The **Green Revolution** refers to a series of research, and development, and [technology transfer](http://en.wikipedia.org/wiki/Technology_transfer) initiatives, occurring between the 1940s and the late 1960s, that increased agriculture production worldwide, particularly in the developing world, beginning most markedly in the late 1960s.[[1]](http://en.wikipedia.org/wiki/Green_Revolution#cite_note-1) The initiatives, led by [Norman Borlaug](http://en.wikipedia.org/wiki/Norman_Borlaug), the "Father of the Green Revolution" credited with saving over a billion people from starvation, involved the development of high-yielding varieties of cereal grains, expansion of irrigation infrastructure, modernization of management techniques, distribution of hybridized seeds, synthetic [fertilizers](http://en.wikipedia.org/wiki/Fertilizer), and [pesticides](http://en.wikipedia.org/wiki/Pesticide) to farmers.

The term "Green Revolution" was first used in 1968 by former [United States Agency for International Development](http://en.wikipedia.org/wiki/United_States_Agency_for_International_Development) (USAID) director [William Gaud](http://en.wikipedia.org/wiki/William_Gaud), who noted the spread of the new technologies: "These and other developments in the field of agriculture contain the makings of a new revolution. It is not a violent [Red Revolution](http://en.wikipedia.org/wiki/October_Revolution) like that of the Soviets, nor is it a [White Revolution](http://en.wikipedia.org/wiki/White_Revolution) like that of the [Shah of Iran](http://en.wikipedia.org/wiki/Mohammad_Reza_Pahlavi). I call it the Green Revolution.

**Pesticides**

Green Revolution agriculture relies on extensive use of [pesticides](http://en.wikipedia.org/wiki/Pesticides), which are necessary to limit the high levels of [pest](http://en.wikipedia.org/wiki/Pest_(organism)) damage that inevitably occur in [monocropping](http://en.wikipedia.org/wiki/Monocropping" \o "Monocropping) – the practice of producing or growing one single crop over a wide area.

**Biodiversity**

The spread of Green Revolution agriculture affected both agricultural [biodiversity](http://en.wikipedia.org/wiki/Biodiversity) and wild biodiversity.[[40]](http://en.wikipedia.org/wiki/Green_Revolution#cite_note-rice-robbery-40) There is little disagreement that the Green Revolution acted to reduce agricultural biodiversity, as it relied on just a few high-yield varieties of each crop.

This has led to concerns about the susceptibility of a food supply to pathogens that cannot be controlled by agrochemicals, as well as the permanent loss of many valuable genetic traits bred into traditional varieties over thousands of years. To address these concerns, massive seed banks such as [Consultative Group on International Agricultural Research](http://en.wikipedia.org/wiki/Consultative_Group_on_International_Agricultural_Research)’s (CGIAR) International Plant Genetic Resources Institute (now [Bioversity International](http://en.wikipedia.org/wiki/Bioversity_International" \o "Bioversity International)) have been established (see [Svalbard Global Seed Vault](http://en.wikipedia.org/wiki/Svalbard_Global_Seed_Vault)).

There are varying opinions about the effect of the Green Revolution on wild biodiversity. One hypothesis speculates that by increasing production per unit of land area, agriculture will not need to expand into new, uncultivated areas to feed a growing human population.[[47]](http://en.wikipedia.org/wiki/Green_Revolution#cite_note-Davies2003-47) However, land degradation and soil nutrients depletion have forced farmers to clear up formerly forested areas in order to keep up with production. A counter-hypothesis speculates that biodiversity was sacrificed because traditional systems of agriculture that were displaced sometimes incorporated practices to preserve wild biodiversity, and because the Green Revolution expanded agricultural development into new areas where it was once unprofitable or too arid. For example, the development of wheat varieties tolerant to acid soil conditions with high aluminium content, permitted the introduction of agriculture in sensitive [Brazilian ecosystems](http://en.wikipedia.org/wiki/Wildlife_of_Brazil) as [Cerrado](http://en.wikipedia.org/wiki/Cerrado" \o "Cerrado) [semi-humid](http://en.wikipedia.org/wiki/Tropical_savanna_climate) [tropical savanna](http://en.wikipedia.org/wiki/Tropical_savanna) and [Amazon rainforest](http://en.wikipedia.org/wiki/Amazon_rainforest) in the geoeconomic macroregions of Centro-Sul and Amazônia Before the Green Revolution, other Brazilian ecosystems were also significantly damaged by human activity, such as the once 1st or 2nd main contributor to Brazilian megadiversity [Atlantic Rainforest](http://en.wikipedia.org/wiki/Mata_Atl%C3%A2ntica) (above 85% of deforestation in the 1980s, about 95% after the 2010s) and the important [xeric shrublands](http://en.wikipedia.org/wiki/Xeric_shrubland) called [Caatinga](http://en.wikipedia.org/wiki/Caatinga" \o "Caatinga) mainly in the [Northeastern Brazil](http://en.wikipedia.org/wiki/Northeast_Region,_Brazil" \o "Northeast Region, Brazil) (about 40% in the 1980s, about 50% after the 2010s — deforestation of the Caatinga biome is generally associated with greater risks of [desertification](http://en.wikipedia.org/wiki/Desertification)).

Nevertheless, the world community has clearly acknowledged the negative aspects of agricultural expansion as the 1992 [Rio Treaty](http://en.wikipedia.org/wiki/Rio_Treaty), signed by 189 nations, has generated numerous national [Biodiversity Action Plans](http://en.wikipedia.org/wiki/Biodiversity_Action_Plans) which assign significant biodiversity loss to agriculture's expansion into new domains.

**Greenhouse gas emissions**

According to a study published in 2013 in [PNAS](http://en.wikipedia.org/wiki/PNAS), in the absence of the crop germplasm improvement associated with the Green revolution, greenhouse gas emissions would have been 5.2-7.4 Gt higher than observed in 1965–2004

**Dependence on non-renewable resources**

Most high intensity agricultural production is highly reliant on non-renewable resources. Agricultural machinery and transport, as well as the production of pesticides and nitrates all depend on fossil fuels.[[50]](http://en.wikipedia.org/wiki/Green_Revolution#cite_note-50) Moreover, the essential mineral nutrient phosphorus is often a limiting factor in crop cultivation, while phosphorus mines are rapidly being depleted worldwide.[[51]](http://en.wikipedia.org/wiki/Green_Revolution#cite_note-51) The failure to depart from these non-sustainable agricultural production methods could potentially lead to a large scale collapse of the current system of intensive food production within this century.

**Health impact**

The consumption of the [pesticides](http://en.wikipedia.org/wiki/Pesticide) used to kill [pests](http://en.wikipedia.org/wiki/Pest_(organism)) by humans in some cases may be increasing the likelihood of cancer in some of the rural villages using them. Poor farming practices including non-compliance to usage of masks and over-usage of the chemicals compound this situations. In 1989, WHO and UNEP estimated that there were around 1 million human pesticide poisonings annually. Some 20,000 (mostly in developing countries) ended in death, as a result of poor labeling, loose safety standards etc.

**Pesticides and cancer**

Long term exposure to pesticides such as [organo-chlorines](http://en.wikipedia.org/wiki/Organochlorines" \o "Organochlorines), [creosote](http://en.wikipedia.org/wiki/Creosote), and [sulfate](http://en.wikipedia.org/wiki/Sulfate" \o "Sulfate) have been correlated with higher cancer rates and organochlorines [DDT](http://en.wikipedia.org/wiki/DDT), [chlordane](http://en.wikipedia.org/wiki/Chlordane), and [lindane](http://en.wikipedia.org/wiki/Lindane" \o "Lindane)as tumor promoters in animal Contradictory epidemiologic studies in humans have linked phenoxy acid herbicides or contaminants in them with [soft tissue sarcoma](http://en.wikipedia.org/wiki/Soft_tissue_sarcoma)(STS) and malignant [lymphoma](http://en.wikipedia.org/wiki/Lymphoma), organochlorine insecticides with STS, [non-Hodgkin's lymphoma](http://en.wikipedia.org/wiki/Non-Hodgkin%27s_lymphoma) (NHL), [leukemia](http://en.wikipedia.org/wiki/Leukemia" \o "Leukemia), and, less consistently, with cancers of the [lung](http://en.wikipedia.org/wiki/Lung_cancer) and [breast](http://en.wikipedia.org/wiki/Breast_cancer" \o "Breast cancer),[organophosphorous](http://en.wikipedia.org/wiki/Organophosphorous) compounds with NHL and leukemia, and triazine herbicides with [ovarian cancer](http://en.wikipedia.org/wiki/Ovarian_cancer)