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COMMITTEE ON FISHERIES

SUB-COMMITTEE ON AQUACULTURE

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SPECIAL EVENT ON "CONTRIBUTION OF AQUACULTURE TO FOOD AND NUTRITION SECURITY, POVERTY ALLEVIATION AND NATIONAL ECONOMIES: EVIDENCE-BASED EXPERIENCES"

SUMMARY

For the last three decades, aquaculture continued growing at a pace exceeding that of other terrestrial food production sectors, contributing, to varying degrees, to food and nutrition security, poverty alleviation and national economies globally. This paper aims at setting the scene for sharing evidence-based national experiences as to the importance and enabling factors of this performance. It argues that aquaculture is poised to maintain its journey to further growth through intensification, species diversification, and expansion into new inland and marine waters and by way of introduction of innovative, more resource-efficient technologies. Further growth will require the sector to overcome various obstacles associated with land, water, feed, seed supply and genetic resources, environmental integrity and diseases, development and adoption of new and improved farming technologies, market, trade and food safety, climate change and investment capital. Well-advised policies and strategies backed by strong research programmes will be of a paramount importance in defeating these barriers, but national, regional and global information and knowledge sharing also will be critical.

The Sub-Committee is invited to:

- Review this paper and provide comments as appropriate;
- Share national experiences as to how aquaculture contributed to food and nutrition security, poverty alleviation and national economies;
- Reflect on ways and means that could be used to enhance the contribution of aquaculture to food and nutrition security, poverty alleviation and national economies;
- Advise the Secretariat on any potential work, which could be undertaken, if at all, with the purpose of increasing the contribution of aquaculture to national, regional and global food and nutrition security, poverty alleviation and economies.

INTRODUCTION AND RATIONALE

1. The contribution of aquaculture to humanity's well-being could be understood as its participation to covering our food and nutrition needs and wants, alleviating poverty and national economic growth.

2. Precise data to quantify the extent of this contribution are lacking. However, the growth in volume and value of the world aquaculture production, and the subsequent increase in per-capita fish consumption experienced in the recent past suggest[1] that aquaculture has made a positive contribution to food and nutrition security, poverty alleviation and economic growth globally[2].

3. Whatever their magnitude, the rapid growth of aquaculture and its subsequent contribution to societal well-being over the past three decades have not been homogeneous worldwide. They have varied across regions, within regions and countries. A range of factors, including natural resource endowment, technological and information development, culture and traditions, population and economic growth, and governance including policy and regulatory regimes, may explain this geographic differential in the sector's expansion.

4. The purpose of this paper is to set the scene for the exchange, in this meeting, of evidence-based national and regional experiences as to how aquaculture affected food and nutrition security, poverty alleviation and economic growth at home.

AQUACULTURE AND FOOD AND NUTRITION SECURITY

5. The concept of food and nutrition security as is known today has evolved extensively over the years. A milestone of this evolution is the 1996 World Food Summit (WFS), which concluded that: "Food security exists when all people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Another striking example is the **2009 World Food Summit**. Like the 1996 World Food Summit's, the food security definition of the 2009 World Food Summit has been identified with the **four pillars of food security**, namely **availability, access, utilisation and stability**[3].

[1] In 2013, global aquaculture production was valued at US$150.3 billion compared to US$9.6 billion in 1984. Similarly, in 2012, global per-capita fish consumption was 19.2 kg compared to 11.5 kg in 1980.
[2] FAO Fisheries and Aquaculture Department. 2011. *World aquaculture 2010*. FAO Fisheries and Aquaculture Department. Technical Paper. No. 500/1. Rome, FAO. 105 pp.
[3] Committee on World Food Security. 2012. Coming to Terms with Food Security, Nutrition Security, Food Security and Nutrition, Food and Nutrition Security (available at www.fao.org/docrep/meeting/026/MD776E.pdf.

Food availability

6. **Availability of food** addresses the "supply side" of food security in terms of food quantity and quality. It is determined by the level of **food production, stock levels** and net **trade**[4].

7. In many cases, cultured fish are not consumed at its production site. Nor is aquaculture practices in all regions in a given country; aquaculture cannot be done everywhere. Within countries, fish from aquaculture is often transported from farm sites, stored and distributed to consumers in different non-fish farming, non-fish producing locations or locations where fish supplies are short. Fish stocked there add to food availability.

8. Food production is not a necessary condition for a country to achieve food security; most food items are easily **tradable** commodities. What is most important is for the non-food producing country to have enough financial resources to import sufficient quantities of quality food items needed to feed all its citizens. In 2012, 58 million tonnes of fish were exported for a value of US$129.2 billion[5]. However, because of the non-disaggregation of fish from the capture and fish from aquaculture in international trade statistics, the quantity (and value) of internationally traded aquaculture fish is not well known[6].

9. Nevertheless, the importance of aquaculture in fish production (43.1 percent of fish produced in 2013) and the fact that global seafood trade continues to grow despite wild harvests stagnating are a strong indication that a substantial part of aquaculture is trade-driven[7]. It is safe to say that aquaculture plays an important role in fish trade, thereby contributing to fish availability worldwide, be it in importing or exporting countries.

10. Export of farmed fish and other products from aquaculture provides exporting countries with foreign exchange earnings that can be used to import not only fish[8], but also other non-fish food items. Food imports can be vital in many countries, including in sub-Saharan Africa and Latin American whose domestic food production often does not keep up with domestic population growth[9]. The contribution of aquaculture to food quantity includes, therefore, its direct fish and fish products supply to domestic markets, and food items purchased through foreign-exchange earnings from aquaculture.

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[4] FAO. 2008. Food security information for action practical guides, an introduction to the basic concepts of food security. Rome (available at www.fao.org/docrep/013/al936e/al936e00.pdf.

[5] FAO. 2014. *The State of World Fisheries and Aquaculture 2014*. Rome, FAO.

[6] Fisheries and Aquaculture topics. International trade in aquaculture products. Topics Fact Sheets. Text by Audun Lem. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 27 May 2005. [Cited 6 May 2015]. http://www.fao.org/fishery/topic/14884/en

[7] Asche, F. 2015. *Aquaculture: Opportunities and Challenges.* E15Initiative. Geneva: International Centre for Trade and Sustainable Development (ICTSD) and World Economic Forum, 2015 (available at www.e15initiative.org).

[8] Countries may export high-value fish such as shrimp and grouper, and import low-value fish including anchovies or vice versa.

[9] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58pp.

Food access

11. While availability of food addresses the supply side of food and nutrition security, **access to food** (and food utilisation) deals with its demand side. In many instances, the causes of hunger and malnutrition are not a scarcity of food, but an inability of consumers to access the available food. **Access to food** refers, therefore, to food affordability and allocation, and preferences of individuals and households[10]. Economic, physical and social factors are the mainstays of access to food[11].

12. **Economic access** to food refers to affordability of food. Affordability of food implies the individuals and households' financial ability to acquire food12. In turn, individuals and households' financial ability to acquire food depends on food prices and on whether they have enough income to purchase the food at the prevailing prices13. This income may be own or provided through social support, or a combination of both.

13. **Economic access** to food occurs, therefore, when individuals and households generate sufficient disposable income to buy food and nations generate foreign exchange to pay for food imports[14] [15] when needed.

14. By supplying aquatic food products to local markets, aquaculture puts a downward pressure on these products, thereby making them accessible to individuals and households. Likewise, aquaculture also contributes to food access by providing individuals and households with jobs and incomes[16], and by generating export earnings with which diverse food items can be imported, allowing

[10] Gregory, P. J., Ingram, J. S. I. and Brklacich, M. 2005. Climate change and food security. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360 (1463): 2139–2148.
[11] There are also legal and political factors. Because legal and political factors affect economic, physical and social dimensions of access to food, it is acceptable to maintain that access to food is mainly determined by economic, physical and social factors.
[12] WFP. 2009. Comprehensive Food Security & Vulnerability Analysis Guidelines. First Edition. Rome: World Food Programme. in: FAO Statistics Division. 2014. *Selecting a core set of indicators for monitoring global food security a methodological Proposal.* Working Paper Series ESS / 14-06 (available at http://www.fao.org/3/a-i4095e.pdf).
[13] Garrett, J & Ruel, M.1999. Are Determinants of Rural and Urban Food Security and Nutritional Status Different? Some Insights from Mozambique. Washington, D.C.: International Food Policy Research Institute.
[14] Sigot, A.J. 1998. *Food Security in sub-Saharan Africa: the role of governmental and non-governmental organisations*. HUGG International Symposium, Durban, South Africa. *As cited in* Cunningham, L. 2005. Assessing the contribution of aquaculture to food security: a survey of methodologies. FAO Fisheries Circular. No. 1010. Rome, FAO. 25pp.
[15] Williams, M.J. 1999. The role of fisheries and aquaculture in the future supply of animal protein. *Sustainable Aquaculture: food for the future?* (eds N. Svennevig, H. Reinertsen & M. New), pp 5-18. Balkerma, Rotterdam. *As cited in* Cunningham, L. 2005. Assessing the contribution of aquaculture to food security: a survey of methodologies. FAO Fisheries Circular. No. 1010. Rome, FAO. 25pp.
[16] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p

individuals and households to access them[17]. There is also evidence that commercialization of farmed fish contributes to improved households' purchasing power and higher overall food consumption[18].

15. **Physical access** to food depends on the availability and quality of infrastructure such as ports, roads, railways, communication and food storage facilities and other installations that facilitate the functioning of markets. Incomes earned in agriculture, forests, fisheries and aquaculture play a primary role in determining food security outcomes[19].

16. **Social access** to food exists when each individual has an assured ability to "acquire and consume acceptable foods in socially acceptable ways". That is, without resorting, for example, to emergency food supplies, scavenging, stealing, or other coping strategies[20] [21].

17. By providing incomes and a protein-and-mineral rich food all year long, aquaculture can help individual's access food and meet their nutritional requirements in dignity.

Food utilization

18. As important as food availability and food access is **food utilization**. Food utilization addresses the nutrition aspect of food and **nutrition security**. Nutrition security is interested in food consumption and in how the food consumed is utilized by the body to make the most of various nutrients in the food"[22]. It combines having access to ***nutritious* diet**, i.e. to adequate food that fully satisfies nutritional needs, with non-food factors that enable a person to metabolize their food and use the nutrients to support growth and maintenance of the body and to carryout basic life functions[23] [24].

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[17] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p

[18] FAO Committee on Fisheries Sub-Committee on Aquaculture. 2013. The role of aquaculture in improving nutrition: opportunities and challenges, Seventh Session, St. Petersburg, Russian Federation, 7-11 October 2013 (available at www.fao.org/cofi/30795-073768ef889213e5bbe595157c65066b.pdf).

[19] FAO. 2013. *Measuring different dimensions of food security*. The State of Food Insecurity in the World.

[20] USDA (United States Department of Agriculture). Food Security: Definition & General Information (available at http://www.disabled-world.com/fitness/nutrition/foodsecurity). Accessed on 18 May 2015 at 23:00.

[21] WFP. 2009. Comprehensive Food Security & Vulnerability Analysis Guidelines. First Edition. Rome: World Food Programme. *In* FAO Statistics Division. 2014. *Selecting a core set of indicators for monitoring global food security a methodological Proposal.* Working Paper Series ESS / 14-06 (available at http://www.fao.org/3/a-i4095e.pdf)

[22] FAO. 2008. Food security information for action practical guides, an introduction to the basic concepts of food security. Rome (available at www.fao.org/docrep/013/al936e/al936e00.pdf.

[23] FAO. 2006. Food Security. Policy Brief, Issue 2, June 2006 (available at www.fao.org/forestry/13128-0e6f36f27e0091055bec28ebe830f46b3.pdf

[24] Committee on World Food Security. 2012. Coming to Terms with Food Security, Nutrition Security, Food Security and Nutrition, Food and Nutrition Security (available at www.fao.org/docrep/meeting/026/MD776E.pdf.

19. In terms of ***nutritious*** **diet**, there is overwhelming evidence that, compared to other foods, fish, including fish from aquaculture, is an important source of essential micronutrients (vitamins D and B in particular), and minerals such as calcium, phosphorus, iodine, zinc, iron and selenium[25] [26] [27]. Lipid-rich fish also contain vitamin A.

20. The potential contribution that fish (even in small quantity) can offer to address multiple micronutrient deficiencies, such as phosphorous deficiency in Low-Income Food-Deficit Countries (LIFDCs) or B-vitamins deficiency, is increasingly recognized by the scientific community[28] [29] [30]. A portion of 150 g of fish provides about 50 to 60 percent of the daily protein requirements for an adult[31].

21. Evidence also shows that the consumption of two or more servings of seafood per week is associated with a lower prevalence of heart disease. Other health benefits of seafood include lowering blood pressure, possible improvement of symptoms of rheumatoid arthritis, improvement of eczema because of fish omega-3s and decreased incidence of depression (Seafood and Health Alliance, 2008)[32].

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[25] Roos, N., Islam, Md. M. & Thilsted, S.H. 2003. Small indigenous fish species in Bangladesh: contribution to vitamin A, calcium and iron intakes. Journal of Nutrition, 133: 4021S–40126S. *As cited in* HLPE, 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.

[26] Roos, N., Chamnan, C., Loeung, D., Jakobsen, J., & Thilsted, S.H. 2007. Freshwater fish as a dietary source of vitamin A in Cambodia. *Food Chem.*, 103(4): 1104-1111. *As cited in* HLPE, 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.

[27] Bonham, M.P., Duffy, E.M., Robson, P.J., Wallace, J.M., Myers, G.J., Davidson, P.W., Clarkson, T.W., Shamlaye, C.F., Strain, J.J. & Livingstone, M.B. 2009. Contribution of fish to intakes of micronutrients important for foetal development: a dietary survey of pregnant women in the Republic of Seychelles. *Public Health Nutrition*, 12(09):1312–1320. *As cited in* HLPE, 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.

[28] Roos, N., Thorseng, H., Chamnan, C., Larsen, T., Holmboe Gondolf, U., Bukhave, K. & Thilsted, S.H. 2007. Iron content in common Cambodian fish species: Perspectives for dietary iron intake in poor, rural households. *Food Chem.*, 104(3): 1226–1235. *As cited in* HLPE, 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.

[29] Kawarazuka, N. & Béné, C. 2011. The potential role of small fish species in improving micronutrient deficiencies in developing countries: building evidence. *Public Health Nutrition*, 14(11): 1927–1938. *As cited in* HLPE, 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.

[30] Thilsted, S.H. 2012. The potential of nutrient-rich small fish species in aquaculture to improve human nutrition and health. *In* R.P. Subasinghe, J.R. Arthur, D.M. Bartley, S.S. De Silva, M. Halwart, N. Hishamunda, C.V. Mohan & P. Sorgeloos, eds. *Farming the waters for people and food*, pp. 57–73. Proceedings of the Global Conference on Aquaculture 2010. Phuket, Thailand. 22–25 September 2010. Rome, FAO, and Bangkok, NACA.

[31] FAO. 2014. *The State of World Fisheries and Aquaculture 2014*. Rome, FAO. *As cited in* HLPE, 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.

[32] Seafood and Health Alliance. 2008. Seafood & health studies (available at www.seafoodandhealth.org). *As cited in* Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p

22. This is particularly important for developing countries where good proportions of the populations depend on fish as part of their daily diet or fish is staple food. In some of these countries, especially in Small Island Developing States, fish contributes or exceeds 50 percent of total animal protein intake. In Low-Income Food-Deficit Countries, fish accounted for about 24.1 percent of animal protein intake in 2011, compared to 11.8 percent in developed countries and 16.7 percent globally. Globally, fish also provided 6.5 percent of all protein consumed[33], with aquaculture contributing 49 percent[34].

Food stability

23. One of the conditions for a population, household or individual to be food and nutrition secure is for them to have access to and consume adequate food **at all times**. They should not risk losing access to food as a consequence of sudden shocks or cyclical events[35]. Hence, **food stability** refers to a population, household or individual's ability to obtain food **over time, at all times**[36].

24. In line with the concept of food and nutrition security, food stability includes both the availability and access dimensions of food and nutrition security; food (and nutrition) security can be transitory, seasonal, or chronic. In **transitory** food (and nutrition) insecurity, food may be unavailable or inaccessible during certain periods of time.

25. Events such as natural disasters, droughts, political instability and civil conflicts can negatively affect food production, and hence, availability, and decrease access to food even if it was available. Instability in markets resulting in food-price spikes can limit access to food, causing transitory food insecurity. Loss of employment or productivity can also lead to temporary access to food cause food and nutrition insecurity[37] [38]. By providing diversified aquatic products, aquaculture can increase the stability of domestic food supplies, thereby increasing the country's resilience to transitory shocks that have negative impacts on food and nutrition security. Moreover, stable aquaculture production will help secure the incomes and jobs of its employees and hence increase the resistance of their households against transitory food and nutrition insecurity[39].

[33] FAO. 2014. The State of World Fisheries and Aquaculture 2014. Rome, FAO.
[34] With an apparent per-capita fish consumption of 19.2 kg, in 2012, aquaculture contributed about 49 percent of the fishery output for human consumption. Source: FAO. 2014. *The State of World Fisheries and Aquaculture 2014*. Rome, FAO.
[35] FAO. 2006. Food Security. Policy Brief, Issue 2, June 2006 (available at www.fao.org/forestry/13128-0e6f36f27e0091055bec28ebe830f46b3.pdf
[36] FAO. 2008. Food security information for action practical guides, an introduction to the basic concepts of food security. Rome, FAO (available at www.fao.org/docrep/013/al936e/al936e00.pdf).
[37] Ecker and Breisinger (2012). The Food Security System (PDF). Washington, D.D.: International Food Policy Research Institute. pp. 1–14.
[38] FAO (1997). "The food system and factors affecting household food security and nutrition". Agriculture, food and nutrition for Africa: a resource book for teachers of agriculture. Rome: Agriculture and Consumer Protection Department. Retrieved 15 October 2013.
[39] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p.

AQUACULTURE AND POVERTY ALLEVIATION

26. Poverty is a multi-dimensional concept that experts summarise as poor living conditions. Some of its many symptoms include inadequate access to food, nutrition, housing, health and education, while its immediate cause is the lack of **real, financial** and other **resources**[40] [41]. Alleviating poverty requires enabling the poor to access these resources.

27. By making it possible for small-scale producers to acquire sales **income** from their produce, large-scale farmers and corporations to create **employment** and pay **wages and salaries** to non-aquafarming, resource-poor and sometimes landless individuals, aquaculture enhances individuals and households' access to financial and other resources, thereby alleviating poverty. These resources can be used by households to purchase food, enhance nutritional and health status and/or access adequate housing and education services, hence, easing the symptoms of poverty.

28. Likewise, by enabling commercial farms to generate sizable profits, export-oriented farms to generate export revenues and governments to collect tax revenues from commercial farms, aquaculture brings in resources for investments in growth-stimulating, and, therefore, poverty-alleviating government programmes[42].

29. In aquaculture, **employment** occurs along all the value chains and includes full-time, part-time and occasional jobs.

30. At farm level, employment occurs in hatcheries, nurseries and grow-out facilities. At other stages along the value chains, aquaculture provides jobs in input supply industries such as feed and infrastructure construction materials, middle trade and domestic fish distribution, processing, exporting and marketing.

31. FAO estimates that, overall, in 2012, fisheries and aquaculture assured the livelihoods of 10 to 12 percent of the world's population, with 32 percent of them, or 18.9 million people were engaged in fish farming. More than 96 percent of those in fish farming are in Asia, followed by Africa (1.6 percent), and Latin America and the Caribbean (1.4 percent)[43]. The same source indicates that, at the global level, the number of people engaged in fish farming has, since 1990, increased at higher annual rates than that of those engaged in capture fisheries, indicating the growing role of aquaculture in sustaining people's livelihood.

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[40] Maxwell, Simon. 1996. Food Security: a Post-modern perspective. Food Policy, 21(2).
[41] Maxwell, S. 1999. The meaning and measurement of poverty, ODI Poverty Briefing No. 3, Overseas Development Institute, London.
[42] FAO Committee on Fisheries Sub-Committee on Aquaculture. 2006. *Improving the socio-economic impacts of aquaculture*, Third Session, New Delhi, India, 4-8 September 2006 (available at ftp://ftp.fao.org/docrep/fao/meeting/013/j7988e.pdf).
[43] FAO. 2014. The State of World Fisheries and Aquaculture 2014. Rome, FAO.

32. A recent case study on ten countries representing about 20 percent of the global aquaculture production estimated that total employment in global aquaculture value chains could be close to 38 million full-time equivalent jobs worldwide[44].

33. Moreover, some studies report cases where aquaculture has created wealth and decreased inequality in communities by reducing income disparities, in addition to indicating that the poorest households are often among those who proportionally benefit most from engaging in aquaculture[45]. In some countries, women have become entrepreneurs in fish processing, carrying out activities in their own cottage level industries. There are also a large number of women who work as wage labourers in the processing industry[46]. This process contributes to the nutritional security of households through the demonstrated influence that women have on the food security of the members of their households, especially children[47].

34. However, there are indications of a few cases where aquaculture development has adversely affected the poor and the socially marginalised. There, sometimes, common resources that are relied upon by socially marginalised groups such as tribal and landless people, and women for their livelihoods, were either privatised or handed over to aquaculture investors with exclusive access rights[48].

AQUACULTURE AND NATIONAL ECONOMIES

35. A country's total production or national income or gross national product (GDP), which represents the sum of all productions or incomes generated by the country's all economic sectors, is the basic measure of the performance of the country's economy. However, other indicators, such as employment, are also important[49].

36. The contribution of each economic sector, such as aquaculture, to these indicators can be direct or indirect. A **direct contribution** of a given sector to an economy represents the share of its own production to the economy. An economic sector can also **indirectly** contribute to economy through its impacts on other sectors to which it is linked.

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[44] HLPE, 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.
[45] Aquaculture for Food Security, Poverty Alleviation and Nutrition (AFSPAN). 2015. Final technical report (available at www.afspan.eu/publications/reports/afspan-final-technical-report-d8.2.pdf).
[46] FAO Fisheries and Aquaculture Department. 2011. *World aquaculture 2010*. FAO Fisheries and Aquaculture Department. Technical Paper. No. 500/1. Rome, FAO. 105 pp.
[47] FAO Committee on Fisheries Sub-Committee on Aquaculture. 2013. The role of aquaculture in improving nutrition: opportunities and challenges, Seventh Session, St. Petersburg, Russian Federation, 7-11 October 2013 (available at www.fao.org/cofi/30795-073768ef889213e5bbe595157c65066b.pdf
[48] Aquaculture for Food Security, Poverty Alleviation and Nutrition (AFSPAN). 2015. final technical report (available at www.afspan.eu/publications/reports/afspan-final-technical-report-d8.2.pdf
[49] Timmer, C. P., 1992, Agriculture and economic development revisited, Agricultural systems, no. 40, 27-58.

37. **Directly**, aquaculture generates business profits, creates jobs[50], pays labour incomes, including wages and salaries, and provides tax revenues. Business profits, wages, salaries and taxes all represent different types of income. They contribute to gross domestic products (GDP) [51].

38. Business profits, wages, salaries and taxes, which represent different levels of income, contribute to gross domestic products (GDP). Business profits from the sector also provide funds for investments in and outside the sector, and, hence, stimulate economic growth. So do savings from aquaculture employees. Tax revenues constitute a part of resources for growth-stimulating, poverty-alleviating and food security-improving government programmes[52].

39. Evidence indicates that, in many countries, aquaculture's contribution to total gross domestic product (GDP) is generally small. For example, a recent study on the value of African fisheries estimated that aquaculture accounted for 0.15 percent of all African countries' GDP while representing 0.96 percent of their total agriculture GDP[53]. Another study conducted in eleven countries of Latin America, Southeast Asia and Sub-Saharan Africa revealed that the contribution of aquaculture to national GDP, excluding multiplier effects, varied from negligible in countries with emerging aquaculture to 5 percent or more in countries where the sector is very dynamic[54].

40. However, in some cases, aquaculture's contribution to national income can be substantial, particularly in developing countries. Some reports suggest that, in many countries of the Asia–Pacific region, it is relatively high; sometimes reaching 16 percent of the national GDP and above 60 percent of the agriculture GDP [55].

41. **Indirectly**, for example and as discussed previously, business profits from aquaculture also provide funds for investments in and outside the sector, and, hence, stimulate economic growth. So do savings from aquaculture employees. Tax revenues constitute a part of resources used in government programmes geared towards fuelling growth, alleviating poverty and improving food security[56].

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[50] For more details, see discussion under "Aquaculture and poverty alleviation".

[51] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p.

[52] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework.* FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p.

[53] de Graaf, G. & Garibaldi, L. 2014. *The value of African fisheries*. FAO Fisheries and Aquaculture Circular. No. 1093. Rome, FAO. 76 pp.

[54] Aquaculture for Food Security, Poverty Alleviation and Nutrition (AFSPAN). 2015. Final technical report (available at www.afspan.eu/publications/reports/afspan-final-technical-report-d8.2.pdf).

[55] FAO Fisheries and Aquaculture Department. 2011. *World aquaculture 2010*. FAO Fisheries and Aquaculture Department. Technical Paper. No. 500/1. Rome, FAO. 105 pp.

[56] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p.

42. Furthermore, development in aquaculture will not only increase its own output, generate profits, create more jobs, and pay more wages, salaries and taxes, but also can stimulate output in other sectors.

43. Examples exist where, stimulated by consumers' tastes and preferences, catfish farming boomed and led to a proliferation of popular restaurants specialized in serving catfish products. These restaurants became big businesses, generating important profits and incomes, paying salaries, wages and taxes, hence, contributing to national economies. This restaurant industry's contribution to national economies would not have been possible without the development in catfish farming[57]. It represents the indirect contribution of catfish aquaculture to the national economy.

44. Numerous other examples exist whereby aquaculture has led to the establishment or consolidation of new industries such as feed, transport, cosmetic and candy industries[58].

OUTLOOK: MAIN ISSUES, CHALLENGES AND OPPORTUNITIES

45. The aquaculture's exceptional growth in the last three to four decades resulting in its important contribution to food and nutrition security, poverty alleviation and economic growth in many economies is unquestionable. However, much more is yet expected from the sector for many years to come.

46. There is a universal consensus amongst professionals that the sector will have to expand further if the world is to close the gap between its increasing demand for safe and quality fish and other aquatic foods and the supply of these products from the wild. Some experts predict that, for this purpose, aquaculture will have to produce about 93 million tonnes of fish and fishery products by 2030[59]. For aquaculture to grow to this extent, several ways will have to be explored; simultaneously. Some of these consist of ***expansion into new milieus such as reclaiming new inland areas and moving further offshore into marine areas, intensification***, species diversification, and introduction of more innovative and resource-efficient technologies[60 61].

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[57] Hishamunda, N.; Cai, J. & Leung, P. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security: assessment framework*. FAO Fisheries and Aquaculture Technical Paper. No. 512. Rome, FAO. 58p.

[58] Ridler, N. & Hishamunda, N. 2001. *Promotion of sustainable commercial aquaculture in sub-Saharan Africa. Volume 1. Policy framework*. FAO Fisheries Technical Paper. No. 408/1. Rome, FAO. 67pp.

[59] World Bank. 2013. *Fish to 2030: prospects for fisheries and aquaculture*. Agriculture and environmental services discussion paper; no. 3. Washington DC; World Bank Group. (available at http://documents.worldbank.org/curated/en/2013/12/18882045/fish-2030-prospects-fisheries-aquaculture).

[60] FAO Fisheries and Aquaculture Department. *World aquaculture 2010.* FAO Fisheries and Aquaculture Department. Technical Paper. No. 500/1. Rome, FAO. 2011. 105 pp.

[61] FAO Committee on Fisheries. 2010. Report of the fifth session of the Sub-Committee on Aquaculture. Phuket, Thailand, 27 September–1 October 2010. FAO Fisheries and Aquaculture Report No. 950. Rome/, FAO. 158pp. (available at http://www.fao.org/docrep/013/k9426t/k9426t00.pdf).

47. The sector will also have to overcome several **challenges** including land and water and associated conflicts, feed and seed supply and genetic resources, environmental integrity and disease problems, farming technologies, market, trade and food safety, climate change, investment capital and information and knowledge exchange.

48. By providing about 62.5 percent of the global aquaculture production, freshwater farming dominates the overall fish farming production. Nevertheless, there is some optimism for its **expansion**, especially in northern temperate regions[62] [63] and Africa.

49. However, there are no credible grounds indicating that this growth will be significant. **Land and water** available for agriculture, aquaculture, livestock and other uses such as human consumption are already scarce in several places around the world; a scarcity leading to, very often, serious conflicts within and between states. This scarcity is likely to grow even higher as the world's population balloons and puts more pressure on these resources. Farming the seas and oceans, including **expanding aquaculture further offshore**, is likely to become increasingly important as a part of the response to the world's land and freshwater scarcity[64].

50. A major challenge associated with expansion of aquaculture in inland and marine waters is the management of national and/or international **conflicts** which arise or could rise from the competing uses of these land and water resources, including for home consumption, agriculture, fisheries, boating and navigation, recreation and tourism, nature preservation and wildlife protection, urban development and oil exploration[65].

51. **Nationally**, with no, weak or improper regulations for allocation and use of land and water, there is often a tendency for the less influential and disadvantaged stakeholders to be denied or complicated **access** to these resources, especially land; which leads to conflicts. Many countries have adopted or are in the process of adopting measures to address this challenge through an ecosystem approach to aquaculture (EAA), including multiple or integrated use of water resources, land-use planning and aquaculture zoning, supported by adequate policies, plans and regulatory measures[66].

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[62] Duarte, C.M., M. Holmer, Y.Olsen, D. Soto, N.Marba, J. Guiu, K. Black and I. Karakassis. 2009. Will the oceans help feed humanity? BioScience (59) (11): 967-76.

[63] Wurmann, C.G. 2011. *Regional review on status and trends in aquaculture in Latin America and the Caribbean – 2010/Revisión Regional sobre la Situación y Tendencias en el Desarrollo de la Acuicultura en América Latina y el Caribe – 2010*. FAO Fisheries and Aquaculture Circular/FAO, Circular de Pesca y Acuicultura No. 1061/3. Rome, FAO. 212 pp.

[64] Goldburg, R.J., M.S. Elliot and R.L. Naylor. 2001. *Marine Aquaculture in the United States. Environmental impacts and policy options.* Pew Oceans Com, Arlington, Virginia.

[65] Bostock, J., B. McAndrew, R. Richards, K. Jauncey, T. Telfer, K. Lorenzen, D. Little, L. Ross, N. Handisyde, I. Gatward and R. Corner. 2010. *Aquaculture: global status and trends*. Philosophical Transactions of the Royal Society B: 365, 2897–2912.

[66] Soto, D., Aguilar-Manjarrez, J. & Hishamunda, N., eds. 2008. Building an ecosystem approach to aquaculture. FAO/Universitat de les Illes Balears Expert Workshop. 7–11. May 2007, Palma de Mallorca, Spain. FAO Fisheries and Aquaculture Proceedings No. 14. Rome, FAO. 221 pp. (available at ftp://ftp.fao.org/docrep/fao/011/i0339e/i0339e.pdf).

52. In the specific case of freshwater use, concerns have been raised as to whether aquaculture can continue to use large volumes of freshwater, particularly in open or flow-through systems, for production purposes[67].

53. However, counter-arguments exist that aquaculture in freshwater ponds contributes to water conservation; the growing cage culture in freshwater is one of the most water-efficient food production systems, as there is no water use other than that incorporated in fish biomass; although they account for only a very small percentage of aquaculture production, closed or recirculation aquaculture systems, which are increasingly used to culture species such as eels, catfish, turbot and tilapia, consume small amounts of water[68]. Even in situations where freshwater is constrained or stressed, as in the case of arid countries, or where freshwater is pumped from groundwater or aquifers, aquaculture may not be a consumptive user, as effective integration of the water uses with agricultural activities such as farming and perhaps livestock rearing can result in net benefits for competing users.

54. Water-stressed areas may also require more innovative approaches such as the use of wastewater and hydroponics[69].

55. Vis-à-vis the use of marine water for aquaculture, the competition is typically not for the quality or volume of water itself. It is more often for the use of marine or coastal areas which are claimed for other purposes such as fisheries, navigation, oil exploration, tourism and urban development as indicated in the previous paragraph[70]. In many countries, effective land-use planning and coastal zoning have promoted healthy competition. As aquaculture moves further offshore, in open-ocean reaching international waters, internationally, there may be the need for adjustments in aquaculture governance to ensure orderly development of the sector, reconcile ecological and human well-being and maintain societal harmony.

56. Two complementary approaches to expansion into new inland and marine areas are intensification of existing farming systems and diversification of cultured species. For intensification and species diversification to be effective and produce meaningful results, an adequate supply of quality feed and seed is one of the necessary conditions.

57. The challenge will be to get effective, efficient and affordable seed-production technologies, hatcheries and sources of quality feed established in Africa and other regions where aquaculture still suffers from inadequate availability of and access to good-quality feed and seed.

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[67] Bostock, J., B. McAndrew, R. Richards, K. Jauncey, T. Telfer, K. Lorenzen, D. Little, L. Ross, N. Handisyde, I. Gatward and R. Corner. 2010. Aquaculture: global status and trends. Philosophical Transactions of the Royal Society B: 365, 2897–2912.

[68] World Bank. 2006. *Aquaculture: changing the face of the waters: meeting the promise and challenge of sustainable aquaculture*. Report No. No. 36622-GLB. Washington, DC, World Bank. 138 pp.

[69] FAO. 2006. *State of world aquaculture 2006.* FAO Fisheries Technical Paper No. 500. Rome. 134 pp. (available at www.fao.org/docrep/009/a0874e/a0874e00.htm).

[70] Váradi, L., Lane, A., Harache, Y., Gyalog, G., Békefi, E. & P. *Lengyel. Regional Review on Status and Trends in Aquaculture Development in Europe – 2010.* FAO Fisheries and Aquaculture Circular. No. 1061/1. Rome, FAO. 2010. 129 p.

58. Over the recent decades, important **technological** advances were made-including in the salmon, Tilapia and other industries- that contributed substantially to increasing aquaculture production throughout the world. Further innovations of this and other nature are expected to emerge and play an essential role in making land, water, energy and feed ingredients more efficient, thereby pushing aquaculture growth further forward and making the sector a better contributor to humanity's food and nutrition security, wealth and economic well-being.

59. The development and adoption of **new and improved farming systems**, particularly cages and innovative enclosure systems for fish culture in offshore and high-energy coastal and ocean environments, has already taken place in many parts of the world, particularly in Europe and North America. They have already produced tangible results there and in many parts of Asia[71].

60. As the sector further expands, intensifies, diversifies and new technologies are introduced, one of the challenges will be to keep the environmental **integrity and to curb the occurrence of diseases**.

61. While responsible aquaculture can provide substantial environmental benefits, such as recovery of depleted wild stocks, preservation of wetlands, desalinization of sodic lands, pest control, weed control, and agricultural and human waste treatment, there have been cases of adverse environmental impacts as well[72]. The most common include discharge of aquaculture effluent leading to degraded water quality, alteration or destruction of natural habitats, introduction and transmission of aquatic animal diseases through poorly regulated translocations, and the negative impact of escapees on populations, communities and genetic diversity[73].

62. Consequently, many countries have put in place policies, strategies and regulations governing environmental sustainability with mixed, but often encouraging results. Sustainable aquaculture development will be possible only by maintaining these efforts. Mainstreaming the Ecosystem Approach to Aquaculture into national aquaculture policies, strategies and planning could be one of the means of achieving this goal. Promotion and adoption of Best Management Practices (BMPs) and the use of Environmental Impact Assessment (EIA) and Biosecurity frameworks, where appropriate, would be an additional way forward in this regard. These measures are also a good instrument for controlling or curving the spread and severity of fish diseases.

63. An additional challenge to further aquaculture expansion is likely to be **market, trade and food safety** related. In many developing countries, infrastructure development is inadequate and is likely to remain so for quite some time. Poor or lack of infrastructure such as road, railroad, seaport, airport, water, electricity and communication can be an important hindrance to fish trade and food safety.

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[71] Halwart, M., Soto, D. & Arthur, J.R., eds. 2007. *Cage aquaculture – regional reviews and* global overview. FAO Fisheries Technical Paper No. 498. Rome, FAO. 241 pp.

[72] World Bank. 2006. *Aquaculture: changing the face of the waters: meeting the promise and challenge of sustainable aquaculture*. Report No. No. 36622-GLB. Washington, DC, World Bank. 138 pp.

[73]FAO. 2006. *State of world aquaculture 2006.* FAO Fisheries Technical Paper No. 500. Rome. 134 pp. (available at www.fao.org/docrep/009/a0874e/a0874e00.htm).

64. To facilitate access to both domestic and international markets, and ensure safe fish and fish products to consumers, governments will need to provide adequate infrastructure development in support of the industry. For domestic markets, networks of quality roads that connect rural producers, particularly small-scale producers, to urban and peri-urban market centres, clean water and electricity infrastructure will be essential. In addition to good roads, clean water and regular supply of energy, access to well-functioning seaports and airports, and efficient information and communication technology services will be critical for exports as aquaculture grows.

65. Provision of infrastructure of such an importance is likely to be a considerable challenge for many countries for years ahead. Nonetheless, it will be crucial for countries to strengthen international, national and interprovincial or interstate biosecurity and food safety measures, enhance governments' and producers' ability to comply with trade and market access requirements for safe and quality products[74] and strengthen further global cooperation and harmonization of standards for aquaculture production and trade.

66. **Climate change** will also continue playing an essential role in aquaculture growth. Its impacts on global aquaculture are not yet fully known, but experts seem to agree that these impacts are likely to be positive and negative, arising from both direct and indirect effects and varying from region to region[75].

67. There are concerns that these impacts will be more pronounced at the small-scale level, particularly in the Asia–Pacific, Africa, and Latin America and the Caribbean regions. Concerns also exist that they could be so severe for large-scale producers in North America, Europe and some countries in the Latin America and the Caribbean regions that they could incur substantial financial losses and lead to closures[76].

68. These concerns underline the need for continued development and implementation of policies and strategies to enhance the resilience and adaptation of the aquaculture sector.

69. Some resilience and adaptive measures could include implementation of an EAA, application of BMPs and implementation of research on, and adoption of, integrated aquaculture, including agro-aquaculture and multitrophic aquaculture, which offers the possibility of recycling nutrients, assisting carbon sequestration and using energy and water more efficiently. They could also include implementation of aquaculture insurance schemes, promotion of aquaculture diversification

[74] Through training, legislation, codes of practice, certification and traceability schemes, especially in developing countries.

[75] De Silva, S.S. & Soto. D. 2009. Climate change and aquaculture: potential impacts, adaptation and mitigation. *In* K. Cochrane, C. De Young, D. Soto & T. Bahri, eds. *Climate change implications for fisheries and aquaculture: overview of current scientific knowledge,* pp. 151–212. FAO Fisheries and Aquaculture Technical Paper No. 530. Rome, FAO. 212 pp.

[76] Handisyde, N.T., Ross, L.G., Badjeck, M.-C. & Allison, E.H. 2006. *The effects of climate change on world aquaculture: a global perspective.* Final Technical Report. Stirling, United Kingdom, Institute of Aquaculture and DFID. 151 pp.

programmes and application of capacity-building programmes on forecasting and early warning systems, including the use of geographic information systems (GISs), remote sensing and mapping for spatial planning. In addition, countries' aquaculture strategies need to be mainstreamed into national climate change strategies[77].

70. Related to all these challenges, directly or indirectly, is investment **capital**. It requires timely access to affordable and adequate financial resources to build modern hatcheries, feed mills, research facilities and production infrastructure, to set up water, energy, transport and communication infrastructure, to develop efficient farming technologies, promote environmental integrity and curve disease threats. It also takes capital to supply adequate human resources to the sector, assure adequate market, trade and food safety, and address climate change challenges, etc.

71. Perhaps with the exception of North America and Europe, and a few countries of Latin America and the Caribbean and Asia-Pacific[78], access to adequate financial resources for aquaculture development remains a thorny and serious threat to the sector growth. Most governments lack financial means to adequately support the sector, and farmers have difficulties accessing bank loans.

72. Financial institutions are generally cautious in extending loans to aquaculture producers because of the inherent risks involved, such as outbreaks, the long production cycle needed for loan repayment, the lack of adequate collateral to cover risks and the lack of down payment[79]. When financial institutions provide loans, interest rates are generally prohibitive[80], which is a disincentive for farmers to borrow. The situation is especially serious for small and medium-scale farmers. This issue will need to be addressed for aquaculture to grow sustainably.

73. In addition to capital, **information sharing and knowledge exchange** amongst nations will continue to be instrumental in pushing aquaculture forward and enhancing its contribution to food and nutrition security, poverty alleviation and national economies.

74. Recent decades have experienced a growing recognition of the importance and benefits of enhanced information sharing and knowledge exchange on emerging issues and technological developments in the aquaculture sector at the national, regional and international levels[81].

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[77] Soto, D., Aguilar-Manjarrez, J. & Hishamunda, N., eds. 2008. Building an ecosystem approach to aquaculture. FAO/Universitat de les Illes Balears Expert Workshop. 7–11May 2007, Palma de Mallorca, Spain. FAO Fisheries and Aquaculture Proceedings No. 14. Rome, FAO. 221 pp. (also available at ftp://ftp.fao.org/docrep/fao/011/i0339e/ i0339e.pdf).

[78] FAO Fisheries and Aquaculture Department. 2011. *World aquaculture 2010*. FAO Fisheries and Aquaculture Department. Technical Paper. No. 500/1. Rome, FAO. 105 pp.

[79] Abban, E.K., Asmah, R., Awity, L. & Ofori, J.K. 2009. *Review on national policies and* programmes on aquaculture in Ghana. Sustainable Aquaculture Research Networks in Sub-Saharan Africa (SARNISSA), EC FPT Project. Stirling, UK, University of Stirling. 83 pp.

[80] Hishamunda, N. & Manning, P. 2002. *Promotion of sustainable commercial aquaculture in sub-Saharan Africa. Volume 2: Investment and economic feasibility*. FAO Fisheries Technical Paper. No. 408/2. Rome, FAO. 2002. 54pp.

[81] FAO Fisheries and Aquaculture Department. 2011. *World aquaculture 2010*. FAO Fisheries and Aquaculture Department. Technical Paper. No. 500/1. Rome, FAO. 105 pp.

75. Enhanced and timely information flows and knowledge exchange at all levels has led to reduced duplications and inefficiencies, increased technology transfer and diffusion amongst nations, enabled training and capacity building in several countries, improved institutional capacities and facilitated consistency and harmonization in areas such as policy, planning and regulations in several places. As a result, aquaculture productivity and growth have increased, food security and nutrition have been enhanced and both employment and incomes have been generated at the household and national levels, which boosted some national economies[82].

76. Major international conferences, FAO COFI Sub-Committees on Aquaculture and Fish Trade, local and regional networking, and bilateral and tripartite cooperation arrangements and regional networking were the major vehicles used for information sharing and knowledge exchange. Strong strategic partnerships, enhanced bilateral and South-South cooperation arrangements, increased direct foreign investment in the sector, more joint ventures, and a greater use of consortiums in aquaculture are some of the additional means of enhancing information sharing and knowledge exchange for further global advancement of aquaculture.

CONCLUDING COMMENTS

77. This paper has shown, among other things, that, globally, aquaculture maintains its path to growth. By providing 49 percent of fish consumed globally, aquaculture makes an important contribution to human food and nutrition security, a complex and flexible phenomenon, which experts identify with food availability, access, utilization and stability.

78. With the impressive growth in volume and value at times of a stagnating capture fisheries production in the last three decades, there is little doubt that aquaculture has also contributed significantly to the well-being of humanity in terms of poverty alleviation and national economies. Evidence exists as to where aquaculture has created millions of decent jobs, sizable revenues, and competitive profits, and has contributed to opening new or upgraded existing roads and other infrastructure such as water supplies, clinics and schools for communities. Aquaculture has also made tangible contribution to GDP in many countries, both developed and developing, while contributing to improvement of their balance of trade.

79. The challenge will be to maintain this momentum for the years to come. Experts expect aquaculture to continue growing be it through intensification, species diversification, expansion into new milieus including reclaiming uncharted inland areas and moving further into offshore marine waters and through introduction of innovative, more resource-efficient farming technologies.

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[82] FAO Committee on Fisheries Sub-Committee on Aquaculture. 2013. *Strengthening international cooperation for accelerating sustainable aquaculture development*, Seventh Session, St. Petersburg, Russian Federation, 7-11 October 2013 (available at http://www.fao.org/cofi/30797-09a20a5a1d9bf194dd53c453ddd8a9b37.pdf).

80. As the sector continues its journey to growth, it will have to overcome land and water and associated conflicts, feed, seed supply and genetic resources, environmental integrity and disease problems, development and adoption of new and improved farming technologies, market, trade and food safety, climate change and investment capital impediments.

81. Well-advised policies and strategies backed by strong research programmes will be of a paramount importance in defeating these constraints, but national, regional and global information and knowledge sharing will be critical.