Industrial Biotechnology and Climate Change: Opportunities and Challenges

Carbon dioxide (CO2) has the second-largest direct contribution to the greenhouse effect of all gases. Since the beginning of the Industrial Revolution, the burning of fossil fuels has contributed to the increase in carbon dioxide in the atmosphere. Moreover, national CO2emissions are strongly linked to wealth, and a global strategic goal should be to prevent growth at the expense of sustainability. A large proportion of CO2 production arises from industrial activities. Therefore, meeting market demands whilst reducing the impact on climate change is critically important for industry. To meet the challenge of greenhouse gas (GHG) emissions reductions, industry has responded in most countries, and as a result GHG emissions from industry have substantially decreased in recent years. However, the targets for reductions are very ambitious, and more remains to be done. Thus the idea of "sustainable growth" has taken hold. New technologies are being developed to counter GHG emissions, and the new industrial biotechnology should be seen as part of the technology toolkit. Industrial biotechnology, based on renewable resources, can save energy and significantly reduce CO2 emissions. It is an embryonic industry, but has already proven its worth in climate change mitigation. It holds much greater promise for the future by avoiding the use of fossil raw materials. It involves the use of enzymes and microorganisms to make biobased products in a diverse variety of industry sectors. The feedstocks are agricultural biomass and organic waste materials, even wastewaters. The new industrial biotechnology arose from international interest in the production of biofuels from a variety of feedstocks. Many countries now have bioenergy strategies and targets. In short order, many supportive policies were developed for the production and utilisation of biofuels, particularly bioethanol. However, very quickly the biofuels boom courted controversy, especially the food versus fuel debate. Now there is a shift in policy towards second generation biofuels using non-food crops as feedstocks. Besides biofuels, industrial biotechnology can contribute to climate change mitigation through diverse products in the plastics and chemicals sectors. These products are less controversial, some are closer to market than second generation biofuels, and yet do not enjoy the wealth of supportive supply and demand policies as seen with biofuels.Several sources predict that biobased chemicals could in the near future occupy a much larger market share than at present. As befits the remarkable biodiversity of microorganisms, the diversity of potential biobased chemicals is wide. In many cases, organic chemistry has no feasible replacement; in other cases, biobased chemicals can replace their fossil-based counterparts with significant GHG emissions reductions. Plastics from fossil fuels have grown faster than any other group of bulk materials for several decades. By 2100, a predicted 1 billion tonnes annual plastics demand would require 25% of current oil production. Biobased plastics are potentially attractive in terms of specific emissions and energy savings. In recent years biobased plastics have been developed for increasing types of applications, way beyond simple packaging applications as once envisaged. Estimates of total technical substitution potential for petro- with bio- plastics is 33-90% and yet global bioplastics consumption is a mere 0.4% of total plastics. As biobased plastics become proven in GHG emissions reductions, they should become an obvious target for supportive policy. This paper explores the potential role of industrial biotechnology in the biobased economy. Along the way it examines emerging trends, the impact of innovation, the convergence of technologies, and goes on to identify the challenges involved. It concludes with a need for an integrated and strategic approach to allow industrial biotechnology to fulfil its potential as a force for good, not a panacea, in the struggle with climate change. Industrial biotechnology has suffered a lack of investment at all levels, and there is a serious mismatch between future expectations of this industry and this low level of investment. Policy intervention is seen to be required across three broad criteria - social/environmental, industrial performance and economical. To make this all happen requires not only national but international policy in a rapidly globalising world.

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