WORLD AGRICULTURE

SEARCH

"*Global warming of 1.5°C, an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*".

Summary and Conclusions

The report of 48thSession of the IPCC indicates how human activities must change during the next 12 years if the worst effects of global warming are to be avoided. These comments relate to challenges faced by the world's agriculture and land use and propose or confirm actions that would go towards mitigating the worst effects of the warming, whilst providing adequate food for an increasing population.

Food security: At present there is sufficient food produced for the current human population;but it is often not in the right place, of the right type or it is too expensive to transport to where needed and that would add to the existing Greenhouse Gas (GHG) burden. Other reasons for this situation, include: human conflict, loss of products through crop disasters, inadequate storage and an inadequate income amongst the impoverished. Therefore there are many areas of the world where malnutrition still exists.

Bioenergy: In the near future there will be a need to increase the area of energy crops, especially for transport. As the population rises the effective land available for food crops is likely to decline. Thus, the output of food energy per unit area of land will have to increase. Otherwise, according to the IPCC, there will need to be a 2.5 million km^2increase of non-pasture agricultural crops. Meeting this demand is very likely to cause serious damage to biodiversity and a greater loss of tropical forests. However, the adoption of new agronomic practices such as conservation agriculture, zero tillage, and adaptive genetic improvements, including herbicide-resistant and heat tolerant genotypes are already increasing yields and water use efficiency of crops. These techniques alongside precision agriculture using hi-tech engineering are decreasing risk in the developed world and policies should be designed to increase their adoption in less developed countries where appropriate.

Land and ruminants: There will need to be up to an 11 million km^2reduction of grassland, pastures. We recommend this should not include pasture unsuitable for arable crops, as pasture has many virtues: a relatively low radiative forcing; it is an effective carbon sink; dairy products from pasture have greater nutritional value than those from concentrate feeding and pasture has several other environmental benefits . However, concentrate-fed ruminants require “resource-intensive diets” and grazing ruminants, in particular, produce excessive quantities of those greenhouse gases (GHG) which are most potent and have extended half-lives. Thus, the consumption of beef and lamb must be reduced, whereas production of dairy products should be maintained. However, only approximately 5% of ruminant GHG are derived from fossil fuels, so the effect of animal production on global warming is exaggerated compared with that of international air, land and sea transport. A large increase in fish-farming with the accompanying increase in research of appropriate foodstuffs, is proposed including vegetable sources of Ω-3 long-chain polyunsaturated fatty acids through genetic manipulation of oilseed crops.

Forests: IPCC propose that there should be a 9.5 million km^2increase in forests by 2050 relative to 2010. Where this occurs in the north temperate zone, these should be broad-leaved deciduous trees rather than evergreen conifers, because of their large difference in radiative forcing.

Transport: International transport of goods, including food, feed and services is expected by 2050 to contribute 40 % of GHG, over 95 % of which are currently derived from fossil fuels. This must be made more carbon-efficient by the application of bioenergy; but not at the expense of food crops.

Population: The human population of many tropical and subtropical countries is growing at a rate that leads to the destruction of forests to provide areas for cropping. Proposals are advanced for increasing the productivity per unit area of land in order to reduce destruction of tropical forest.

Highly desirable in less developed countries is an expansion of policies to improve education, particularly among young girls and women, together with increased availability of contraception within an economic framework that allows people to make use of these means. Emphasis must also be given to motivating young men who otherwise remain unemployed and depressed. On the other hand, developed countries are consuming the world's natural resources at far too high a rate per capita to be sustainable and in the process polluting the world with wasteThese two activities must be reduced. The consumption of non-renewable resources that produce GHG must cease by 2050 and be replaced renewable resources.

Introduction

The report from the 48thSession of the IPCC held in Incheon, Republic of Korea, is concerned primarily with the implications and necessary steps required to limit global temperatures increasing over pre-industrial levels by more than 1.5°C rather than increasing by more than 2°C.

Agriculture in its broadest sense (crops, pastures, fibre, forests, animals and aquaculture) is a major contributor to greenhouse gas (GHG) production. It is also a potential sink for GHG. Thus, limiting the global temperature increase to 1.5°C has major implications for agriculture, food security, sustainable development goals and poverty reduction.

The IPCC Summary for Policy Makers says: "Model pathways that limit global warming to 1.5°C with no, or limited, overshoot project a 4 million km^2 reduction to a 2.5 million km^2increase of non-pasture agricultural land for food and feed crops and a 0.5–11 million km^2reduction of pasture land, to be converted into a 0–6 million km^2increase of agricultural land for energy crops and a 2 million km^2reduction to 9.5 million km^2increase in forests by 2050 relative to 2010".

Such large transitions pose profound challenges for sustainable management of the various demands on land for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services. Mitigation options limiting the demand for land include sustainable intensification of land-use practices, ecosystem restoration and changes towards less resource-intensive diets.

The implementation of land-based mitigation options would require overcoming socio-economic, institutional, technological, financing and environmental barriers that differ across regions. World Agriculture agrees in principle with the IPCC report, but wishes to emphasise that in meeting the goal of limiting the global temperatures to 1.5°C above pre-industrial temperatures risks increasing food insecurity and poverty.

The question is: While food production needs to increase by ~40% by 2050 to meet the nutritional requirements of the growing world population, can yields predicted for the near future adequately meet population growth? Malnutrition persists widely due to inadequate distribution of food and uneven income distribution to purchase food. There is also wastage through loss of harvested crops and of food products due to inadequate preservation and access to markets prior to consumption in less developed countries, and excessive consumption and waste in more developed countries. Finally, meeting the demands of the expected increase in population without causing serious damage to biodiversity is most likely to cause a major problem, especially for tropical forests.

Over the next 30 years, productivity in tropical and sub-tropical countries is most likely to decline owing to the expected rise in ambient temperature, increased frequency of droughts, and increased frequency and intensity of storms and floods, while in high-latitude temperate regions, yields will likely rise due to warmer temperatures accelerating the rate of plant growth and yield[1].

Further, the adoption of new agronomic practices such as conservation agriculture, zero tillage, and adaptive genetic improvements, including herbicide-resistant, and heat- and drought-tolerant genotypes are already increasing yields and water use efficiency of crops. These techniques are decreasing risk in the developed world and can be adapted for other regions[2].

1. **Nutritional health**

A major problem facing food security is the large number of people increasing the proportion of meat in their diet as standards of living increase, while poor vegetarian diets can be deficient in lysine, cyanocobalamin (vitamin B_{12}), folates, and haem iron, especially for the young and for women of reproductive age.

Generally "Western" diets can provide excessive protein, energy and saturated fat that contain oxidized products and can be deficient in fresh fruit, green vegetables and indigestible carbohydrate[3].

While animal producers are aiming to make meat production carbon neutral by 2050, as pointed out by the IPCC Report, GHG production can also be reduced by a decrease, rather than an increase, in the consumption of beef and lamb, and to a lesser extent pig meat, to be replaced by poultry, fish and pulses.

This would also have a significant impact on people's health. However, it should be noted that ruminants such as cattle, sheep and goats are very efficient converters of poor-quality pastures, hill-slopes and rangeland into meat and should be retained for beef and lamb production for a variation in diets.

1. **Science vs "organic"**

The world is already facing unprecedented long-term pressures on agricultural landscapes that will increase in intensity if global warming is to be limited to 1.5°C above pre-industrial temperatures.

It will be necessary to increase food production to meet demand; but this must be undertaken sustainably. According to the best scientific evidence[4]it has been demonstrated that in a comparison of output per unit area of crop, "organic" farming would fail to produce adequate food to feed even the present world population.

Neither would “organic” farming be better for biodiversity when comparing equal output of produce under similar sustainable conditions, i.e. while maintaining ecosystem services. If farm management continues to reduce intensive agriculture’s impact on the environment, e.g. through new technologies that reduce GHG emissions from conventional farms, then the conflict between intensive and extensive systems could be lessened.

1. **Biodiversity**

Biodiversity is vital for the following reasons[5]:

1. as a source of genes which may be desirable in future,
2. as a guard against unanticipated interactions in the general environment,
3. for the amenity of the human race.

The destruction of tropical forests must be curtailed. In temperate regions, especially where annual yields of forest carbon do not exceed 2.5 t/ha* and where deciduous broad-leaved trees will grow they should largely, but not entirely, replace evergreen coniferous forests[6]e.g. where pit-props are no longer required, whereas insect-resistant building timber is, and the unique habitats of conifers are desirable.The ability of conifers to protect the soil, especially in hill land, is also an important characteristic they possess.

1. **Human Population**

In most sub-Saharan countries there are presently 4-6 children born per woman. As an example, the current birth rate in Nigeria is 38 per 1000 of population (in the UK it is 12) with 5.25 children born per woman.

Saving today’s children is clearly an imperative, but this can disguise a long term challenge If all the children at risk survive to adulthood in the next 35-40 years the population of sub-Saharan Africa will increase by 800%.This is most likely to lead to a massive increase in neonatal mortality, less access to scarce food and to increased migration of surviving populations to developed temperate regions.

Highly desirable in less developed countries is an expansion of policies to improve education, particularly among young girls and women, together with increased availability of contraception within an economic framework that allows people to make use of these means..

If numbers are not regulated there are climatic consequences. Global climate change would accelerate even more as a result of an increased rate of destruction of tropical forest to make way for increased local food production. One way to mitigate these effects would be to build more towns to accommodate internal migration, as is being carried out in China, so that effective scientific agricultural techniques could be pursued more rapidly on the land left by the migrants.

This process must be adopted most sensitively to avoid social upheaval for peoples who are born to a rural life. Current moves to increase forested areas in temperate regions of the world, as a means of mopping up atmospheric CO_2 to compensate for the loss of tropical forests, would be only a partial solution.

And, unfortunately, temperate evergreen coniferous afforestation on average may not contribute to reducing global climate change[7,8]. Moreover, the important insect and arachnid populations at the base of many food chains would change[9,10] with unpredictable consequences; although honey bees are desirable they are not absolutely required for the major agricultural, or horticultural, food crop pollination[10].

5. Export/import- movements of goods and services

The indications are that the movement of services is desirable and is likely to increase rapidly over the coming decades, with the input of both technical advice and finance from temperate to tropical regions.

While the flow of goods will be in both directions, the environmental cost of this will be large, especially if GHG production of transport is not significantly reduced. By 2050, global aviation and shipping are together expected to contribute almost 40% of global carbon dioxide emissions unless further mitigation actions are taken[11,12].

By 2050 it is essential that international transport adopts methods that use predominantly renewable sources of energy, both in their manufacture and in their use.

6. Effects of climate, including drought and flooding, on sustainability of land surfaces and production

Modelling[13,14] has shown that by 2030 it will not be possible in some years to grow existing crops in semi-arid areas of the tropics, due to heat and drought.

In other years, it has been demonstrated that with early rains, or with heavy summer rain, where the soil can retain the moisture, farmers are able to grow a crop. These areas have only one growing season per year. Genetically modified, including gene-edited plant breeding must take the necessary steps to provide essential crops that will grow under these anticipated climatic conditions.

Depending on soil type and structure, grassland (pasture) can help to absorb water during storms, reducing flooding risk and act as a reservoir during periods of drought when grassland also sustains the integrity of the surface, preventing loss of soil during high wind.

Grassland can be a source of complete feed for grazing livestock (in specific regions with trace element supplements e.g. Se, Co or Cu) and specific species of pasture plants will survive and grow in areas unsuitable for other crops.

The felling of trees on steep slopes must be discouraged, and replanting of eroded hillslopes must be encouraged, as their roots reduce the risk of landslides. Trees also take up excessive rainfall reducing the risks of flooding in the lower reaches of an associated river, providing a source of clean drinking water.

7. Greenhouse Gas (GHG) Production[15,16].

Carbon (C) already in the biological cycle converted to carbon dioxide (CO_2) does not increase the size of the pool of cycled CO_2, so can have no net influence on global warming, whereas C_n (derived from prehistoric sinks, e.g. fossil fuel and carbonate rocks) can do so.

Pastured beef can be produced with <5 % of its C derived from C_n, whereas in the manufacture of vehicles, their marketing and use, and road, air and sea transportation to final markets (over trans-global), as much as 95 % of CO_2 produced must be derived from C_n at present[17].

Nevertheless, methane is eructed from the rumen and N_2O originates from faecal matter (dung) deposited on pasture. Several ways are proposed to decrease the methane production of ruminant livestock.

These include: (1) plant breeding of lower protein grasses of higher digestibility, also requiring a lower N fertilizer input; (2) using forages of high digestibility and (3) chemical means of inhibiting rumen methanogenic bacteria. Such means would improve energy efficiency by up to 5 per cent and all three proposals would reduce ammonia and nitrous oxide emissions[17,18].

Nevertheless, since ruminants will still constitute a major source of these GHGs (other than CO_2), thereby exerting a disproportionately large effect on climate, it is recommended that beef consumption should be reduced in developed countries (see para. 2).

Intensive beef production produces less methane per kg of beef than pastured beef; but the feed conversion efficiency of beef cattle relative to that of poultry is poor and their intensive diet competes directly with that of humans. Moreover, pastured beef and sheep have low productivity per ha, but convert herbage into a high quality human food. The fat from pastured beef is a much richer source of omega-3 fatty acids than that of intensively-fed beef.

Dairy fat, in particular is the richest food source of C4 fatty acid (butyrate has health yielding properties). Pastures have low radiative forcing, and act as both carbon sinks and water reservoirs, sources of biodiversity, reduce soil erosion and rejuvenate soil in a rotation. We consider all these factors must be accommodated for specific regions in decisions about climate change[19].

Along with other means of control it will be important to cut the number of cattle now and improve their individual yield per unit of GHGs produced. But an excessive reduction in methane production could lead to a failure of cattle to achieve their goal of adequately converting fibre into human food, although their output of human food per ha is relatively poor[18,19].

There should be an increase in fish-farming, as a source of high quality human food which has very high efficiency of feed conversion, through the "cold-blooded" existence of fish and their lack of need of physical support, owing to water's buoyancy. Nonetheless, for these reasons it has low haem iron content, a potential disadvantage. Moreover, the world shortage ofΩ-3 long-chain polyunsaturated fatty acids should also be urgently rectified by genetic manipulation of oilseed crops[,20,21].

8. Effects of land surface type on radiative forcing

Atmospheric gases and land surface produce their effects on climate temperature by influences measured as radiative forcing ($w.m^{-2}$).

Type of land surface has a large effect on this forcing. In some situations the effect on forcing through CO_2 sequestered in trees, as a sink, is insufficient to equal the effect of land surface difference in forcing[7,17,22,23].

Where growing evergreen conifers sequestrate no more than 2.5 t C/ha per year (as occurs in the UK) the reduction in radiative forcing brought about by the equivalent reduction in atmospheric CO_2concentration, is insufficient to equal the lower radiative forcing of some agricultural field crops.

In this situation deciduous broad-leaved trees leaved trees that produce, at least 2.5 t C/ha.yr should be used. Alternatively, where the soil-type is suitable, grassland would be less-inclined to contribute to global warming than conifers, and therefore should be considered for use. Moreover, where trees are essential, evergreen conifers which have reached maturity and are no longer accumulating carbon, should be replaced by younger growing trees, as those conifers will be contributing to global warming in a large and unacceptable way!

Some other environmental considerations

Shale-gas fracking

The IPCC states that the global CO_2 emissions must be cut by 80% by 2050.

Carefully regulated fracking could help achieve this target. Not only is the burning of natural gas less polluting than coal or oil, gas can be environmentally cleaner.

For example, a recent report estimated that over 4200 tonnes of oil was discharged and spilt in the North Sea in 2014, thereby causing pollution of the ocean[21]. The combustion of natural gas produces negligible amounts of sulphur, mercury, lead and particulates, substances that when deposited on pastures present a hazard to grazing livestock.

Gas does produce some nitrogen oxides (NOx), but at much lower levels than from oil. Gas burning inevitably provides over twice the energy of coal and more than 1.5 times that of oil per unit of carbon dioxide produced, owing to differences in chain length (which can be variable, so it not possible to give more precise values). However, care should be exercised to keep the methane leakage rate from the extraction gear to less than 1 % of total gas, owing to its potency as a greenhouse gas. This mayrequire new legislative policies and investments.

Nuclear energy and improved renewables will undoubtedly play a large part in the future. Fracking would reduce dependence of the EU on unreliable imported sourcesand the money saved must in part be used for improving solar, wind,tidal, hydro, pumped hydro and nuclear sources of energy. But the investment in fracked gas should not delay the cessation of the combustion of fossil fuel sources of energy[22].

Tables 1 and 2 give albedo values*, which show that even pasture has a higher value than coniferous forest. Although these values do not allow for differences in C sequestration rate, it has been demonstrated[17]in situations where the annual forest carbon sequestration rate is ≤2.5 C t/ha that the net radiative forcing (including C sequestration) of grassland is less than that of coniferous evergreen forest . Grassland itself is an unmeasured Csink. Thus, grassland accumulates C, in a similar way to forests, although less extensively than do trees.

*Albedo is adimensionless ratioand measured on a scale from 0, corresponding to a black surface that absorbs all incident radiation, to 1, corresponding to a white surface that reflects all incident radiation.

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Figures

	Breuer *et al.* 2003[44]		**Otto *et al.* 2014** [45]	
	MINIMUM MAXIMUM Breuer *et al.*		**true background albedo (VIS)**	**true background albedo (NIR)**
Agricultural crops	0.20	0.24		
Pasture, grasses	**0.19**	**0.27**		
Conifers	**0.11***	**0.14***	**0.077****	**0.137****
Deciduous***	**0.21**	**0.27**	**0.149******	**0.248******
Larch, , Needle-leaf, deciduous[C]	0.127	0.145		
Overall difference, (DB–Grassland) = +0.01				
Overall difference, (CE–Grassland) = –0.105				
Overall difference, (DB–CE) = +0.115				

Table 1.*Albedo values for crops, grasses CE(Coniferous Evergreen) and DB (Deciduous Broad-leaved).. Data from two European reports 0-1.0, VIS, visible spectrum, NIR, near infra-red*[3] *n.b. for access to references 44 and 45 access reference 6.*

*19 data sets in Breuer *et al.* review

** CE, *Pinus sylvestris*

***38 data sets in Breuer *et al.* review

****Mean DB, *Fagus* spp ,*Quercus robur* & *Q. petraea*

[C] Deciduous needle-leaf (larch, *Larix laricina*) albedo variation exceeded that of CE species and overlaps the albedo range of BD species.

Broad-leaf deciduous	0.1477
Needle-leaf deciduous, *Larix laricina*[c]	0.1350
Needle-leaf evergreen, Northerly*	0.0840
	(0.005)
Needle-leaf evergreen, Southerly	0.1077 (0.012)
Needle-leaf evergreen, Mean	0.0959
Grassland	0.1957
Crop	0.1867
Needle-leaf evergreen, Overall	0.0959
Broad-leaf deciduous	0.1477

Table 2.*Mean Albedo estimates for land surface models*[6,17]

*Northerly would be more akin to UK latitudes, but 0.0518 is used cautiously in calculation.

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8th January 2019

Comments