below we tried to summarise the fundamental points of the debate, starting from the very definition of GMO.

The term "genetically modified organism" refers to any "organism whose genetic material has been modified differently from what occurs in nature with natural genetic coupling and/or recombination".[12] In truth, the improvement or modification of the genetic characteristics of an animal or of a plant species has always been known. For this reason, it is good to clarify that the GMO techniques "under trial" are those developed in the last 40 years[13] and that allow the modification "in the laboratory" of some characteristics of the living species: for example, it is possible to increase the resistance of a plant to pesticides or certain pests, improve its nutritional profile or the ability to adapt to adverse climatic conditions (for example increasing its resistance in case of drought). The ***WHO*** *(World Health Organization)* ***has long said that GMOs currently on the market do not pose a risk to human health.***[14] *Nevertheless, their use in the agri-food sector is opposed by a considerable part of the public opinion, above all because in the face of possible risks people do not perceive any direct advantage from the introduction of this new technology.*

To help the average consumer juggle with scientific evidence, clichés, ideologies, the FAO provides a comprehensible synthesis of the potentially positive and negative effects of GMO cultivations, with a brief analysis of their verifiability.[15] *In Italy other interesting contributions to the debate on the subject come from the work of the Barilla Foundation Centre for Food & Nutrition which since 2010 has published a series of reports aimed at deepening the issue of biotechnology, trying to identify which points are the most contrasting on the topic of genetically modified organisms*[16]*.*
Among the relevant topics there are certainly environmental and ethical ones. As for the environment, among the aspects that attract the most attention is that of crop simplification, to which is inevitably binded the risk of a possible reduction in biodiversity. This concern is also exacerbated by the lack of knowledge of how these species can be invasive compared to traditional ones, which could lead to the disturbance of ecosystems in the areas surrounding those in which they are introduced.
On the other hand, from an ethical point of view, the problem of the patentability of GMO seeds arises, and therefore of the possible economic repercussions that the development of an oligopolistic market in the hands of a few companies could have on small farmers.

But where and why are GMOs used? The varieties of GMO

plants on the market today have been created to achieve resistance to parasitic insects (Bacillus thuringiensis, BT), tolerance to herbicides (Herbicide tolerant, HT) and resistance to viruses. Recently in Europe the cultivation of an Amflora potato (EH 92-527-1) has been authorised, with a high amylaceous content for the paper industry, with the aim of increasing the productivity level of the supply chain in question.
In the near future, the main reason for commercialisation will still be linked mainly to resistance to pests and herbicides, even if, for a while now, the need has emerged for complete plant varieties capable of adapting to adverse environmental and climatic conditions: studies have been started to develop plants that can adapt to drought or significant temperatures variations, or that can grow in soils that are rich in some minerals or metals. The main GMO crops in the world are ***soy, corn and cotton****.*

1.4 Breeding of animals

Breeding farms are the place where most of the environmental impacts of the meat and cured meats production process are generated; the most relevant aspects concern **enteric fermentations and the management of manure**.

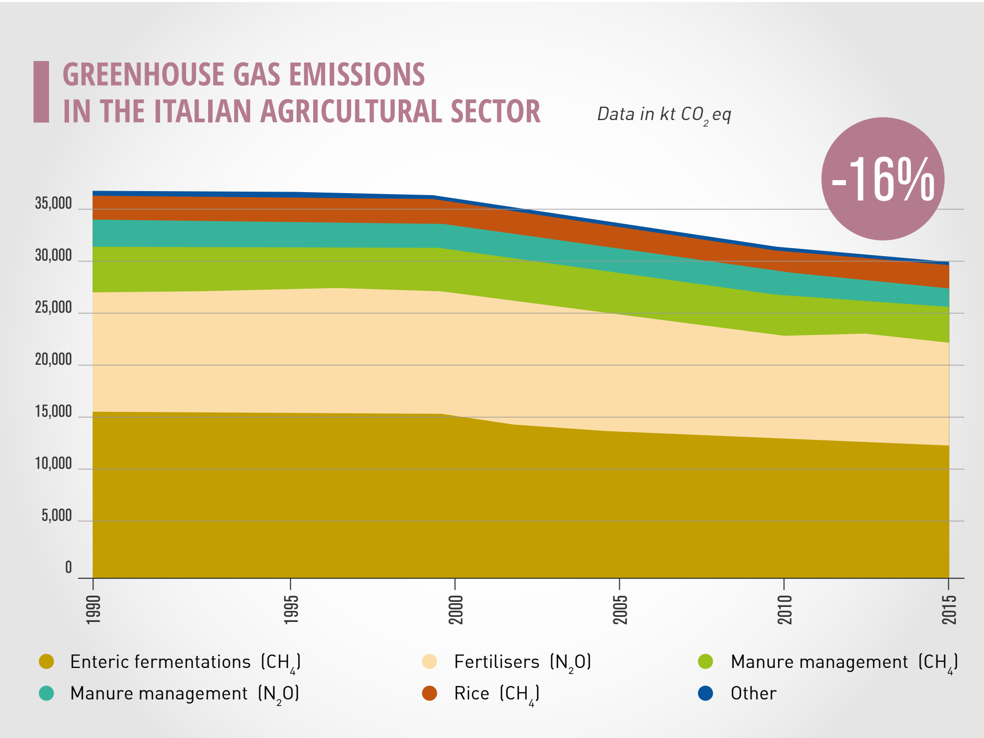
These statements are supported, at least as far as greenhouse gases are concerned, by the data published by ISPRA[17] which also shows a **reduction** of about **16%** of the total value compared to 1990.

The enteric fermentations

Enteric fermentation is one of the results of the process of food digestion; it becomes particularly relevant in the case of ruminant herbivorous animals (cattle, sheep, buffaloes, etc.), as it involves the production of a large amount of methane (CH_4). This gas has an effect on climate change 28 times higher than that of carbon dioxide (CO_2). The amount of methane produced depends mainly on the characteristics of the animal (race, age, weight), but also on the type and quantity of the food supplied. Some studies (Lauder A. R. et al., 2013) argue that **the relative impact of methane on climate change is overestimated, due to its short duration in the atmosphere compared to CO_2**.

How they are calculated

The IPCC organization has dealt with the calculation of enteric emissions in the guidelines published in 2006[18], defining 3 approaches to estimate them with a dif-



 ISBN 9788891793324

ferent level of detail and insight.
The **Tier 1** methodology is the least accurate, but the simplest, as it provides the estimation of emissions only on the basis of the type of animal (for example beef or milk cattle) and the geographical area of origin.
The **Tier 2** methodology provides a more complex approach to calculation and a deeper knowledge of the farm in question; it should be used when the contribution is relevant, as in the case of cattle.
Finally, the **Tier 3** methodology is the most precise, but requires an even more in-depth knowledge of the farm examined.

For its application it is in fact necessary to have different primary information, such as the composition of the ration, the seasonal variation in the animal population, the quality and quantity of foods administered and the possible strategies to mitigate the impacts generated. Often this is information derived from direct experimental measures.

How emissions vary: an example of calculation

Tier 2 is the most used approach and an analysis of the formula leads to understanding how **emissions can vary** significantly with the diet of animals, both for the quantity and for the type of food. The calculation is based on specific emission factors that are a function of the diet administered according to the following formula, where:

$$EF = \left[\frac{GE * \left(\frac{Y_m}{100} \right)}{55.65} \right] * d$$

- **EF** (emission factor) = emission factor expressed in kilograms of CH_4 per head per year;
- **GE** (gross energy intake) = total caloric intake per head per year. It depends on the type of food and the quantity;
- **Y_m** (methane conversion factor) = energy conversion factor contained in food in methane. It depends on the type of breeding;
- The factor **55.65** (MJ/kg CH_4) is the energy content of methane;
- **d** is the number of days of administration of the reference ration.

Regarding the Y_m factor, its value depends mainly on the type of breeding: in bovine, the IPCC values are 3% for barn animals and 6.5% for pasture animals (or for cow's milk). With the same energy (constant GE), **the methane emissions generated by a pasture animal are twice that of an animal in the barn**. This statement cannot lead to a direct conclusion because, as mentioned, the total quantity of food administered must also be considered. Again with the logic of illustrating the calculation method, an example is presented in which the diets of a cattle at pasture and one reared according to the Italian production system are compared, then with a period of pasture and one in the barn. The comparison is to be considered preliminary, because in truth the assumptions and implications would be many: the first limit, for example, is to consider rations constant throughout the life of the animal, which in reality is not true.

The assumptions made can be considered reasonable for the purposes of this document, that of elaborating on the calculation and showing, among other things, why barn breeding generates a total of less emissions than at pasture.

 ISBN 9788891793324

ENTERIC FERMENTATIONS
CALCULATION EXAMPLE

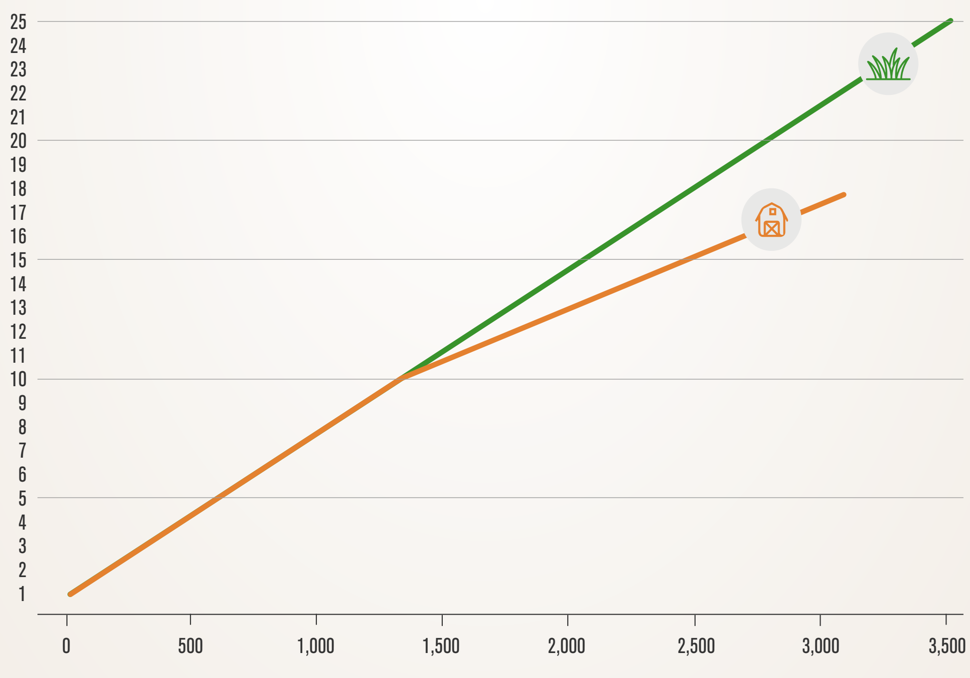
BOVINE AT PASTURE

- *diet with 25 kg of grass per day;*
- *breeding time to reach the weight of 650 kg: 25 months.*

BOVINE IN THE BARN

- *breeding times: 10 months' pasture; 8 in the barn;*
- *diet in the pasture period: 25 kg of grass a day;*
- *diet during the period in barns: 16.5 kg of food consisting of silage and corn pasty (60%); straw and hay (21%); beet (6%); soy (5%); sunflower (4%); wheat (4%).*

The presented value includes both the enteric and the agricultural production of the raw materials used during the barn period. The diet in the barn is overall more impactful because despite being characterised by lower enteric emissions, it must keep account of the cultivation of food. From an overall point of view, however, the impact is less because of the less time needed to reach the weight suitable for slaughter.



Total greenhouse gas emissions - kg CO_2 eq

 ISBN 9788891793324

The management of manure

The impact in the management of animal waste is due both to the **air emissions** of the volatile substances present (ammonia, methane and nitrous oxide) and to the release of **nitrogen in the soil**. In livestock farms these environmental aspects are related to two different times in the whole management flow: the **collection and storage** phase and the **final disposal** phase. When in the presence of outdoor farms, however, collecting the manure is impossible and the impact depends on its spreading around the fields and its control is almost impossible.

Collection and storage of manure on barn breeding farms

A first aspect to consider is the management of the breeding farm, that in the case of litter with straw or other absorbent material can give rise to **manure** (bovine) or **pollen** (poultry), or **slurry** (bovine or pig), in the case of breeding organised on slatted floor. Being almost solid materials, manure and pollen are more easily manageable than sewage. They are therefore to be preferred, because they make more alternatives possible for the subsequent storage and disposal phases.

In addition to this, it is to be borne in mind that they are generated by farms that provide for litter, and are therefore also better for animal welfare. After collection, the manure is stored to make sure that its treatment occurs in the most suitable time, way and place. Typical storage systems are many, but they can be characterised by a fundamental aspect that is coverage: especially in the case of sewage you can indeed find **open** or **closed** tanks, with very different effects from an environmental point of view. The open structures, of course, involve greater emissions, both for the direct release of volatile substances, and for the occurrence of spontaneous fermentation phenomena that entail an additional dispersion of methane, CO_2 and other substances.

As for enteric fermentations, the **emissions generated** during storage can be estimated using the indications contained in the IPCC[19] guidelines for the three main substances: **methane, nitrous oxide and ammonia**. Also in this case three approaches are possible, whose extremes are the tabular and the experimental ones; the intermediate scenario, Tier 2, is the one used for environmental impact calculations because it allows sufficient accuracy starting from normally known data.

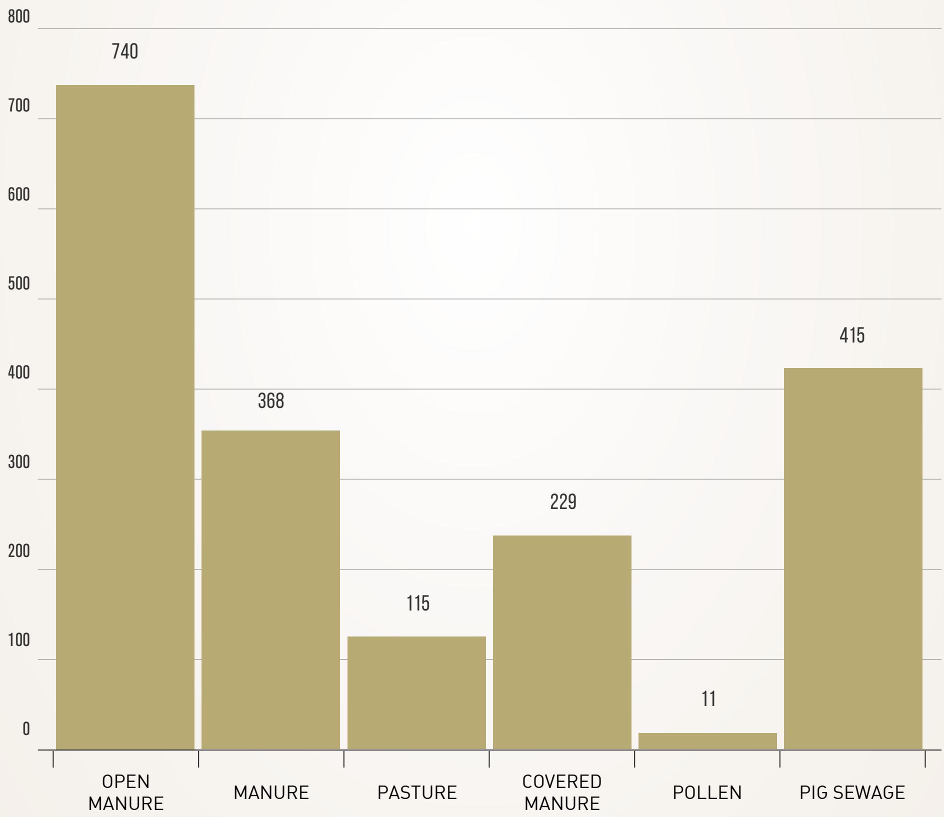
Also in this case some elaborations can be presented, which allow to understand the differences in impact between the various possible storage methods. Unlike enteric emissions, however, formulas are more complex; for details refer to the IPCC documents. Emissions obviously depend on the amount of manure, from typology, but above all from storage modalities as technology and geographic area: the climate, for example, can be extremely influential in the biological degradation processes responsible for emissions.

To improve its sustainability, the livestock sector should then direct investments towards a more rational waste management, **preferring, where possible, the production of solid material and therefore farms on litter**. In the case of beef cattle, this evolution is quite tangible, as shown by the data of COOP Italia published on the environmental product declaration which shows how almost half of the produced manure is managed in litter with manure production.

 ISBN 9788891793324

THE IMPACTS OF DIFFERENT TYPES OF MANURE STORAGE

To provide a preliminary estimate of the emissions associated with the main technologies of manure storage, a calculation was made keeping all the characteristics constant (climate, type of manure, quantity) and only modifying the storage technology used. Annual emissions of CH_4 and N_2O per head related to sewage management both in the case of cattle and poultry were estimated using the data and methodology reported in the IPCC Guidelines[20]. Regarding emissions related to the handling of pig manure reference was made to the study by Fabbri et al.[21]



Greenhouse gas emissions - Impact per head (kg CO_2/head/year)

 ISBN 9788891793324

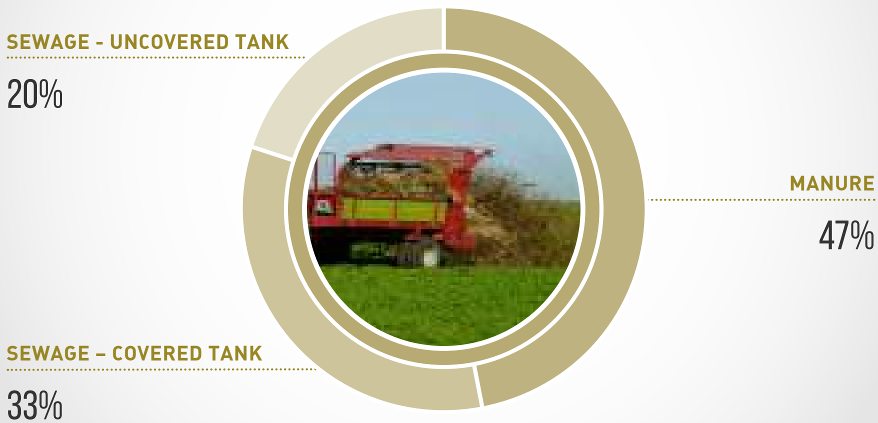
The spreading of manure in agriculture

After storage, manure must be disposed of. The possibilities are different and the choice depends on both the animal species from which they derive (they may have a different substance content) and the storage methods used.

In principle, their **spreading** in agriculture can be seen as a "closure of the cycle", because nutrients (mainly nitrogen and phosphorus) can be returned to crops without resorting to chemical fertilisers. In this case, however, a correct management is fundamental, since an excess of use can result in uncontrolled releases of polluting substances, first of all nitrogen. For this evaluation, besides the quantity, it is also important to consider the quality of the material used, because the organoleptic characteristics can vary greatly. In the case of pollen, for example, the low moisture content (30% compared to 90% of that of bovine or pig manure) makes it very concentrated in nitrogen and therefore its spreading must be done with extreme caution.

To limit impacts, the agronomic use of livestock effluents is governed by specific action programs (first of all the **Nitrates Directive**) that vary from region to region, so as to protect vulnerable areas from nitrates of agricultural origin. The fundamental principle is to have **available an amount of land proportional to the animals bred**, in order to be able to manage the manure directly on the farm.

MANAGEMENT OF BEEF CATTLE MANURE IN THE SUPPLY CHAIN



Percentage breakdown of the methods used to manage the manure produced by beef cattle on farms that produce head destined for the COOP[22] chain. This figure is representative of about 125,000 animals, equal to about 2% of cattle raised in our country (5.7 million cattle reared in 2014, with a decrease of about 8% compared to 2005, ISTAT-SIEV[23] data).

 ISBN 9788891793324

Intensive farms need to resort to the availability of agricultural land to transport the manure to areas with lower livestock density. The transport of manure is rather complex, but technological innovation has allowed us to develop various processes to make it economically sustainable, such as, for example, the drying of digestates, using the heat obtained from the combustion of the biogas produced by anaerobic digestion.

The treatment of manure: from problem to resource

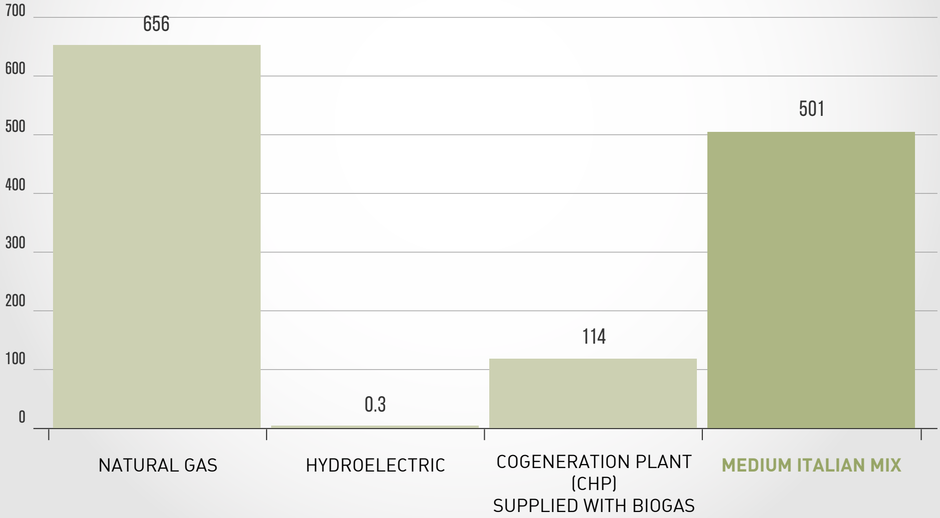
The treatment systems of manure are generally aimed at the concentration of nutrients (nitrogen and phosphorus), so as to make it easy to transport as well as its use by farmers, in the case of products such as soil improvers or dung. One of the best known processes is composting which, by means of a controlled process of aerobic degradation, makes it possible to transform the material (usually manure or pollen) into soil improver. The process is done by mixing different types of organic material, to provide micro-organisms engaged in the biological process with a constant substrate: the manure can therefore be mixed with sewage sludge, cuttings and organic waste deriving from separate collections. It is also interesting the case of the pollen which, when dried, can become an excellent fertiliser used also in organic productions. Among all the processes, however, one of the most noteworthy **is that of anaerobic digestion which, in addition to the treatment of manure, also allows energy production from non-fossil sources**. In fact, the process generates biogas, a mixture of CH_4 and CO_2 originating from anaerobic degradation processes of mixtures of organic compounds (manure, plant remains, whey, etc.). In this case the biological process is rather delicate: the treated material must be sufficiently balanced between dry materials (manure, food waste, vegetable residues) and wet (sewage, whey, blood, etc.), and a very well organised management of the plants is necessary.

	DAIRY COWS	BEEF CATTLE	POULTRY MEAT	PORK
Total Solids (ST) [kg]	12	8.5	22	11
Volatile Solids (SV) [kg]	10	7.2	17	8.5
TKN[24] [kg]	0.45	0.34	1.1	0.52
NH_3N [kg]	0.079	0.086	NP	0.29
P [kg]	0.094	0.092	0.3	0.18

Main characteristics of different types of manure - data referred to 1000 kg p.c.[25]
(Handbook of Agriculture, 1997 - chapter 6.7 "Management of animal waste" p. E-343 - HOEPLI ed.)

BIOGAS: A RENEWABLE SOURCE

When the farms are structured and of adequate size, the necessary investments for the construction of a biogas production plant are sustainable. The environmental advantage in energy conversion, if compared to traditional energy production, is relevant. The operations chosen for the comparison derive from the Ecoinvent[26] database.



Comparison of 1 kWh of electricity produced with different systems - g CO_2/kWh

THE NITRATE DIRECTIVES

The Nitrates Directive (91/676/EEC[27]) promotes the rationalisation of the use of nitrogen compounds in agriculture and provides that distributed fertilisers do not exceed the needs of crops, both for synthetic fertilisers which, in the case of organic matrices use, and for livestock manure.

Member States are obliged to:

- *identify the Nitrate Vulnerable Zones (NVZ) of agro-livestock origin, areas characterised by already contaminated waters or that could become such in the absence of adequate interventions. These measures must ensure that, for each agro-livestock farm, the average quantity of livestock manure distributed on the land, including that deposited by the animals themselves, does not exceed each year a contribution of 170 kg of nitrogen per hectare. The limit for non-vulnerable areas is 340 kg of nitrogen per hectare;*
- *define and apply specific Action Programs in the NVZ that regulate the agronomic use of livestock effluents and the use of mineral and organic fertilisers containing nitrogen.*

Member States may submit a request for derogation to the European Commission in the NVZ up to a maximum limit of 170 kg/ha/year of nitrogen from livestock effluents. This request must be supported by detailed agro-livestock and environmental information derived from previous and current monitoring data, which demonstrate how the increase in nitrogen quantities (generally up to 250 kg/ha/year) do not compromise the quality of the underground and superficial water.

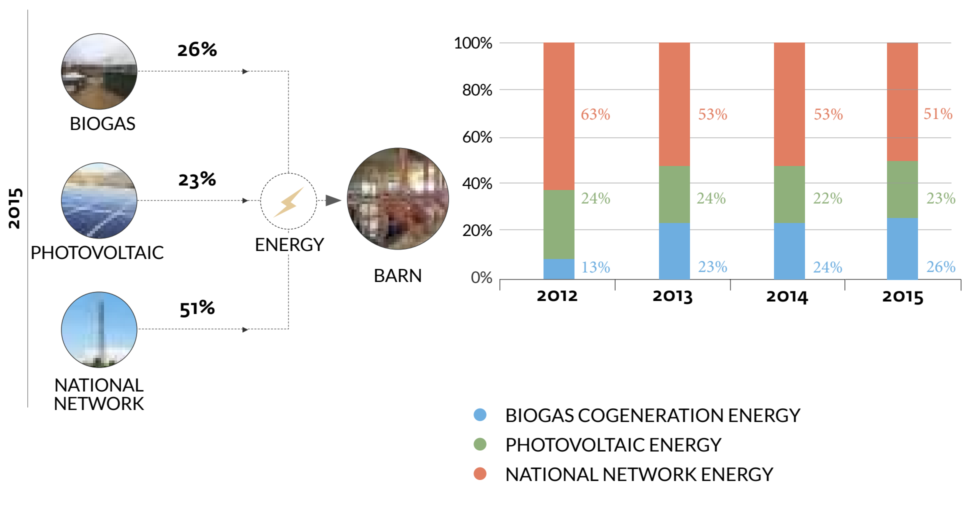
Energy consumption on farms

Energy consumption in livestock farms is due to the use of electricity for machinery and thermal energy to heat barns, food and water for washing. To reduce the impacts related to energy use, beyond the obvious practices of consumption containment, it is possible to use renewable energy production. In addition to the case of the biogas already mentioned, the large availability of space (think of the roofs of the breeding farm) permits the creation of interest for solar energy.

The improvement of the efficiency of solar panels, as well as their duration and the low maintenance need of the systems, have made some applications in the livestock/agricultural sector very interesting (for example on the roof of shelters, barns and sheds).

The main applications of the production of energy from solar sources are the exploitation for thermal uses and that for the production of electricity. These systems, as well as the production of biogas through anaerobic digestion, allow the reduction of direct energy consumption related to the breeding stage (which are usually modest).

The use of these systems is quite widespread, thanks also to the interventions of economic support made over the years by the Italian government. By way of example, the case presented is shown in the EPD of the COOP branded beef, which highlights the "virtual" energy mix used in the barns of the reference supply chain.



Medium energy mix used in Italian barns for the environmental declaration of COOP branded adult bovine meat[28].

Water consumption in breeding farms

The water consumption on breeding farms is largely influenced by the use of water for washing: the **reduction of waste** passes through procedures that prevent the generation of dirt.
Another consumer item is the one linked to drinking troughs, whose volumes depend on many factors such as health status, microclimatic conditions, type of feed and drinking system. Also in this case the technology can limit consumption, allowing the minimisation of waste without affecting animal welfare.

1.5 Slaughter and transformation

The "industrial" phase in the meat supply chain **starts at slaughter and ends with the creation of products** that are placed on the market. As with all processes, the environmental aspects relate to the use of energy and water, as well as the generation of waste.
It should however be noted that in the whole life cycle of foodstuffs the processing part is the **least problematic** from an environmental point of view, both because the impacts are quantitatively smaller than in the other phases, and because they are concentrated in a few points with high technological concentration, which makes it possible to maximise efficiency: consumption reduction and better waste management are in fact first of all a prerogative to reduce costs.

Waste or by-products?

The transformation of meat involves the generation of a large quantity of products that, although **not intended for human consumption, are a secondary resource very useful for other processes.** The management of this waste is quite complex, because it is necessary to distinguish between by-products, co-products and waste, in a context where legislation is rather attentive in avoiding practices that pose a risk to human health.

The by-products are in fact divided into 3 families[29]:

- category 1 (parts of regularly slaughtered cattle such as skull, entrails or carcasses of sick animals, etc.), intended for incineration;
- category 2, which includes manure, stomach contents of ruminants or dead animals in general;
- category 3, which includes materials with characteristics that would also make them suitable for human consumption (e.g. fat or bone), but are intended for other uses (such as production of pet food).

Without prejudice to compliance with the legislation and focusing attention on by-products destined for a second use in other productive systems, the industry is trying to exploit as much as possible the research and innovation achieved in the scientific field to give **added value to the by-products of animal origin**, going well beyond the usual profitability. In fact, there are many possible uses: human or animal food, feed, pharmaceuticals, fertilisers and by-products to generate biodiesel[30].

It should also be remembered that the organic material that cannot be recovered in other productions can be sent to **anaerobic digestion** for the production of biogas, and therefore of renewable energy, with the environmental and economic advantages already discussed previously in the part concerning the treatment of manure.

1.6 Distribution

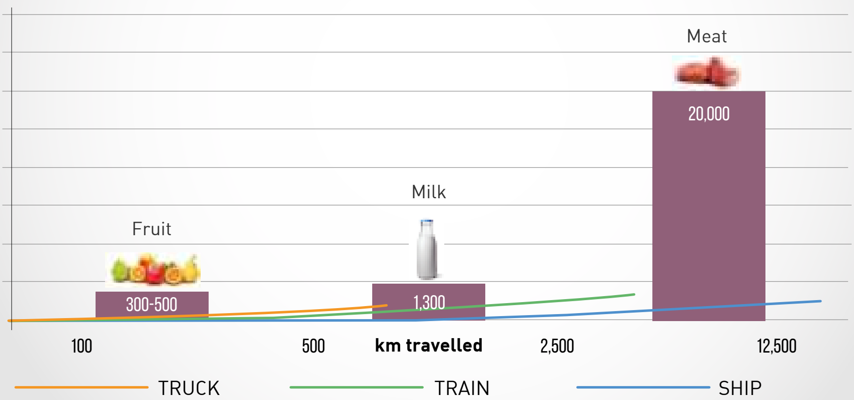
The life cycle analysis approach allows processes to be examined with a complete logical system, sometimes leading to non-intuitive results and considerations. One of these are, for example, the 0 km products which are considered "sustainable" from an environmental point of view, intended as those which travel the least kilometres possible, from the place of production to the point of sale and consumption.

The basic idea would be to reduce the environmental impact that the transport of a product entails, for example by reducing carbon dioxide emissions. **It is not obvious, however, that consuming local products entails a reduction of the total CO_2 emissions of the food, as it is quite simple to show that transport has an almost irrelevant impact on the overall cycle.** Comparing the impact on production and distribution of different agri-food products, it is clear that transport is relevant only for those characterised by a "simple" supply chain, such as fruit and vegetables. In the case of more complex products, such as meat or cheese, the environmental burden associated with distribution is almost as irrelevant, considering the impacts of the entire supply chain. For complex supply chains it is therefore much more important to focus on efficient processes with little impact, rather than on "neighbouring" products.
The advantage of "0 km" comes from other points of view, such as the promotion of the regional agri-food heritage and the drive to rediscover territorial and cultural identity.

CARBON FOOTPRINT

grams of CO_2 per kg

Transport by truck, train or ship: CO_2 eq emissions related to the transport phase are always very low compared to those related to the production phase, except for fruit where long distance transportation (5 or 10,000 km) can have a relevant impact on the total.



Source: Marino M., Pratesi C.A. "The Perfect Food", 2015

CAN COWS CAUSE MORE CLIMATE CHANGE THAN CARS?

*edited by Frédéric Leroy**

Can cows cause more climate change than cars? How can this be possible? When comparing direct emissions, the global output of livestock is much below the one of transportation.

*In 2006, the FAO stated that livestock represents a larger issue than transportation with respect to climate change, leading to 18% versus 14% of the **greenhouse gas (GHG) emissions**. This news aroused incredulity and perplexity, and in fact, many objections were coming from experts in the field. A trenchant critique was given by prof. Frank Mitloehner (UC Davis, USA), protesting against the unfair use of LCA data for livestock but not for transportation, so that a direct comparison was not justified. This was a pertinent remark, acknowledged by a representative of the FAO in 2010. When comparing direct emissions instead (due to the lack of a common LCA framework), the calculated global output of livestock is even much below the one of transportation (5% versus 14%). Moreover, in its "**Tackling climate change through livestock**" report from 2013, the FAO modified its LCA-based estimate of 18% for livestock to 14.5% based on an improved methodology using the GLEAM framework (corresponding with 7.1 out of 49 gigatons CO_2-eq/y).*

In other words, the cows-are-worse-than-cars slogan was shown to be a fiction. Yet, anti-meat militants are not very eager to update their credo and keep on parroting the same line over and over again. Within livestock's overall 14.5% contribution, most of the blame goes to cattle. Beef and milk are said to be responsible for 41% and 20% of the emissions, respectively. Enteric methane fermentation and animal feed have been identified as the largest causes, whereas the rest has been ascribed to other factors such as manure decay. Enteric fermentation by ruminants indeed generates substantial amounts of methane (which is mostly belched by the cows, so it is not even about the "farts" in the first place). The latter correspond to some 29% of the total anthropogenic methane emissions worldwide. Methane receives a lot of attention because it is known to be a more potent GHG than carbon dioxide (28x), but not so potent as nitrous oxide (265x). Because of its potency, methane is said to be responsible for about 16% of the total GHG emissions, when expressed as CO_2-eq. However, whereas methane emissions increased massively during the post-industrial era, they are now levelling off, in contrast to the ever-increasing CO_2 levels.

Globally, the calculated total emissions of methane are almost in tune with the total sinks, where it not for the fact that calculations have been underassessing the massive methane emission leaks from the oil and gas supply chain, according to a recent study published in Science (Alvarez et al. 2018). It is of primordial importance to point out that methane has a short lifetime and can thus still be mitigated, while the more worrying effect is related to CO_2, which is out of control.

The conventional metric viewing methane as many times more harmful than CO_2 is misleading, not in the least because the kinetics of at-

 ISBN 9788891793324

mospheric stabilisation are very different. Stabilisation of methane can be obtained by a drop of 30%, whereas CO_2 can only be stabilized upon a massive reduction (80%), whereby the lifetime of the former is in the order of 10 years and that of the latter of hundreds of years. Nonetheless, cows are usually taking most of the blame. Traffic, interestingly, seems to get away with it, although the latter largely drives CO_2 levels and has been increasing spectacularly over the last decades. And what is worse: traffic's impact on CO_2 levels is expected to upsurge in the coming years, as both air and land traffic will continue to develop, especially in emerging countries.
Not only do methane emissions have to be put in perspective, analysis should also take into account regional variability. In the US, for instance, direct emissions by livestock have been estimated at 4% by EPA, far below the impact on GHGs by ***transportation (28%), electricity (28%), or industry (22%)***. Taken ad absurdum, an elimination of all US livestock would only result in a 2.6% reduction in the country's GHG emissions, corresponding to a global difference of only 0.4%. Furthermore, the presence of large amounts of ruminants on US territory is not even a recent phenomenon. Far from that: over 60 million bison must have been roaming the North-American plains before the 19th century. Today's cattle produce more GHGs than the native bison but maybe not all that much.

It is worth mentioning that the US also harbours a ***massive population of pets, which rely on feed that creates an environmental impact equalling 25-30% of that of animal production***. Understandably, almost nobody dares to put the latter sensitive issue on the table when arguing for a drastic reduction in meat consumption. Neither is it being stated that going vegetarian in an industrialized country will not cut your GHG emissions all that much: not the often-promised 50% but more likely 4% (or even only 2% as "rebound" effects need to be accounted for as well).

Things become even more problematic for anti-meat campaigners when GHG emissions are expressed on a basis of essential amino acids instead of weight (which is a common but meaningless metric) or energy density (which overlooks nutritional quality). Not only would the impact of crops such as rice and cauliflower then exceed the one of beef, even the production of peas would become more emissive than the one of pork or chicken. Nutrient density matters – which is conveniently ignored – and animal products are by far the most nutrient-dense and nutrient-complete foods in the human omnivorous dietary spectrum. So why is that rice is never blamed for damaging the environment, notwithstanding the fact that its nutritional value is very low in comparison to meat and its cultivation is a main driver of methane emissions too (10% of the global anthropogenic methane production)?

Although industrialized countries have been effectively reducing their methane output from cattle during the last decades, developing countries have been witnessing an increase. A 30% reduction can nevertheless be achieved globally if all producers would adopt the practices used by the 25% most efficient ones. Several options are available, from the use of feed additives to regenerative grazing. Interestingly, the latter may even create a net emissions sink, by drawing more carbon into the soil than the methane produced by the cows. Optimized deployment and management of ruminant herds may thus not only contribute to a more sustainable food system based on the principle of soil carbon sequestration, but also by facilitating the provision of ecosystem services. In line with the vision of the FAO, policy makers need to acknowledge that "the livestock sector should be part of any solu-

tion to climate change" (my emphasis), highlighting the global importance of animal husbandry, contributes to the livelihoods of innumerable rural farmers, and has the potential to increase educational attainment and to reduce gender inequalities in developing countries.

Although livestock indisputably contributes to the emission of greenhouse gasses into the earth's atmosphere, it is unfair to depict this longstanding fundament of human civilization as the main cause for climate deterioration. A single return flight from Rome to Brussels generates much ***higher emissions than the annual consumption of meat and cold cuts of a single person****, so can we just blame prosciutto while organising our next city trip? The real problem we need to face is an unpopular one: hyperconsumerism and an unbridled exploitation of fossil fuels. Burning of the latter is brutally releasing enormous amounts of carbon – that had been sequestered for millions of years – into the atmosphere at a yet unseen rate. Instead, animal products are now used as a convenient scapegoat, rather than as respected contributors to healthy and sustainable diets, whilst the root causes of climate change remain mainly unaddressed.*
In the meanwhile, ***multinationals and venture capital funds have discovered the gold mine of the "plant-based" hype****, which mostly translates into abominable imitations of meat and dairy products. Easy profit is generated through the ultraprocessing of cheap ingredients (protein isolates, starch, and oil), generated from biodiversity-obliterating monocultures through the application of fossil fuel-derived fertilizers and by depleting valuable topsoil. For now, the public anti-livestock narrative needs to be maintained, so have decided the powers that be.*

Let me be clear: it is our moral obligation to address any food production system that has detrimental effects on the environment. That is true for certain livestock systems, as well as for certain crops, of which some are particularly devastating indeed (cf. the cultivation of avocados in Mexico and the greenhouse apocalypse in Almeria). ***Distorting the data for ideological purposes is scientifically dishonest and socially irresponsible****. More importantly, rather than focusing on sustainable diets as such, we urgently need shift the attention to lifestyles. Unfortunately, the growing influence of ideological agendas, the perverting interventions by vested interests, and the contemporary post-truth environment do not make the debate any easier.*

Source: http://carnisostenibili.it/en/can-cows-cause-more-climate-change-than-cars/

** After having studied Bio-engineering Sciences at Ghent University (1992-1997), prof. Leroy obtained a PhD in Applied Biological Sciences at the Vrije Universiteit Brussel in 2002, where he continued his academic career at the research group of Industrial Microbiology and Food Biotechnology (IMDO) as a post-doctoral fellow of the Research Foundation Flanders (FWO). Since 2008, he holds a professorship in the field of food science and (bio)technology.*
His research primarily deals with the many ecological aspects and functional roles of bacterial communities in (fermented) foods, with a focus on animal products. In addition, his interests relate to human and animal health and wellbeing, as well as to elements of tradition and innovation in food contexts.

 ISBN 9788891793324

2 HOW TO CALCULATE THE ENVIRONMENTAL SUSTAINABILITY OF FOOD[31]

When we talk about sustainability, very often we tend to deal mainly with the environmental issue. However, it is clear that when we talk about food, and especially about what derives from animal production, the analysis must be complete and must also include other aspects, as is being undertaken with this report.
Remaining still in the environmental field, it is important to clarify some aspects of methodology to avoid the indicators being used in an inconsistent way relative to their purpose, reaching results and conclusions that are not completely correct.
A little study on some of these aspects can be useful, referring to specific texts for further information.

2.1 Are impacts all the same? The importance of the context

Very often within the term "environmental impact" two phenomena are confused which, in fact, are clearly distinct: it would be more correct to divide between environmental aspects and impacts. **An environmental aspect is any interaction between a human activity** (for example a production process) **and the environment, while the environmental impact is the alteration (positive or negative) that the environment undergoes**[32]. The introduction of pollutants into a river is an environmental aspect, but the damage to aquatic organisms caused by the substances released is an environmental impact. The difference between cause and effect may seem to be a purely academic distinction, but in reality it is very useful to describe the next concepts better. In particular, it should be stressed that the relationship between environmental aspects and impacts is not always obvious and can be influenced by different issues.

One is **time**: under certain conditions, the environment has the ability to dispose of the effects of pollution immediately and to return (almost) to its initial state. However, this natural phenomenon has limits: when the environmental aspects are excessive and too pressing, the ability of "self-repair" comes less and the environmental impact manifests itself[33]. Almost like when alcohol is consumed: this does not create problems if the doses and frequencies of consumption are such as to allow the body to eliminate this form of "pollution". When consumption is instead exaggerated (as in the case of environmental aspects that are too frequent or too large), then you get drunk (high impact) and sometimes the damage is irreversible.
Then there is the **context**, i.e. the local conditions in which the environmental aspects are manifested, which is fundamental for the quantification of the damage (impacts) generated: if a production process is characterised by repeated emission of 10 grams of pollutant in water, the relative impact will be very different if this happens in a small mountain lake or in the middle of the Atlantic Ocean.
Other phenomena that influence the dif-

ference between aspects and impacts are the **chemical-physical and biological mechanisms** that occur in the environment following the release of a pollutant. This is the case of fertilisers for example: once nitrogen is supplied to the soil through their use, the biochemical reactions of the soil lead to the formation and release of nitrous oxide (N_2O) into the air, which has a far greater impact than the initial nitrogen fertiliser.

2.2 Local and global impacts

An additional variable to consider is the distance between the appearance of the environmental aspect and the damage generated.
If, for example, the machinery of a large production plant generates noise in places very distant from each other, the environmental aspects (therefore the noise) will not add up and every machine will

GLOBAL AND LOCAL IMPACTS
CAUSE OR EFFECT

"THE ENVIRONMENTAL ASPECT IS THE CAUSE, THE ENVIRONMENTAL IMPACT IS THE EFFECT (THE DAMAGE)"