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GLOBAL SUSTAINABLE FARMING AND THE "SOCO" SOIL CONSERVATION PROJECT

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I. INTRODUCTION

According to the United Nations, the world's population reached 7 billion people in 2013.[1] According to their projections, the world's population is expected to reach 9.6 billion people by 2050.[2] Of the many issues we are faced with as a planet, one principal concern is how we will feed an additional 2.6 billion humans by 2050. In addition to socio-economic, hunger, and poverty concerns, another issue brought about by the rise in population is how Earth's agriculture can provide an adequate yield without creating further environmental degradation.

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) established one of the most rigorous and comprehensive assessments of agriculture to-date: *Agriculture at a Crossroads* (the Report).[3] Co-sponsored by other leading organizations such as the World Bank and the Food and Agriculture Organization (FAO), this report concluded that, in order to address hunger and poverty, social inequities, and environmental sustainability, a radical change was needed in agricultural policy and practice.[4] The Report indicated that because modern industrial farming uses enormous amounts of water, fertilizer, and energy, it causes collateral damage to the environment.[5] This damage ripples, increasing land loss, habitat loss, climate change due to greenhouse gas emissions, soil erosion from monoculture (the intensive and continual farming of one type of crop on a plot of land), toxic run-off into drinking water, and increased chemical pesticide use.[6]

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1. Dep't of Econ. & Soc. Affairs, Population Div., *World Population Prospects: The 2012 Revision, Volume I: Comprehensive Tables*, U.N. Doc. ST/ESA/SER.A/336, at 1 (2013).

2. *Id.*

3. INT'L ASSESSMENT OF AGRIC. KNOWLEDGE, SCI. & TECH. FOR DEV., AGRICULTURE AT A CROSSROAD: GLOBAL REPORT (Beverly D. McIntyre, et al. eds., 2009) [hereinafter IAASTD, the Report].

4. *Id.* at 118.

5. *Id.* at 146.

6. *Id.* at 35, 329; FRED MAGDOFF & BRIAN TOKAR, AGRICULTURE AND FOOD IN CRISIS: CONFLICT, RESISTANCE, AND RENEWAL 125, 283–284 (Monthly Rev. Press 2010) (referencing the University of Minnesota study concerning the environmental damage of farming and noting current agriculture practices are harmful to the environment); DALE ALLEN PFEIFFER, EATING FOSSIL FUELS: OIL, FOOD AND THE COMING CRISIS IN AGRICULTURE 12–13 (B.C. Gabriola ed., 2006); João Carlos da

Agricultural production techniques most recently placed a significant emphasis on high production. Farmers industrialized their trade, in order to feed as many people as possible which decreased levels of starvation around the world.[7] However, the pursuit of high production took a tremendous toll on the environment. In the long-run, industrialized farming techniques wreaked havoc on air and water quality, negatively impacting nearby farming communities. Air and water pollution are just a glimpse into the issues that communities must shoulder as a result of high-yield farming, and unfortunately these issues generally fall on the shoulders of the most vulnerable, the global poor.[8] Negative externalities from industrial farming also contributes to poverty, drought, and, ironically, hunger in many underprivileged communities.[9] As resource scarcity conditions worsen, it can also create an atmosphere in which political unrest can unfold – causing increased global food prices, and even violence if left unchecked.[10] It is therefore imperative that efficient yet sustainable farming becomes a high-priority in discourse related to the environment, global planning, and human rights.

The backbone of agricultural efficiency and production is soil quality. Without nutrient-rich soil, resulting crops are fewer and less healthy. Modern farming practices have caused soil degradation to become a chief concern among the agricultural community.[11] Soil degradation is often accelerated by human activities, such as improper soil use and cultivation practices.[12] A recent sustainable agriculture project entitled the "Sustainable Agriculture and Soil Conservation through Simplified Cultivation Techniques" (the SoCo Project) focused on solving soil degradation issues in the European Union and can be used as a model for how soil health can be evaluated and managed.[13] The program used initial research; formal discussions between communities, stakeholders, and

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Silva Dias, *Biodiversity and Plant Breeding as Tools for Harmony Between Modern Agriculture Production and the Environment*, *in* MOLECULAR APPROACHES TO GENETIC DIVERSITY 1, 11 (Mahumut Caliskan et al. eds., 2015); Kumi Naidoo, *The Food System We Choose Affects Biodiversity: Do We Want Monocultures?*, GUARDIAN (May 22, 2014), https://www.theguardian.com/sustainable-business/food-system-monocultures-gm-un-diversity-day.

7. IAASTD, the Report, *supra* note 3, at 117; John Ikerd, *The Inevitable Economic, Ecological, and Social Consequences of CAFOs* 12 (Mar. 4, 2013), http://web.missouri.edu/ikerdj/papers/WalesInevitableConsequencesofCAFOs.pdf.

8. Daniel Maxwell, *Food Security and Political Stability: A Humanitarian Perspective*, *in* FOOD SECURITY & SOCIOPOLITICAL STABILITY 279, 280 (Christopher B. Barrett ed., 2013); Ikerd, *supra* note 7, at 8–9, 12; John Ikred, *Impacts of CAFOs on Rural Communities* 1–2 (July 26, 2008), http://web.missouri.edu/ikerdj/papers/IndianaCAFOsCommunities.pdf.

9. IAASTD, the Report, *supra* note 3, at 146.

10. Daniel Maxwell, *supra* note 8, at 280; John Ikerd, *supra* note 7, at 8–9, 12; Ikred, *supra* note 8, 1–2; IAASTD, the Report, *supra* note 3, at 269.

11. Martha M. Bakker et al., *The Effect of Soil Erosion on Europe's Crop Yields*, 10 ECOSYSTEMS 1209, 1217 (2007).

12. *Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions: Toward a Thematic Strategy for Soil Protection*, at 9–10, COM (2002) 179 (Apr. 16, 2002).

13. *Final Report on the Project 'Sustainable Agriculture and Soil Conservation (SoCo)'*, at 1, EUR 23820 EN (2009) [hereinafter *SoCo Project*].

researchers; and a variety of organic and conservation farming techniques to ultimately increase short-term productivity while maintaining the integrity of the soil for long-term production.[14] From this project, we understand that utilizing certain farming practices can better protect soil and result in healthier crops and less environmental degradation.[15]

The SoCo Project's main success was proving that the modern industrialized farming techniques that developed countries had hung their hats on, were not the *only* way to increase production. Rather, this study proved that where more sustainable practices were implemented, more long-term productivity and less negative externalities would result.[16]

This Article highlights the precedence and growth of modern agriculture under the Green Revolution, an era coined as such after the growth of agricultural modernization in the 1940's. The Green Revolution promoted increased uses of pesticides, synthetic nitrogen fertilizers, monoculture techniques, and genetically-engineered crops and ultimately increased productivity in the short term.[17] The Green Revolution was born out of scientific ingenuity and the desperation of a looming global famine.[18] During this time, scientists discovered ways to breed hardier grains and used improved technology to produce more crops, faster.[19] Because of the new practices encouraged by the Green Revolution, thousands of people were able to avoid famine.[20] Overall, the Green Revolution was a major success because it allowed for an unprecedented level of national food security, leading to a human population boom; it could be said that it aided in producing the 7 billion people on the planet today.[21] While the Green Revolution initially had a positive impact, the revolution brought about great problematic environmental consequences globally resulting in poverty and economic instability.[22]

Additionally, this Article will focus on the SoCo Project as a successful sustainable agriculture project, and an answer to the problems developed under modern farming. This Article will highlight the SoCo Project's implementation, strategy, challenges, and conclusions. Finally, this Article concludes that the SoCo Project should stand as a model for the obstacles and successes involved in the implementation of sustainable agriculture projects.

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14. *Id.* at 17.

15. Sustainable Agriculture and Soil Conservation (SoCo), *Fact Sheet 1: Linking Soil Degradation Processes, Soil-Friendly Farming Practices and Soil-Relevant Policy Measures* 2 (May 2009), https://esdac.jrc.ec.europa.eu/projects/SOCO/FactSheets/ENFactSheet-01.pdf.

16. *SoCo Project, supra* note 13, at 137.

17. U.N. DEP'T OF ECON. & SOC. AFFAIRS, WORLD ECONOMIC AND SOCIAL SURVEY 2011: THE GREAT GREEN TECHNOLOGICAL TRANSFORMATION, at 79, 88, U.N. Doc. ST/ESA/333, U.N. Sales No. E.1.II.C.1 (2011) [hereinafter WORLD ECONOMIC & SOCIAL SURVEY].

18. Prabhu L. Pingali, *Green Revolution: Impacts, Limits, and the Path Ahead*, 109 PROC. NAT'L ACAD. SCI. 12302, 12302 (2012) [hereinafter Pingali].

19. *Id.*; WORLD ECONOMIC AND SOCIAL SURVEY, *supra* note 17, at 88.

20. Pingali, *supra* note 18, at 12302.

21. *Id.*; PETER B. R. HAZELL, *GREEN REVOLUTION: CURSE OR BLESSING?* 4 (Int'l Food Pol'y Res. Inst., 2002).

22. Pingali, *supra* note 18, at 12303–04.

II. PRACTICES IN MODERN AGRICULTURE AND THEIR EFFECTS ON SOIL HEALTH

A. The Green Revolution

In the 1940's, when famine was looming in Mexico, Norman Borlaug, an American scientist working in Mexico, developed a disease-resistant, high-yield varietal of wheat to prevent further starvation in the country.[23] The hardier new wheat, along with the implementation of different farming techniques, allowed Mexico to produce more wheat than it had ever before.[24] This was a massive transformation, as Mexico had been importing *half* of its wheat just years before.[25] Borlaug used a method called "shuttle breeding," which created greater imperviousness in crops.[26] He also developed strains of crops that could be grown in various climates.[27]

Because of Norman Borlaug's success in Mexico, these new farming techniques and hardier crop varieties spread globally and the Green Revolution was born.[28] Borlaug then tackled starvation faced by both India and Pakistan after his success in Mexico.[29] After the implementation of Borlaug's techniques, Pakistan and India were not only able to meet the demand of the rising population, but exceed it, producing more crops than ever before.[30]

Borlaug later won the Nobel Peace Prize for his contribution to industrialized agriculture and is credited with saving millions of people from starvation.[31]

Since the Green Revolution, between 1950 and 1992, global crop production has increased by over 150%.[32] Between 1950 and 2000, world production of grain nearly tripled.[33] Grain production rose by 140% in Africa, by almost 200% in Latin

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23. *Dr. Borlaug: Biography*, NORMAN E. BORLAUG: LEADERSHIP ENHANCEMENT IN AGRIC. PROGRAM, http://borlaugleap.org/dr-borlaug (last visited Feb. 27, 2017) [hereinafter *Dr. Borlaug: Biography*].

24. Salil Singh, *Norman Borlaug: A Billion Lives Saved*, AGBIOWORLD, http://www.agbioworld.org/biotech-info/topics/borlaug/special.html (last updated 2011).

25. Amanda Briney, *Green Revolution: History and Overview of the Green Revolution*, THOUGHTCO (Mar. 3, 2017), https://www.thoughtco.com/green-revolution-overview-1434948.

26. Gregg Easterbrook, *Forgotten Benefactor of Humanity*, ATLANTIC (Jan. 1997), at 5, https://www.theatlantic.com/magazine/archive/1997/01/forgotten-benefactor-of-humanity/306101/ [hereinafter Easterbrook].

27. *Id.*

28. *Dr. Borlaug: Biography*, *supra* note 23, at 1–2.

29. Easterbrook, *supra* note 26.

30. *Id.*

31. *Id.* ("Perhaps more than anyone else, Borlaug is responsible for the fact that throughout the postwar era, except in sub-Saharan Africa, global food production has expanded faster than the human population, averting the mass starvations that were widely predicted – for example, in the 1967 best seller *Famine – 1975!* The form of agriculture that Borlaug preaches may have prevented a billion deaths.").

32. Henry Miller, *Norman Borlaug: The Genius Behind the Green Revolution*, FORBES (Jan. 18, 2012, 11:56AM), https://www.forbes.com/sites/henrymiller/2012/01/18/norman-borlaug-the-genius-behind-the-green-revolution/#5dc45ae56a43.

33. Food and Agric. Org. [FAO], *The State of the World's Land and Water Resources for Food*

America, and by 280% in Asia.[34] Because of the increase in crop production, the human population has skyrocketed, owing its growth, in part, to the Green Revolution and Norman Borlaug.[35] Now we are faced with a similar crisis, in which we must craft a solution to feed billions of people, and correct the problems caused by the Green Revolution.

B. Modern Agriculture's Impact on Soil

The most important part of any agricultural system is the soil.[36] When the soil is poor, it cannot sustain a productive agriculture. Many agricultural systems are at risk and unproductive because "soils have been damaged, eroded, or simply ignored during the process of modern agricultural intensification."[37]

The Green Revolution's use of monoculture (also called mono-cropping), or planting the same type of crops repeatedly, has caused a lack of fertility in the soil.[38] Individual crops use particular nutrients and when harvested, the nutrients are removed from the soil, leaving it depleted.[39] Before the Green Revolution, farmers "fallowed" their fields, leaving them barren, for short periods of time.[40] Alternatively, farmers have historically alternated between different crops in order to maintain robust nutrient levels.[41] By fallowing and rotating fields, pre-Green Revolution farmers allowed the soil to rest and regain nutrients necessary for abundant and healthy crops.

While monoculture produces crops at a very efficient rate, it is harmful to the soil in the long-term. Because of the lack of diversity, crops become fragile and more dependent on fertilizers and pesticide use.[42] In 2009, scientists at the University of Illinois found that loss of organic matter depletes soil's ability to store nitrogen, and causes the soil to become dependent on chemical fertilizers.[43]

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and Agriculture: Managing Systems at Risk xxiv (2011), http://www.fao.org/docrep/017/i1688e/i1688e.pdf.

34. *Id.*

35. *Whitepaper: Growing for Our Future,* AGRICEN & AGRICEN SCIENCES, http://www.agricensciences.com.

36. Alexandra Bot & José Benites, *The Importance of Soil Organic Matter*, 80 SOILS BULL. OF FOOD & AGRIC. ORG. 51 (2005), http://www.fao.org/docrep/009/a0100e/a0100e.pdf.

37. JULES PRETTY & RACHEL HINE, CENTRE FOR ENVIRONMENT & SOCIETY, UNIVERSITY OF ESSEX, REDUCING FOOD POVERTY WITH SUSTAINABLE AGRICULTURE: A SUMMARY OF NEW EVIDENCE 17 (Feb. 2001).

38. Katherine Killebrew & Hendrik Wolff, *Environmental Impacts of Agricultural Technologies EPAR Brief No. 65* 3 (Evans Sch. Pol'y Analysis & Res., Mar. 17, 2010), https://evans.uw.edu/sites/default/files/Evans%20UW_Request%2065_Enviro%20Impacts%20of%20Ag%20Technologies_03-17-2010_0.pdf.

39. Bot & Benites, *supra* note 36, at 71.

40. *Id.*

41. Why is Crop Rotation Important?, WONDEROPOLIS, http://wonderopolis.org/wonder/why-is-crop-rotation-important.

42. Plant Production and Protection Division: Agriculture and Soil Biodiversity, FOOD & AGRIC. ORG. OF THE UNITED NATIONS, http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/soil-biodiversity/agriculture-and-soil-biodiversity/en/.

43. R. Mulvaney, S. Khan, T. Ellsworth, *Synthetic Nitrogen Fertilizers Deplete Soil Nitrogen: A*

The researchers noted that such evidence is common in scientific literature but has seldom been acknowledged because synthetic nitrogen fertilizer practices have been predicated largely on short-term economic gain rather than long-term sustainability.[44]

Thus, an analysis which includes the importance of soil nutrition, and not merely economic gain, must be conducted in order to implement a sustainable agricultural system.

III. FOOD SECURITY AND ITS ROLE IN INTERNATIONAL CONFLICT

Alarming predictions have been made about the potential for climate change to fuel war and other forms of violent conflict.[45] At the extreme end, it has been suggested that the uncontrolled effects of climate change could generate conflicts on the same intensity scale of the world wars and last for centuries.[46] A study suggests that forty-six countries, totaling 2.7 billion people, are at high risk for violent conflict in the immediate future due to climate change exacerbating underlying causes of conflict.[47] Moreover, a further fifty-six countries, totaling 1.2 billion people, are at high risk of political instability, possibly leading to violent conflict in the longer term.[48]

In 2007, UN Secretary-General Ban Ki-moon warned that the increased flooding and droughts could harm those already marginalized communities, stating, "The consequences for humanity are grave. Water scarcity threatens economic and social gains and is a potent fuel for wars and armed conflict."[49] Thus, as we engage in public discourse on topics of peace, climate change and its impacts on resource scarcity must have a seat at the table.

The role of climate change and its effects on water are vital to soil health and crop production. Over the past three decades, the area of land under irrigation has expanded, increasing the heavy use of water input to cropland.[50] Agriculture accounts for sixty-nine percent of water globally withdrawn from rivers, lakes and aquifers, and up to ninety percent in some developing countries.[51] As a result of climate change, crop yields may decline by as much as thirty percent.[52]

Global Dilemma for Sustainable Cereal Production, 38 J. ENVTL. QUAL. 2308 (Nov. –Dec. 2009).

44. *Id.*

45. John Podesta & Peter Odgen, *The Security Implications of Climate Change*, 31 WASH. Q. 115, 116 (2007–08).

46. *Summary, 69* 1, 2 (Whitehall Papers 2007), http://www.tandfonline.com/doi/abs/10.1080/02681300802012886.

47. DAN SMITH & JANANI VIVEKANANDA, A CLIMATE OF CONFLICT: THE LINKS BETWEEN CLIMATE CHANGE, PEACE AND WAR 3 (Nov. 2007).

48. *Id.*

49. *Id.*

50. Food and Agric. Org. [FAO], *Summary Report: World Agriculture toward 2015/2030* 44 (2002), http://www.fao.org/3/a-y3557e.pdf.

51. Don Hinrichsen & Henrylito D. Tacio, *The Coming Freshwater Crisis is Already Here*, *in* FINDING THE SOURCE: THE LINKAGES BETWEEN POPULATION AND WATER 1, 5 (2002).

52. David Pimentel, *Climate Changes and Food Supply*, CIESIN, http://www.ciesin.org/docs/004-138/004-138.html.

When the soil, the very foundation of the global breadbasket, is used beyond its capacity, human suffering and starvation is inevitable.[53] In his 1970 Nobel Peace Prize Speech, Norman Borlaug stated:

> Perhaps no one in recent time has more pungently expressed the interrelationship of food and peace than Nobel Laureate Lord John Boyd Orr, the great crusader against hunger and the first director general of the Food and Agricultural Organization, with his famous words, "You can't build peace on empty stomachs." These simple words of wisdom, spoken twenty-one years ago, are as valid today as when they were spoken. They will become even more meaningful in the future, as world population skyrockets and as crowding, social pressures and stress increase. To ignore Lord Orr's admonitions would result in worldwide disorders and social chaos, for it is a fundamental biological law that when the life of living organisms is threatened by shortages of food they tend to swarm and use violence to obtain their means of sustenance.[54]

Poor crop production, coupled with climate change symptoms like drought, have historically caused starvation and conflicts among those jockeying for precious resources.[55] For example, scholars have cited climate change, poor crop production, and food prices were huge contributors to the period of violence in the Middle East known as the "Arab Spring", in 2011.[56] A year prior, food prices increased in Russia, Ukraine, China, Argentina, Canada, Australia, and Brazil due to droughts and torrential storms, which diminished global crops.[57] Because of these factors, countries that were already experiencing political unrest were pushed further to violence. The region was experiencing internal sociopolitical, economic, and climatic frictions, researchers concluded the resulting food crisis drove tensions over the edge.[58]

Regardless of the speed at which the climate warms, only wealthy countries have the infrastructure and social safety nets to effectively handle the crises.[59] Less wealthy countries may see a faster increase in food shortage and a greater need for

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53. *See generally* PETER SCHWARTZ & DOUG RANDALL, AN ABRUPT CLIMATE CHANGE SCENARIO AND ITS IMPLICATIONS FOR THE UNITED STATES NATIONAL SECURITY (U.S. Dept. of Def. eds., 2003); COURTNEY WHITE, GRASS, SOIL, HOPE: A JOURNEY THROUGH CARBON COUNTRY 28, 29, 71 (2014).

54. Norman Borlaug, The Green Revolution: Peace and Humanity, 1970 Nobel Lecture in Oslo, Norway (Dec. 11, 1970), http://www.nobelprize.org/nobel_prizes/peace/laureates/1970/borlaug-lecture.html.

55. Henk-Jan Brinkman & Cullen S. Hendrix, *Food Insecurity and Violent Conflict: Causes, Consequences, and Addressing the Challenges* 7 (Occasional Paper No. 24 of the World Food Programme, July 2011).

56. *Id.*

57. Ines Perez, *Climate Change and Rising Food Prices Heightened Arab Spring*, SCIENTIFIC AMERICAN (Mar. 4, 2013), https://www.scientificamerican.com/article/climate-change-and-rising-food-prices-heightened-arab-spring/.

58. *Id.*

59. Marie L. Miranda et al., *The Environmental Justice Dimensions of Climate Change*, 4 ENVTL. JUST. 17, 21 (2011).

food security, making more efficient farming techniques all the more urgent.[60] It is more important than ever to protect the quality of soil in order to prevent resource-scarcity conflicts and humanitarian disasters.

IV. SUSTAINABLE FARMING PRACTICES: IMPACTS ON SOIL HEALTH

Current understanding maintains that "agriculture is sustainable when current and future food demands can be met without unnecessarily compromising economic, ecological, and socio-political needs."[61] Ideally, sustainable farming practices will benefit three major objectives: economic stability, environmental sustainability, and social sustainability.[62]

The University of Essex recently completed the largest-ever survey of sustainable agriculture initiatives in developing countries, covering more than 200 projects in fifty-two countries.[63] Researchers found improvements in food production occurring through one or more of four mechanisms: (1) intensification of a single component of a farm system, (2) addition of a new productive element to a farm system, (3) better use of water and land, and (4) improvements in yields of crop staples (such as grains) through introduction of new locally appropriate crop varieties and animal breeds.[64]

The study found that sustainable agriculture practices led to an average increase of ninety-three percent in per hectare food production, without increasing environmental degradation.[65] This increase in production flies in the face of modern agriculture, proving that sustainable agriculture can also be, literally, fruitful.

The majority of sustainable agriculture projects attempt to reduce soil erosion and make improvements to the physical structure of soil.[66] Projects strive to balance water holding capacity and nutrients through the adoption of organic farming and conservation measures.[67] Some examples of the practices employed to meet these ends are: use of cover crops, crop rotation, use of compost, adoption of zero-tillage, and use of organic fertilizers.[68] The following is a discussion of how many of these sustainable practices were put to use on the ground, in a study entitled, the "SoCo Project".

V. SOIL CONSERVATION PROJECT CASE STUDY: THE SOCO PROJECT

Soil erosion in Europe has been a major concern for European policy-makers

60. *Id.* at 18.

61. Agnieszka Latawiec & Jolanta B. Królczyk, *Sustainability Indicators for Agriculture in the European Union*, *in* SUSTAINABILITY INDICATORS IN PRACTICE 182, 184 (2015).

62. *Id.* at 184–85.

63. J.N. Pretty et al., *Reducing Food Poverty by Increasing Agricultural Sustainability in Developing Countries*, 95 AGRIC., ECOSYSTEMS & ENV'T 217, 220–221 (2003).

64. *Id.* at 220–21.

65. *Id.* at 223.

66. *SoCo Project*, *supra* note 13, at 37.

67. *Id.* at 19.

68. *Id.* at 37, 89.

and farmers alike.[69] Erosion can result in productivity losses and cause contamination to local water sources.[70] To correct further erosion, European Parliament requested the European Commission carry out the SoCo Project to determine how best to implement more sustainable practices.[71] The project was a joint collaboration between the Directorate-General for Agriculture and Rural Development and the Joint Research Centre.[72]

The SoCo Project focused narrowly on soil because of its impact on agriculture as a whole. In order to make recommendations to stakeholders, the SoCo Project investigated how local communities could tailor their farming techniques to increase soil quality and how policies could be adapted to ensure proper implementation.[73] In carrying out this project, the European Parliament reasoned that policy makers may decide to support particular farming practices discovered through this project, or implement new relevant policies.[74] The Project faced obstacles in its implementation, however, this was mainly due to lack of resources to enable long-term implementation; farmers were concerned about income loss and expenses of new equipment.[75] Despite some challenges, the Project was successful in established a baseline of understanding of how, where, and when to implement sustainable farming practices to benefit the health of the soil.

A. Soil-Focus Impacts Agriculture from the Ground Up.

Throughout history, farming has contributed to creating and maintaining a rich variety of landscapes and habitats. However, agricultural practices have also had a myriad of adverse environmental effects. As a result of inappropriate agricultural practices, farming has caused: degradation of soil, pollution, water contamination, decreased air quality, fragmentation of habitats, and loss of wildlife.[76] The care of soil results in better food production, which in turn contributes to poverty reduction and social maladies related to hunger and malnutrition.[77]

To further clarify, soil is subject to a series of degradation processes linked to agriculture such as: erosion due to water, wind, and tillage; compaction; declining organic carbon and biodiversity; salinization; and contamination by heavy metals

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69. *Id.* at 5.

70. *FactSheet: Soil Erosion – Causes and Effects*, ONTARIO MINISTRY OF AGRIC., FOOD, & RURAL AFFAIRS, http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm.

71. *SoCo Project*, *supra* note 13, at 17.

72. *Id.*

73. *Id.* at 141.

74. *Id.* at 96–98.

75. *Id.* at 112.

76. *FactSheet No 1: Linking Soil Degradation Processes, Soil Friendly Farming Practices and Soil-Relevant Policy Measures* (Sustainable Agric. & Soil Conservation) http://esdac.jrc.ec.europa.eu/projects/SOCO/FactSheets/EN%20Fact%20Sheet.pdf.

77. JULES PRETTY & RACHEL HINE, REDUCING FOOD POVERTY WITH SUSTAINABLE AGRICULTURE: A SUMMARY OF NEW EVIDENCE 9 (Univ. of Essex, Feb. 2001).

and pesticides, or excess nitrates and phosphates.[78] Additionally, the major drivers for erosion are intense rainfall, topography, low organic matter content, percentage and type of vegetation cover, inappropriate farming practices, and land marginalization or abandonment.[79] The area with the highest wind erosion risk is found across areas with looser soil, such as sandy regions, and coastlines.[80]

B. Objectives of the SoCo Project

The three main objectives of the SoCo Project were: (i) to improve the understanding of soil conservation practices; (ii) to analyze how farmers can be encouraged to adopt soil conservation practices; and (iii) to make this information available to relevant stakeholders and policy makers in the European Union.[81]

C. Implementation and Practices

The SoCo Project relied heavily on research and a "measure twice, cut once" methodology.[82] A series of questionnaires were designed for experts, farmers, and government officials involved in soil conservation.[83] The questionnaires assessed risks of policies and agricultural measures.[84] Interviews were carried out to improve the understanding of soil conservation practices, to analyze how farmers could be encourage to adopt sustainable practices through policies, which was eventually made available to policy-makers and important stakeholders across the European Union.[85]

The selection of case study areas was designed to capture differences in soil degradation, soil types, climate, farming practices, institutional settings, and policies.[86] The implementation was very detailed in its initial research. Initially, research was done on the area and region to determine the exact soil issue (run-off, contamination, top-soil loss, etc.).[87] Case studies were carried out in Belgium, Bulgaria, the Czech Republic, Denmark, France, Germany, Greece, Italy, Spain, and the United Kingdom in 2008.[88] The results of the case studies were elaborated through discussions at stakeholder presentations.[89] Many of the results were region-specific; however, there were many overlapping conclusions regarding implementation and community involvement, which can now be used to help guide

78. *SoCo Project*, *supra* note 13, at 18.

79. *Id.*

80. *Id.*

81. *Id.* at 17.

82. *Sustainable Agriculture and Rural Development*, AGRILIFE (last visited Mar. 6, 2017), http://agrilife.jrc.ec.europa.eu/rural_soco.htm [hereinafter AGRILIFE].

83. EZIO RUSCO, ET AL., SUSTAINABLE AGRICULTURE AND SOIL CONSERVATION (SOCO PROJECT): CASE STUDY REPORT (WP2 FINDINGS) – ITALY 11 (Sept. 2008).

84. *Id.*

85. *Id.* at 17.

86. *SoCo Project*, *supra* note 13, at 65.

87. *Id.* at 65–66.

88. *Id.* at 22.

89. AGRILIFE, *supra* note 82.

future projects.[90]

The SoCo Project focused on two specific farming systems, conservation agriculture and organic agriculture, and detailed a range of practices based in each system.[91] The review considered the system's impact on soil quality and assessed uptake and effects.[92] Some of the conservation practices used were: no-tillage and reduced tillage, permanent soil-cover crops, crop rotation, ridge tillage, contour farming, sub-soiling, intercropping, grassland establishment, agro-forestry, buffer strips, and terracing.[93] These practices were selected because of their potential to remedy soil degradation processes.[94]

While each of these practices is fascinating and important, a discussion of a select few is sufficient to establish understanding. For example, one practice used is ridge tillage, which entails cultivating crops on pre-formed ridges. Ridge tillage allows moisture to be more effectively maintained within the soil, preventing erosion and run-off.[95] Another practice used is intercropping. Intercropping is the growth of two or more crops in the same field during a growing season to promote the interaction between them.[96] As in any diverse ecosystem, the interaction between complementary plants enhances the overall stability of the system, including a significant resilience against pests, diseases, and weeds.[97] Both ridge-tilling and intercropping minimize the risk of soil degradation by increasing the organic nutrients and preventing run-off and erosion.[98] The research found that labor and costs also decreased.[99]

Finally, the study found that organic farming has significant positive effects on the nutrition of soil.[100] When organic farming is employed, energy consumption is decreased and water quality is maintained, due to less run-off and the use of organic fertilizers.[101]

D. Challenges with Implementation

In almost every region, adoption of long-term organic or conservation farming techniques faced numerous obstacles, such as inadequate machinery, and lack of information for farmers.[102] Farmers needed extensive training and access to skilled advisory services.[103] Compared to conventional farming, the study found that a fundamental change in approach is required. Additional economic factors,

90. *SoCo Project*, *supra* note 13, at 22.
91. *Id.* at 19.
92. *Id.*
93. *Id.*
94. *Id.*
95. *Id.* at 38.
96. *Id.*
97. *Id.*
98. *Id.* at 19.
99. *Id.*
100. *Id.*
101. *Id.*
102. *Id.* at 23.
103. *Id.* at 25.

including the costs of new machinery and the risk of income loss during transition periods, were also barriers.[104] Lastly, some local policy measures have not been appropriately targeted.[105] The effectiveness of policy measures could be significantly increased if the reference levels were clearly defined, incentive payments were better targeted and monitored, and if greater levels of advice and support were provided.[106]

While, initially, the conservation techniques of the SoCo Project produced positive effects, many of the promising practices for the sustainable management of agricultural soil were not consistently adopted.[107] Economic factors barred implementation.[108] The costs of new machinery and the risk of income loss during transition periods were not adequately handled and policy measures did not appropriately target these concerns. [109] For example, farmers in Italy were given instructions on how to "terrace" their crops, a technique consisting of planting within leveled platforms, similar to stairs, up a hillside.[110] Terracing is beneficial for the soil's infiltration rate and can help control water erosion.[111] However, high maintenance and costs led farmers to abandon terracing.[112]

Moreover, switching to conservation agriculture might require up-front costs in equipment.[113] In the study, Finland and Greece show the highest uptake of no-tillage, but reduced tillage was practiced on about half of the crop land.[114] As the study indicated, conservation agriculture is very site-specific, which could be a possible future challenge to implementation. Conservation agriculture may be too complex for a particular region, if the farmers do not have resources to be trained, implementation will be barred.[115] The study also indicated that while the farmers were aware of the challenges in implementing the techniques, they did not consider them urgent.[116] Further, stakeholders in many of the regions indicated there was not an infrastructure for soil conservation advice for farmers.[117]

E. Results

When the SoCo Project conducted a survey of policy implementation at regional levels across the European Union, the results indicated that the existing policy measures had the potential to address all recognized soil degradation

104. *Id.* at 23.
105. EZIO RUSCO, ET AL., *supra* note 83, at 120.
106. *SoCo Project*, *supra* note 13, at 134.
107. *Id.* at 23.
108. *Id.*
109. *Id.*
110. *Id.* at 39.
111. *Id.*
112. *Id.*
113. *Id.* at 19.
114. *Id.*
115. *Id.*
116. *Id.* at 23.
117. *Id.* at 93.

processes.[118] Policies were only implemented when there was already a support system in place or in order to prevent great damage (if it was determined that taking on the risk that the policies would not be properly implemented was worth the risk).[119] The study found that when mandatory measures were implemented, awareness and implementation was increased.[120] This may inform policy-makers that techniques may be legislatively-forced.

There was an unfortunate lack of data on the levels of soil degradation in many areas and limited monitoring of the impacts of adopting specific farming practices.[121] This left uncertainty as to which practices to put in place.[122] The techniques were most successful when the commission focused on a very specific set of improvements, tailored to the land.[123] It was *not* successful when the commission tried to implement a practice or technique that had worked in other areas, without tailoring it to that particular land.[124] Additionally, techniques were more successful when they were implanted in areas where they received widespread recognition, and where the techniques were mandatory.[125]

F. Recommendations and Extrapolation

Farm advisory services should support the implementation of farming practices aimed at sustainable soil use. In order to do so, projects should have a baseline of information from which data can be estimated and measured.[126] This would allow better future evaluation of the impact of soil conservation measures adopted and inform future implementation[127]

Proper implementation of permanent soil conservation techniques requires policies that provide incentives for famers and communities.[128] Policy makers and stakeholders must understand which agricultural practices are sustainable and for which particular regions.[129] Further, implementation must be supported and monitored to provide long-term success.

VI. CONCLUSION

The solution to global economic issues, poverty, and environmental degradation concerns lies beneath our feet, in the soil. The precedence and growth of modern agriculture under the "Green Revolution" brought about hugely problematic global changes for the climate and human security. Modern

118. *Id.* at 21.
119. *Id.* at 44.
120. *Id.* at 23.
121. *Id.*
122. *Id.*
123. *Id.* at 113.
124. *Id.*
125. *Id.* at 117.
126. *Id.* at 26.
127. *Id.*
128. *Id.* at 134.
129. *Id.* at 26.

agricultural practices have caused significant environmental degradation leading to social problems such as global hunger and poverty. The SoCo Project was implemented to increase crop yield, while still maintaining the integrity of the soil. The SoCo Project concluded that information and advice are essential to support any changes in farming practices. Additionally, one of the SoCo Project's successes was the intense research that went into the project before anything was even implemented. This project should stand as a model for the obstacles and successes involved in the global implementation of sustainable agriculture projects.