Scientific Papers Series Management , Economic Engineering in Agriculture and Rural Development
Vol. 13 , Issue 1, 2013
PRINT ISSN 2284-7995 , E-ISSN 2285-3952

THE PIONEERS OF THE GREEN REVOLUTION AS FORERUNNERS OF TODAY'S ECOLOGICAL AND BIOTECHNOLOGICAL REVOLUTIONS

Codrin TAPU [1]

[1] University of Agricultural Sciences and Veterinary Medicine, Bucharest, 59 Marasti, District 1, 011464, Romania, Phone: +40213182567, Fax:+403182888, Email: tapucodrin@yahoo.com

Corresponding author: tapucodrin@yahoo.com

Abstract

This paper presents the milestones of the Green Revolution, outlining its role in the development of today's sustainable and biotechnological agriculture. In order to do this we used the material found in papers and books on the research in agriculture from the 1940s to the late 1980s. Current sustainable agriculture and biotechnological advancement, incuding the creation of genetically modified organisms could never have been possible without the Green Revolution. Reducing the height of the stalk allowed the production of high-yielding cultivars that now are used and modified with genetic engeneering methods in the context of a sustainable agriculture.

Key words: *biotechnology, ecology, green revolution*

INTRODUCTION

The Green Revolution refers to a series of research, development, and technology transfer initiatives, occurring between the 1940s and the late 1970s, that increased agriculture production around the world, beginning most markedly in the late 1960s. It forms a part of the 'neo-colonial' system of agriculture wherein agriculture was viewed as more of a commercial sector than a subsistence one.[1]

The initiatives, led by the American agronomist **Norman Borlaug** (1914–2009) – fig. 1, 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, and pesticides to farmers.

Apparently, there is a contradiction between an intensive agriculture intendwed to feed millions of people, like the one proposed by the Green Revolution, and an extensive agriculture imposed by the principle of sustainable development. But there is not.

Paradoxically, genetic engineering provides the means to increase production without spoiling soil or polluting it with chemicals.

That is why we think that now is the time for a Second Green revolution, a “Really Green” Revolution, which needs to be both quantitative and qualitative, providing plenty of healty food for the world's increasing population, while preserving their environment. As Borlaug put it, you can't build a peaceful world on empty stomachs.

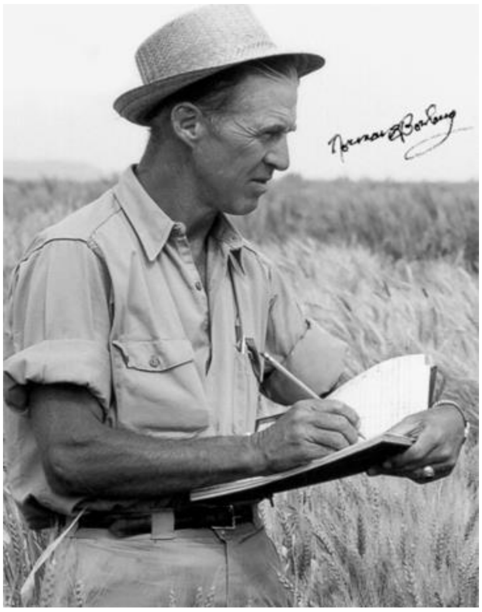

Photo 1. **Norman Borlaug** (picture in the public domain)

MATERIALS AND METHODS

This paper present the milestones of the Green Revolution, outlining its role in the development of today's sustainable and biotechnological agriculture. In order to do this we used the material found in papers and books on the research in agriculture from the 1940s to the late 1980s.

RESULTS AND DISCUSSIONS

The Green Revolution in common wheat

Cecil Salmon (1885–1975), an American biologist working in post-World War II Japan, collected 16 varieties of wheat, including one called “Norin 10”, which was very short, thus less likely to suffer wind damage. Salmon sent it to the American agronomist **Orville Vogel** (1907–1991) – fig. 2 in Washington in 1949. Vogel began crossing Norin 10 with other wheats to make new short-strawed varieties. Vogel led the team that developed Gaines, the first of several new varieties that produced 25 percent higher yields than the varieties they replaced. Vogel shared his germplasm with Norman Borlaug, who later received the 1970 Nobel Peace Prize for his role in the “green revolution.” Borlaug publicly acknowledged Vogel’s contributions to his research.[2]

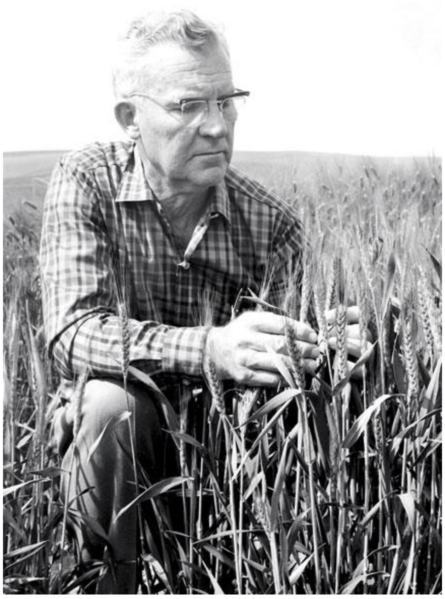

Photo 2. **Orville Vogel** (picture in the public domain)

Dwarfing is an important agronomic quality for wheat; dwarf plants produce thick stems. The cultivars Borlaug worked with had tall, thin stalks.

Taller wheat grasses better compete for sunlight, but tend to collapse under the weight of the extra grain—a trait called lodging—from the rapid growth spurts induced by nitrogen fertilizer Borlaug used in the poor soil. To prevent this, he bred wheat to favor shorter, stronger stalks that could better support larger seed heads. In 1953, he acquired a Japanese dwarf variety of wheat called Norin 10 developed by Orville Vogel, that had been crossed with a high-yielding American cultivar called Brevor 14.[20] Norin 10/Brevor is semi-dwarf (one-half to two-thirds the height of standard varieties) and produces more stalks and thus more heads of grain per plant. Also, larger amounts of assimilate were partitioned into the actual grains, further increasing the yield. Borlaug crossbred the semi-dwarf Norin 10/Brevor cultivar with his disease-resistant cultivars to produce wheat varieties that were adapted to tropical and sub-tropical climates.[2]

Borlaug's new semi-dwarf, disease-resistant varieties, called Pitic 62 and Penjamo 62, changed the potential yield of spring wheat dramatically. By 1963, 95% of Mexico's wheat crops used the semi-dwarf varieties developed by Borlaug. That year, the harvest was six times larger than in 1944, the year Borlaug arrived in Mexico. Mexico had become fully self-sufficient in wheat production, and a net exporter of wheat.[2] Four other high yield varieties were also released, in 1964: Lerma Rojo 64, Siete Cerros, Sonora 64, and Super X.

The Green Revolution in Durum wheat

Proving the possibility of obtaining high yield cultivars from parents with low productivity (through heterosis), [3] between 1967 and 1989, the Romanian agronomist **Zoe Tapu** (1934–2013) – Fig. 3, working at the National Agricultural Research and Development Institute at Fundulea, developed a research program for improving winter durum wheat, in order to obtain cultivars with fall resistance and high yield, using height-reduction genes from summer durum developed at the

International Maize and Wheat Improvement Center (CIMMYT) in Mexico[4][5][6].

Photo 3. **Zoe Tapu** (picture in the public domain)

In order to achieve that, she used dwarf plants from CIMMYT, which survived to a mild winter, back-crossing them with Romanian durum wheat varieties. Repeated selection for cold resistance of semi-dwarf variants led to the creation of the first semi-dwarf winter durum wheat varieties, Topaz (1977) and Rodur (1984).[7] This original type of wheat set the ground for further progress in durum wheat breeding in many countries.

CONCLUSIONS

Current sustainable agriculture and biotechnological advancements, incuding the creation of genetically modified organisms could never have been possible without the Green Revolution. Reducing the height of the stalk and increasing pest resistance allowed the production of high-yielding cultivars that now are used and modified with genetic engineering methods in the context of a sustainable agriculture.

Along with United States agricultural scientists as Borlaug, Vogel, and Salmon, Romania had an important contribution to the Green Revolution through Zoe Tapu, who extended it to durum wheat, with its high nutritive value in the form of pasta and good quality bread.

High-yielding varieties of durum wheat developed also using genetic modification technologies can thus be a solution of feeding millions, in the context of a sustainable agriculture.

How is the time for a Second Green revolution, a “Really Green” Revolution, which needs to be both quantitative and qualitative, providing plenty of healty food for the world's increasing population, while preserving their environment.

Studying the methods and work of the personalities of the past can only be to the benefit of a new agriculture designed for future generations.

ACKNOWLEDGMENTS

The author wants to acknowledge Ms. Olivia Firi, editor at Revista Ferma for the article on Dr. Zoe Tapu's life and work.

REFERENCES

[1]"In Memoriam". Ferma 3, 2013, (118): 78. March 2013.
[2]INCDA Fundulea - Câteva din rezultate: ameliorare si genetică, in Ceapoiu, N. (red.) Grîul, Ed. Academiei, 1984, p. 241
[3]Săulescu N.N. ,2003, The Romanian durum breeding program. In Durum Wheat Breeding: Current Approaches and Future Strategies (editors Conxita Royo and Natale Di Fonzo), The Haworth Press, Inc., New York: 907-920.
[4]Săulescu N. N., Ittu G., Ittu Mariana, Mustătea P., Cinci decenii de ameliorare a grâului la Fundulea
[5]Woolston J. E., 1997, Wheat, barley, and triticale cultivars: A list of publications in which national scientists have noted the cooperation or germplasm they received from CIMMYT, p. 78
[6]Crăciun, T., Ionescu-Sisesti V., 1977, Perfomance of some new Winter Wheat Lines in irrigated and non-irrigated comparative trials, Lucrări Stiintifice: Agronomie 17: 14.
[7] Verzea M., 2007, Fifty years of Breeding in field crops at the National Agricultural Research and Development Institute Fundulea, Romanian Agricultural Research 24:22

Scientific Papers Series Management , Economic Engineering in Agriculture and Rural Development
Vol. 13 , Issue 1, 2013
PRINT ISSN 2284-7995 , E-ISSN 2285-3952