

Green Algae Strategy Series

BioWar I, where food is burned for biofuel, must end with the withdrawal not of soldiers but subsidies that damage human and animal health and our ecological systems. America and our global neighbors are currently over-consuming the precious fossil resources such as fertile soil, freshwater, fossil fuels and fossil nutrients that will not be available when our children most need them.

Mark Edwards makes the *Green Algae Strategy* books available for free color download at GreenIndependence.org.

Biowar I Why Battles over Food and Fuel Lead to World Hunger

Mark Edwards



The four books in the **Green Algae Strategy Series** create an urgent call to action for sustainable and affordable food and energy, SAFE production.

- *BioWar I: Why Battles over Food and Fuel Lead to World Hunger* (2007)
- *Green Algae Strategy: Engineer Sustainable Food and Fuel* (2008)
- *Green Solar Gardens: Algae's Promise to end Hunger* (2009)
- *Crash! The Demise of fossil Foods and the Rise of Abundance* (2009)

America and our world face a crisis with population expansion and climate chaos. SAFE production will save millions from starvation and avoid catastrophic wars over fossil resources such as water and fossil nutrients.

Burning 100 million tons of our primary food for fuel is **unsustainable** and wastes non-renewable fossil resources including fertile soils, freshwater, fossil nutrients and fossil fuels. Growing massive amounts of corn represents ecological suicide as it drains trillions of gallons of non-replenishable groundwater, spikes food and fuel prices, decimates food exports and threatens millions with starvation from a food cascade.

BioWar I inflicts costs, casualties and catastrophe in a magnitude far greater than a conventional war. Taxpayers are forced to pay \$20 B annually to subsidize erosion and pollution of our air and water for a tiny, 3% replacement of foreign oil. America has insufficient disposable cropland, water or energy to waste on a policy that fails its objectives.

Compared with other biofuel alternatives:

- Corn requires more water, land, fertilizer, herbicides and pesticides
- Severely pollutes air, soils, rivers, lakes and well-water
- Degrades and erodes soils
- Grows slowly and produces a low energy biomass yield, only 7%

Corn ethanol is not sustainable. It takes too much water, land, energy and money. Burning food for fuel is antithetical to American values when 1 out of 6 Americans are on food support and 30,000 children starve daily.

BioWar I must end not with a withdrawal of soldiers but a halt to wasteful and ecologically destructive subsidies and tariffs. Subsidies should be shifted to ecologically positive food and energy production such as algae.

Green Algae Strategy End Oil Imports and Engineer Sustainable Food and Fuel

Mark Edwards



Oil independence, sustainable and affordable food and halting climate change represent the most critical challenges of the 21st C., not just for America but for all nations. Half the 6.8 billion people on our planet are very hungry. Our best hope may lie in the oldest, tiniest yet fastest growing plant on Earth — the same plant that once saved the Earth when it transformed Earth's deadly CO₂ atmosphere to life-giving oxygen. Green Algae Strategy lays out a path towards energy independence and sustainable and affordable food production.

Water-based plants called algae are 100 times more productive per acre than land plants because they grow much faster and do not waste biomass on cellulosic structure. Algae may be 50% lipids, algal oil that can fuel diesel engines, cars or jet planes. The carbohydrate component of the biomass may also be refined to other biofuels such as methane or gasoline or to bioplastics, textiles or paper. The protein component may be 60% of the biomass and offers value as food, ingredients, health foods, nutraceuticals, vitamins and fine medicines. Algae can also clean polluted wastewater, recover, reclaim and recycle lost nutrients in waste water streams, sequester CO₂ from coal-fired power plants and provide rich organic fertilizers.

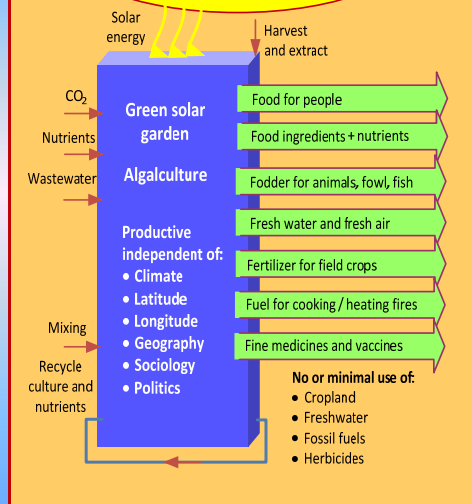
Green solar or algaculture applies a seemingly novel but actually nature's ancient strategy for growing biomass; the use of water-based plants with special characteristics that capture and store solar energy. Algae offer a wide range of sustainable products and pollution solutions that produce in spite of climate chaos.

Green Algae Strategy won the Independent Publisher Gold Medal as the "Best Science Book" published in 2008 from over 4,000 books.

Green Solar Gardens

Algae's Promise to End Hunger

Mark Edwards



If one way be better than another, that you may be sure is nature's way.

— Aristotle

Nature created the most efficient and productive food and energy system on Earth – Green Solar. *Green Solar Gardens* lays out a strategy to mimic nature's way by cultivating algae in a manner that enables anyone on the planet with desire to grow sustainable and affordable food and energy.

Our world faces a crisis of poverty and hunger for roughly half the people on our planet. *Green Solar Gardens* addresses the root causes of poverty and hunger including solutions that promise sufficient and affordable food, fodder, fuel, freshwater, fertilizer and fine medicines. Numerous sources describe the dire circumstances of poverty and hunger. *Green Solar* offers viable solutions that can save millions from malnutrition and starvation.

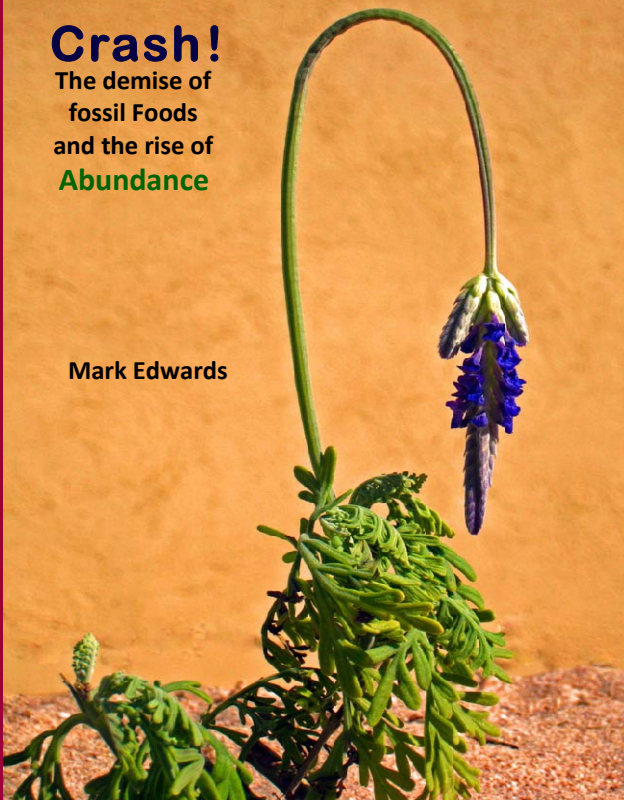
Unlike fossil food, green solar uses abundant resources that are cheap and will not run out. *Green Solar Gardens* provides a set of practical solutions to difficult challenges facing those caught in the web of poverty and hunger by distributing food production knowledge and capability globally so people can grow nutritious and delicious food for the needs of their family and community, locally.

**Solve hunger globally with SAFE production —
Sustainable and Affordable Food and Energy grown locally.**

Crash!

The demise of fossil Foods and the rise of Abundance

Mark Edwards



Crash! sounds the alarm that a food supply built on eroding fossil resources cannot stand. We will run out of non-replaceable inputs, freshwater, fertile soil, fossil fuel and an vital agricultural chemicals that have no substitutes, such as phosphorous, copper and zinc. The Green Revolution was actually Black because it ravenously consumed non-renewable inputs while enabling catastrophic population expansion. When the first fossil resource becomes unavailable or unaffordable to farmers in about 20 years, industrial food production will crash leaving billions of people very hungry. Farmers are extracting and consuming resources their children will find gone just when they need them most.

Farmers consume 100 million tons of fossil inorganic (mined) chemicals each year for fertilizers and agricultural chemicals. Over 75 million tons of nutrients are lost each year; 50% to the human and animal waste streams and 25% to erosion. Industrial agriculture is productive because it is leveraged on eroding assets; fossil resources. Several will run out soon, others will become unaffordable within 20 years — and there is no safety net.

Abundant agriculture enables sustainable and affordable food and energy, SAFE production with plentiful cheap inputs that will not run out. Green solar energy captured in water-based plant bonds — algalculture — is the oldest yet most productive food and energy system on Earth.

Crash! provides the scientific evidence that fossil foods are doomed unless we quickly create a supplemental food and feed supply that recovers, recycles and reuses fossil nutrients in the human and animal waste streams. *Crash!* shows a positive path forward where green solar enables a truly Green Revolution with Abundant Agriculture.

GreenIndependence.org is a non-profit social venture advancing sustainable and affordable food and energy, (SAFE) production with green solar energy captured in algae. SAFE production is needed globally to supply energy for food, fuels, feeds and fine medicines. Green Independence advances research, development, demonstration and diffusion of novel solutions that enable SAFE production for anyone on Earth who has desire to produce critically needed products for their family and community. Mark Edwards makes the *Green Algae Strategy Series* available for free color download at:



GreenIndependence.org serves as an open source collaboratory for scientists, educators, and policy makers who focus on algal solutions that create more social equity, moderate climate change, deforestation, smoke death, pollution and disease with algal biomass and coproducts. Oil independence, sustainable and affordable food and halting climate change represent the most critical challenges of the 21st Century, not just for America but for all nations. Our best hope for solving these crucial challenges lies in the oldest and tiniest yet fastest growing plant on Earth — algae.

People tend not to act until the wolf is at the door. — Aesop, 630 BC
The wolf is at our door with climate change and peak fossil resources.

Green Algae Strategy
End Oil Imports and Engineer Sustainable Food and Fuel

Mark Edwards



Oil independence, sustainable and affordable food and halting climate change represent the most critical challenges of the 21st C., not just for America but for all nations. Half the 6.7 billion people on our planet are very hungry. Our best hope may lie in the oldest, tiniest yet fastest growing plant on Earth — the same plant that once saved the Earth when it transformed Earth's deadly CO₂ atmosphere to life-giving oxygen.

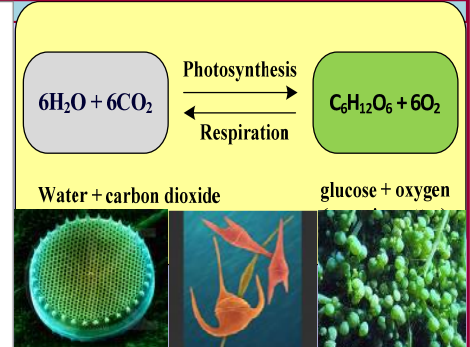
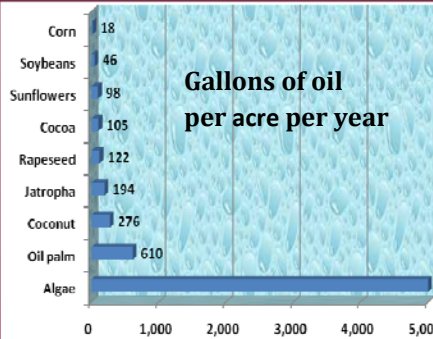
Green Algae Strategy shows the path to a future with abundant food, energy, feed, freshwater, fresh air and fine medicines with the lowest plant on the food chain — algae.

Green Independence

Sustainable and Affordable Food and Energy

Algae hold promise to provide extraordinary solutions using three different strategies.

- Displace oil imports.** Large scale algal farms will displace oil imports, enable energy independence and eventually end to the need to use fossil fuels with extensive help from other forms of carbon neutral fuels.
- Defeat hunger.** Micro -algal gardens will serve for ending hunger in America and the world and stop smoke death from fossil fuel cooking fires.
- Recapture fossil carbon.** Growing algae in large areas of the oceans will sequester the CO₂ released from fossil fuels and halt global climate change.



It sounds too easy. Algae consume abundant and cheap inputs that will not run out — sunshine, wastewater, CO₂ and nutrients. Green solar simply does in a matter of days what nature took 300 million years to do in making black solar — petroleum, coal and coal shale. Algae are nature's oldest and tiniest yet fastest growing biomass. Green solar does not make gold out of lead. It simply taps the most efficient growing system on Earth, that captures solar energy in plant bonds.

Sustainable Foods and Biofuels

Algae can grow independent of:

- Latitude, altitude or longitude
- Geology, philosophy or sociology
- Heat, cold or temperature spikes
- Weather, storms or climate
- Poles, glaciers or brutal deserts

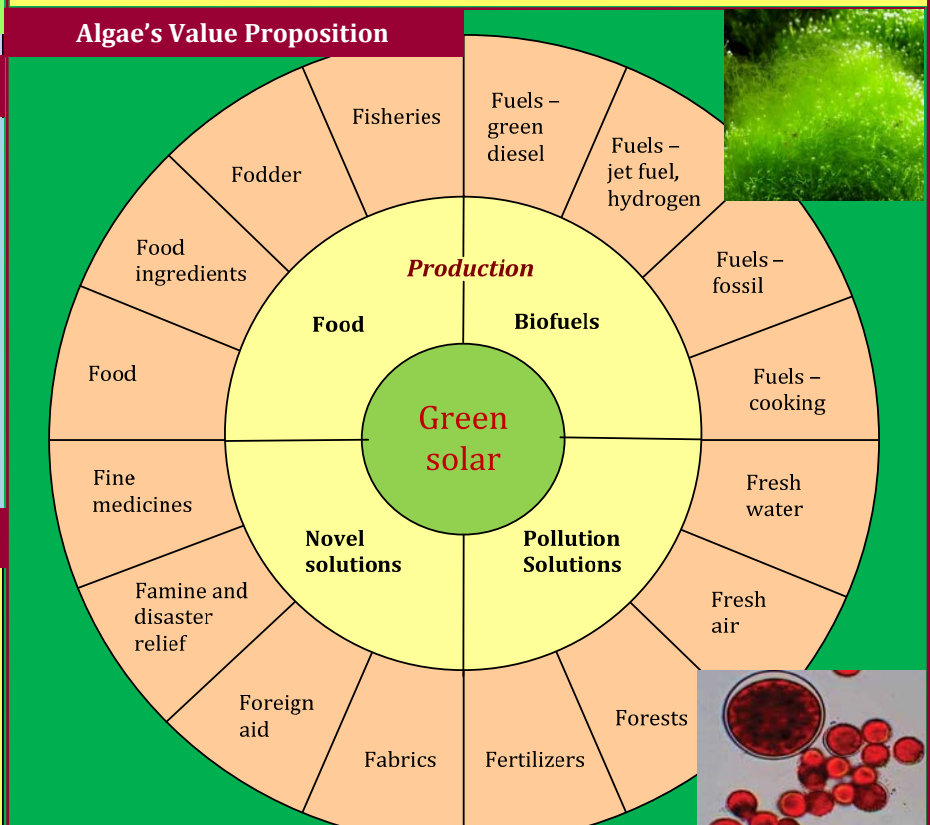
Algae need no: (algae grow well on)

- **Cropland** — deserts, mountains, wasteland
- **Fresh water** — brine, salt or wastewater
- **Fossil fuels** — use solar, wind or make their own algal oil and biodegradable plastic

Threats from non-action

1. Climate change passes its tipping point and causes multiple catastrophes.
2. A food cascade causes starvation for 30 million people.
3. A few big companies lock up intellectual property. The world will have a great solution but not affordable access for those who need it most. We need open source. Let's put algae to work and rescue our planet — **now!**

Algae's Value Proposition



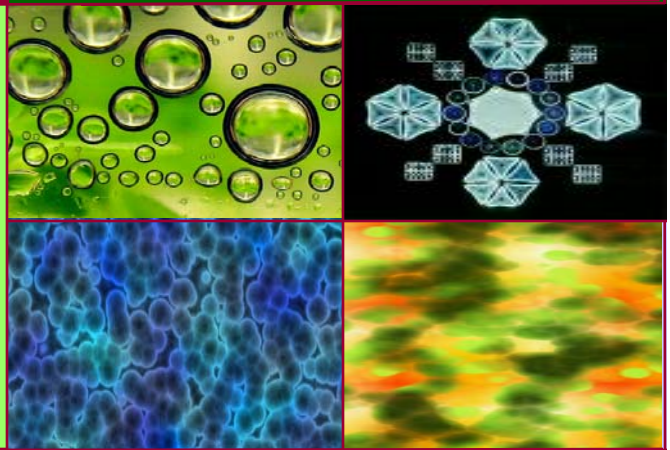
Green Solar

Green solar produces energy in a variety of ways for:

- **People** – protein in food, food nutrients and medicines
- **Animals, fish and fowl** – high energy organic protein
- **Plants** – organic nitrogen fertilizer and soil conditioners
- **Fire** – high energy cooking and heating oil
- **Cars** – carbohydrates refined to gasoline for transportation
- **Trucks, tractors and trains** – high energy green, clean diesel
- **Planes** – high energy jet fuel

Green solar also produces other coproducts such as low cost organic fertilizer and fine medicines, vaccines and pharmaceuticals. Algae also provide a wide range of pollution diagnostics, measures and air and water pollution solutions.

Algae Biomass



Water-based plants called algae are 30 to 100 times more productive in producing biomass than land plants. The microalgae biomass may be 20% to 60% lipids, called algal oil and common vegetable oil that can fuel diesel engines directly without conversion. The carbohydrate component of the biomass may also be refined to other biofuels such as methane or gasoline.

Green solar or algaculture applies a seemingly novel but actually nature's ancient strategy for growing biomass; the use of water-based plants with special characteristics. Algae are among the oldest, tiniest yet fastest growing plants on Earth. Algae form the bottom of the food chain and are eaten by many herbivores from the tiniest shrimp to the largest animals on Earth; the great blue whales.

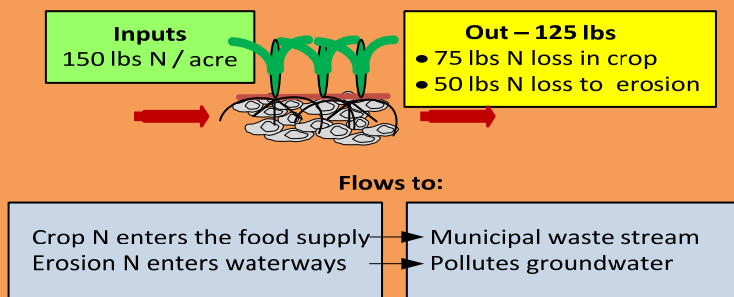
Arizona

Algae needs

Arizona

Sunny days	Algae rests on cloudy days	360 days
Temperature	60° F to 110° F	350 days
Few frost days	Altitude < 1,000 feet to minimize frost	< 1,000 feet 5 days of frost
Flat, cheap land	Non-crop land, undeveloped	Hundreds of miles of desert
Waste or brine water	Algae get nutrients from waste and brine water	Oceans of brine water

Fossil resource sink — fossil foods



Fossil Agriculture. The Green Revolution was a Black Revolution.

- Three times increase in crop production.
- 10 times increase in irrigation.
- 23 times increase in fossil fuels.
- Heavy reliance on fossil inorganic (mined) chemicals.

Is fossil agriculture sustainable? No, only until fossil reserves run out.

- Heat + drought + wind = less soil moisture; less fresh water
- Increasing population + rising sea levels = less cropland
- More fertilizers + pesticides + herbicides = pollution
- More fierce storms — destroys crops, reserves and infrastructure
- Pest immunity — pest invasions destroy crops and amplify
- Ag erosion + pollution — agriculture's self-inflicted destruction



Challenges. Convey algae's value proposition.

1. Create collaborative networks — GreenIndependence.org.
2. Design and build green solar farms for energy production.
3. Design and build micro green solar farms to solve hunger.
4. Find or develop optimal species for oil, foods, fertilizers, CO₂ sequestration, water remediation and other products.
5. Soften the hard cell wall to make algal food more digestible.
6. Enhance algae's nutritional profile, texture and taste.
7. Engage great green gardeners — 10 M Green Masterminds.
8. Implement R3D locally and globally to share capabilities.

Green Solar Gardens

Social Entrepreneurship to Save our Planet

Food for 3.7 billion malnourished world citizens.
Distribute knowledge and capability globally to grow sustainable food and energy locally.

Algae's Green Solar Pledge

Give us food and energy,
 And tomorrow our family will be hungry and cold.

Instead, teach us to harvest our green solar garden,
 To collect the sun's energy in high-energy plant bonds.

Let us learn algaculture – nature's first agriculture,
 To grow sustainable, nutritious and delicious food,
 And strong fuels, fertilizer, fodder and fine medicines,
 Using no cropland, no freshwater and no fossil fuels.

Please end our malnutrition,
 That leaves our children stunted, weak, dumb and blind.

Enable us to grow green solar gardens independent of
 Altitude, latitude, longitude, geography or climate.

Show us how to grow healthy organic foods and clean fuels,
 And to produce vital nutrients that make our children strong.

Show us how to grow affordable food for our local needs,
 Using abundant and cheap sunshine, wastewater and CO₂.

Endow us a legacy with a positive ecological footprint,
 And tomorrow our family will be healthy, well-fed and warm.

Green solar produces energy in a variety of ways for:

- **People** – organic protein in food, health foods and medicines
- **Animals, fish and fowl** – high energy organic protein
- **Plants** – organic nitrogen fertilizer and soil conditioners
- **Fire** – algal oil for high energy, clean burning cooking
- **Trucks, tractors and trains** – high energy clean, green diesel
- **Boats, barges and ships** – high energy green, clean diesel

Abundant agriculture. Algae consume abundant and cheap inputs that will not run out – sunshine, wastewater, CO₂ and nutrients. Green solar does in a matter of days what nature took 400 million years to do in making black solar – petroleum, coal and coal shale. Algae are nature's first food and the fastest growing biomass on Earth.

Sustainable / Affordable Food and Energy

Algae consume no fossil resources:

- **Cropland** – deserts, mountains, wasteland
- **Freshwater** – brine, salt or wastewater
- **Fossil fuels** – use solar, wind or make their own algal oil and biodegradable plastic

Algae can grow independent of:

- Latitude, altitude or longitude
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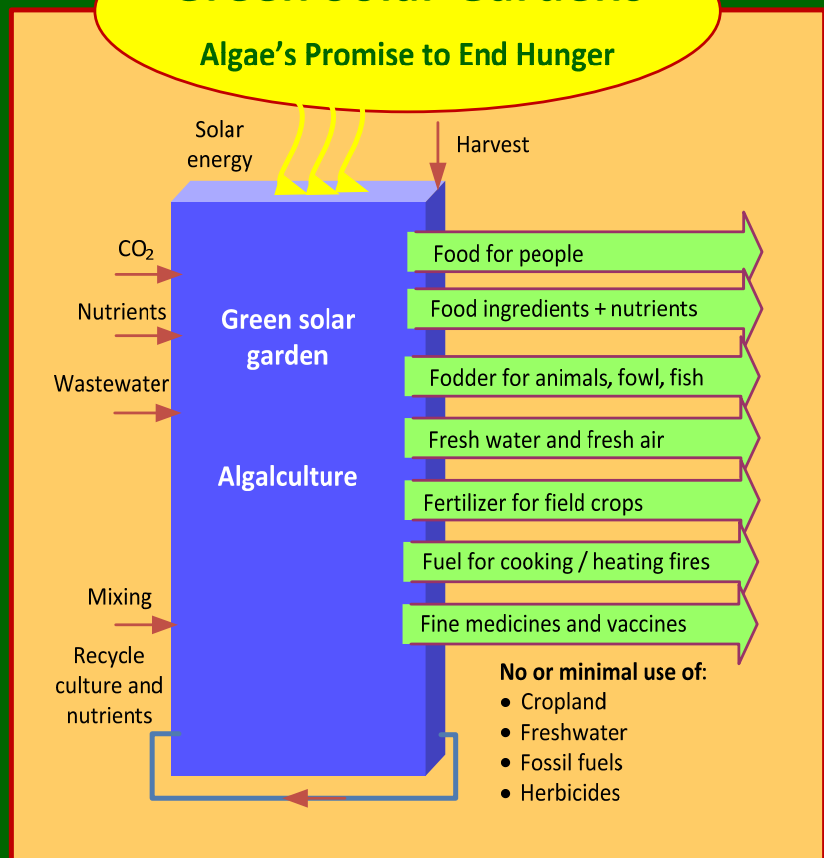
Threats from non-action

1. Climate change passes its tipping point and causes multiple catastrophes.
2. Food riots expand causing more deaths, disabilities and disasters.
3. A food cascade causes starvation for 30 million people.

Let's put algae to work and rescue our planet
 — now!

Green Solar Gardens

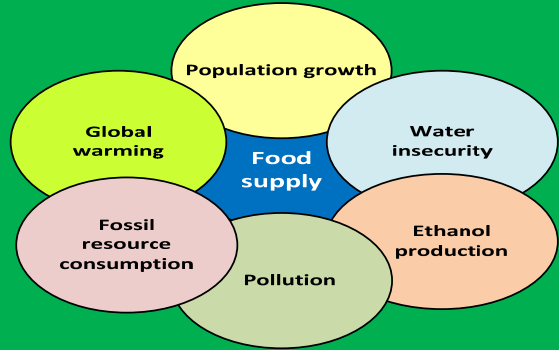
Algae's Promise to End Hunger



Environmental Scan

Challenge	The most since humans have been on Earth:
Hunger	<ul style="list-style-type: none"> • Children who starve to death, > 33 million / year • Starvation death rate – every 3 minutes • Food insecure global citizens, > 3 billion people • People plagued with malnutrition, > 2.7 billion • Americans on food stamps, > 30 million • Americans on food support, > 66 million
Water security	<ul style="list-style-type: none"> • Aquifer crashes; water tables too deep for pumping • Springs, rivers, lakes, and reservoirs that go dry • Cities facing water supply and quality crises • Melting glaciers and diminishing snow packs • Deforestation and expanding deserts worldwide
Heat and drought	<ul style="list-style-type: none"> • High ocean surface and subsurface temperatures • Hottest days, months, years and decades • Food growing areas facing heat and drought • Loss of Arctic and Antarctic ice sheets • Severe forest, rangeland and wild fires • Fierce hurricanes, cyclones, tornados and storms • High ocean tidal and storm surges
Pollution	<ul style="list-style-type: none"> • CO₂ levels in the atmosphere, soils and oceans • Largest loss of coral reefs and coral ecosystems • Cropland lost to salt invasion and rising oceans • Dead zones in lakes, estuaries, bays and oceans • Greenhouse and poisonous gas emissions • Polluted wetlands, creeks, rivers and lakes • Well-water too polluted for human use • Acute human and animal poisonings

Is fossil agriculture sustainable?



Population is growing faster than food production increases. Food produced per person has decreased every year since 1983.

Global warming diminishes crop production, creates fierce storms and droughts, increases ocean levels destroying prime cropland.

Expanded irrigation has doubled food production at the cost of using three times as much water. Fossil aquifers will crash within a generation on each food producing continents. New food crops are more productive but consume more water.

Fossil resources especially the critical plant fertilizer phosphorus and other agricultural chemicals are nearing their end. Fossil fuels are used in agriculture for cultivation, harvest, distribution, pesticides, herbicides. Over 90% of the cost of nitrogen fertilizer comes from the fossil energy required to produce it. Long supply chains jeopardize fossil agriculture due to costs, storms, politics or terrorists.

Fossil agriculture acts like a parasite destroying its host by eroding soils, disrupting ecosystems, polluting air and poisoning water. Over-irrigation destroys cropland from erosion in salt invasion.

Ethanol production consumes 40 million acres of precious U.S. cropland, 2 trillion gallons of fresh water in 7 billion gallons of diesel fuel each year while severely polluting air, soils and water. We need to end ethanol production and shift expensive subsidies from ecologically destructive fossil production to ecologically positive, truly renewable and sustainable food and energy production.

Is fossil agriculture sustainable?

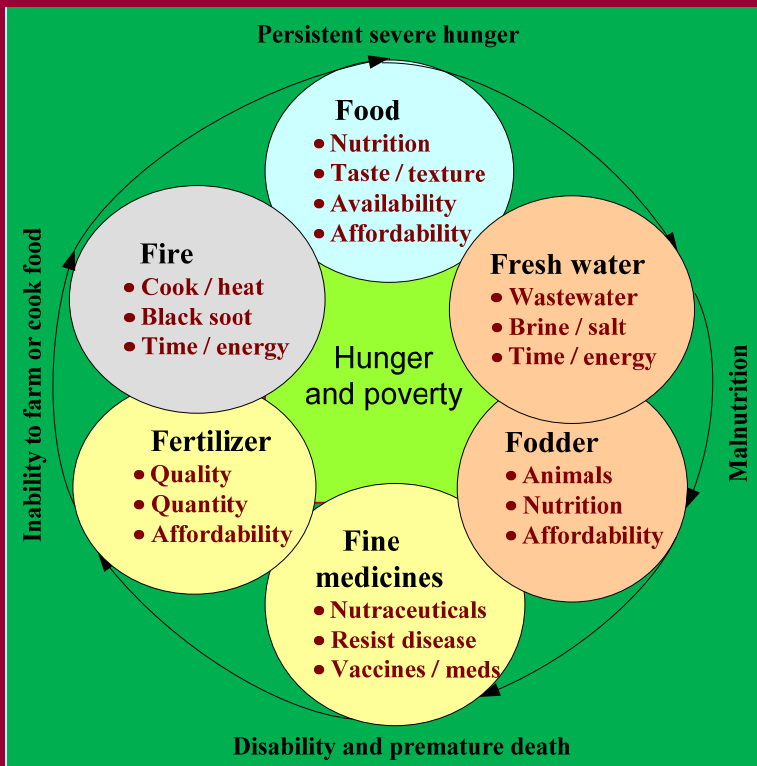
No. Fossil like the culture uses too many diminishing natural resources that will become too expensive and then run out.

Green solar gardens offer abundant agriculture that does not rely on fossil resources. Green solar uses plentiful inputs that are affordable and sustainable for many generations.

Challenges. Convey algae's value proposition.

1. Create collaborative networks — GreenIndependence.org.
2. Design and build green solar farms for energy production.
3. Design and build micro green gardens to solve hunger.
4. Find or develop optimal species for oil, foods, fertilizers, CO₂ sequestration, water remediation and other products.
5. Soften the hard cell wall to make algal food more digestible.
6. Enhance algae's nutritional profile, texture and taste.
7. Engage great green gardeners — 10 million Green Masterminds.
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The Web of Poverty and Hunger



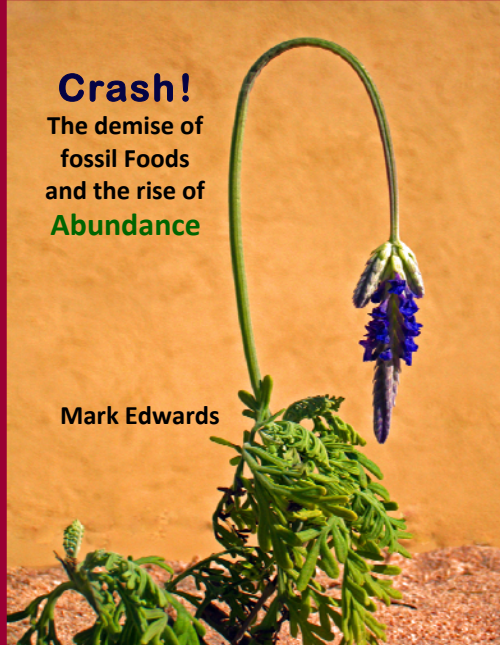
Crash!

Crash! sounds the alarm that our global food supply built on eroding fossil resources cannot stand. We will run out of non-replaceable inputs, freshwater, fertile soil, fossil fuels and vital agricultural chemicals that have no substitutes such as phosphorous. The Green Revolution was actually Black because it ravenously consumed non-renewable inputs. When the first fossil of many resources crashes, industrial food production stops. Farmers are extracting and consuming resources their children will find gone just when they need them most.

Abundant agriculture enables sustainable and affordable food and energy, SAFE production with plentiful cheap inputs that will not run out. Green solar energy captured in water-based plant bonds — algaculture — is the oldest yet most productive food and energy system on Earth. *Crash!* provides the scientific evidence that fossil foods are doomed and shows a positive path forward where green solar enables a truly Green Revolution with Abundant Agriculture.

Crash! chapters:

1. The Problem – Fossil Agriculture
2. Fresh Water Challenges
3. Topsoil and Nutrients
4. Fossil Fuels and Elements
5. External Factors
6. The Tiny Plant that Saved the Earth
7. Abundant Agriculture
8. Cultivating Abundance
9. The Rise of Abundance



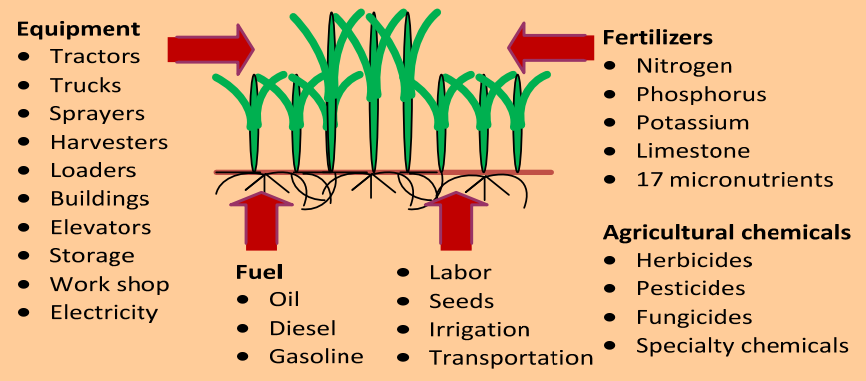
Crash!
The demise of fossil Foods and the rise of Abundance

Mark Edwards

Fossil Agriculture — Nutrient Extinction

The Green Revolution may have been the biggest disaster of the 20th century because increasing food production ignited a population explosion of 4 billion people that threatens to devour our planet's natural resources necessary to grow crops. The Green Revolution was not green but black because food productivity was built on an eroding foundation of black fossil fuels and mined agricultural chemicals. Increased food production was leveraged on the unsustainable actions of substituting fossil fuels for labor, expanding irrigation 6 times and increasing fertilizer application 10 times. Pesticide and herbicide use has increased over 500 times.

Fossil inputs to Agriculture



Fossil Agriculture. The Green Revolution was a Black Revolution — unsustainable.

Increases by farmers since 1950:

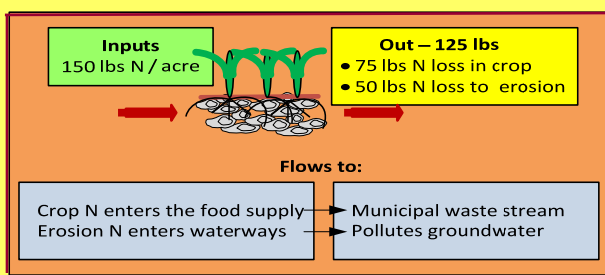
• Crop production	300%
• Irrigation	1,000%
• Fossil fuels	2,300%
• Fossil fertilizers	600%
• Herbicides/pesticides	3,500%

Increases by consumers since 1950:

• People + 4 billion	200%
• Meat consumption	800%
• Cars	1,000%
• Fossil fuels	1,200%
• Houses	500%
• Air miles	1,000%

Farmers consume **100 million tons** of fossil inorganic (mined) chemicals each year. Over 75 million tons of nutrients are lost each year; 50% to food and 25% to erosion. Several will run out shortly and others will become unaffordable within 20 years. When the **first** fossil input runs out, industrial food production then will end. When the first nutrient, probably phosphorous, becomes extinct, food supplies will crash.

Fossil nutrient problem:
Waste stream water is not usable, too much salt. Erosion water is not usable, nutrients are too diluted. Land plants are limited to fossil reserves because they cannot recover nutrients lost to water.



The demise of fossil agriculture is simple physics; the supply of mined fossil resources will crash. Many of the mined resources on which plants depend such as phosphorus, sulfur, copper and zinc have sparse reserves. Farmers cannot substitute any other element for these vital nutrients and there are no practical synthetic alternatives. Mined agricultural chemicals cannot be recycled because they are lost to harvest and erosion. The world needs a food source that can recover nutrients from water sources.

Green Solar — Abundant Agriculture

Green solar produces energy in a variety of ways for:

- **People** – protein in food, food nutrients and medicines
- **Animals, fish and fowl** – high energy organic protein
- **Plants** – organic nitrogen fertilizer and soil conditioners
- **Fire** – high energy cooking and heating oil
- **Cars** – carbohydrates refined to gasoline for transportation
- **Trucks, tractors and trains** – high energy green, clean diesel
- **Planes** – high energy jet fuel

Green solar also produces other coproducts such as low cost organic fertilizer and fine medicines, vaccines and pharmaceuticals. Algae also provide a wide range of pollution diagnostics, measures and air and water pollution solutions.



Energy expended

- 25% respiration
- 35% structure
- 35% reproduction

Waste energy – 90%

- Roots
- Trunk / stems
- Leaves
- Cellulose
- Reproductive apparatus

Harvestable energy:
Flower, fruit or seed



Energy expended

- 10% respiration
- 85% biomass
- 5% reproduction

Waste energy – 10%
Residue

Harvestable energy:
Entire biomass

- Lipids (oil)
- Proteins
- Carbohydrates

Water-based plants called algae are 30 to 100 times more productive in producing biomass than land plants. The microalgae biomass may be 20% to 60% lipids, called algal oil and common vegetable oil that can fuel diesel engines directly without conversion. The biomass may also be refined to other biofuels such as jet fuel, methane or gasoline.

Green solar or algaculture applies a seemingly novel but actually nature's ancient strategy for growing biomass; the use of water-based plants with special characteristics. Algae are among the oldest, tiniest yet fastest growing plants on Earth. Algae form the bottom of the food chain and are eaten by 100 times more creatures than any other food on Earth. Nearly every creature eats algae or algal feeders, the plankton, krill or fish that eat algae, from the tiniest shrimp to the largest animals on Earth; the great blue whales. Humans and our animals have eaten naturally occurring algae for thousands of years.

Our challenge is to cultivate and tame this amazing plant so our world can enjoy its many benefits.

Arizona	Algae needs	Arizona
Sunny days	Algae rests on cloudy days	360 days
Temperature	60° F to 110° F	350 days
Few frost days	Altitude < 1,000 feet to minimize frost	< 1,000 feet 5 days of frost
Flat, cheap land	Non-crop land, undeveloped	Hundreds of miles of desert
Waste or brine water	Algae get nutrients from waste and brine water	Oceans of brine water

Magic 21 Fossil inputs for Food

Primary inputs

1. Fertile soil
2. Freshwater
3. Fossil fuels
4. Seeds

Macronutrients

5. Nitrogen (N)
6. Phosphorus (P)
7. Potassium (K)
8. Calcium (Ca)

Note: Reserves of several fossil inputs will run out by 2030.

Micronutrients

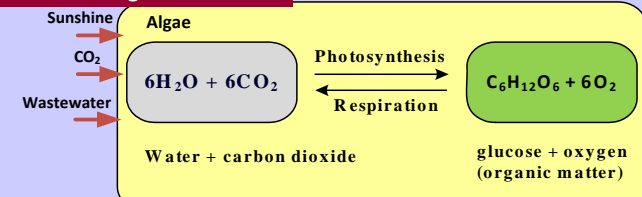
9. Carbon (C)
10. Oxygen (O)
11. Hydrogen (H)
12. Sulfur (S)
13. Magnesium (Mg)
14. Boron (B)
15. Copper (Cu)
16. Chlorine (Cl)
17. Iron (Fe)
18. Molybdenum (Mo)
19. Manganese (Mn)
20. Nickel (Ni)
21. Zinc (Zn)

Industrial agriculture

Industrial farms are productive because they leverage food production with mechanization, synthetic and inorganic fertilizers, pesticides and herbicides. Fossil farms tend to be so specialized that crop and livestock production are geographically separated. Crop residues and manure that were once recycled have become waste streams that create a disposal problem. Crop residues are often buried or burned, the cheapest method of disposal. Meat and dairy production occurs indoors or on large feedlots with thousands of birds or animals whose waste stream pollutes the local ecology.

Food production, whether organic or industrial, requires the Magic 21 fossil inputs and nutrients to grow crops. Failing the availability or affordability of just one fossil input, crops fail.

Abundant agriculture



Abundant agriculture uses nature's first food production system – green solar – to provide sustainable and affordable food and energy, (SAFE), production. Green solar reclaims, recycles and reuses nutrients in wastewater, brine water and oceans and represents the simplest and most efficient food production system on Earth. Mother Nature's first energy storage system, algae, promises to provide poor, thirsty, hungry and malnourished people affordable food and energy they can grow locally.

Challenges. Convey algae's value proposition.

1. Create collaborative networks — GreenIndependence.org.
2. Design and build green solar farms for growing sustainable food and energy production locally.
3. Find or develop optimal species for oil, foods, fertilizers, CO₂ sequestration, water remediation and other products.
4. Soften the hard cell wall to make algal food more digestible.
5. Enhance algae's nutritional profile, texture and taste.
6. Engage great green gardeners — 10 M Green Masterminds.
7. Engage you, your friends and communities globally.

ZooPoo360

Crash! sounds the alarm that a food supply built on an eroding foundation of fossil resources cannot stand. We will run out of several of the Magic 21 fossil inputs for food that are non-replaceable and have no substitutes. Modern agriculture is not sustainable because it ravenously consumes non-renewable resources such as fertile soils, freshwater, fossil fuels and phosphorus. When the first of the 21 vital fossil resources becomes unavailable, industrial food production stops. Farmers are extracting and consuming resources their children will find gone just when they need them most.

Abundant agriculture enables sustainable and affordable food and energy, (SAFE production) with plentiful cheap inputs that will not run out. Green solar energy captured in water-based plant bonds — algaculture — is the oldest, yet most productive food and energy system on Earth. **Crash!** provides the scientific evidence that fossil foods are doomed and shows a positive path forward where green solar enables a truly Green Revolution with Abundant Agriculture.

Crash! and the Rise of Abundance

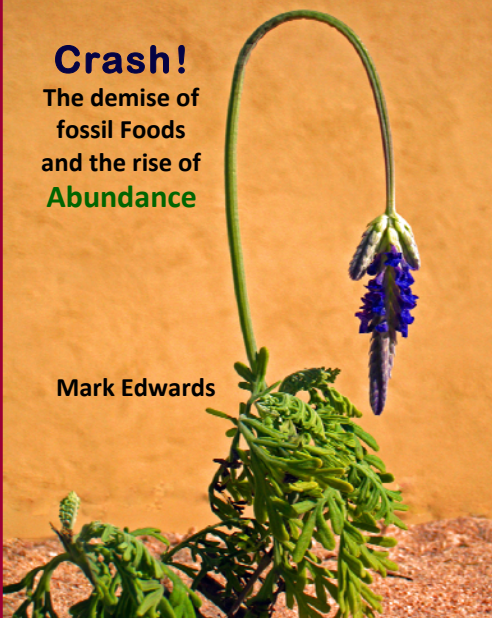
How to produce abundant and sustainable food, freshwater and energy despite:

- **Climate change** — global warming
- **Water pollution** and water scarcity
- **Peak fossil fuels** and fossil nutrients
- **Soil degradation**, erosion and loss
- **More fierce storms** and wildfires
- **Drought**, heat and dry winds
- **Sea level rise** and ocean surge

Crash!

The demise of fossil Foods and the rise of **Abundance**

Mark Edwards



Fossil Agriculture. The “Green Revolution” was not green but black because modern food production is unsustainable. Increases by farmers since 1950:

- Crop production 300%
- Irrigation 1,000%
- Fossil fuels 2,300%
- Herbicides/pesticides 3,500%

Increases by consumers since 1950:

- People + 4 billion 200%
- Meat consumption 800%
- Cars 1,000%
- Fossil fuels 1,200%
- Houses 500%
- Air miles 1,000%

Farmers consume **200 million tons** of fossil inorganic (mined) chemicals each year. Over 150 million tons of nutrients are lost each year; 50% to food harvest and 25% to erosion. Several will run out shortly and others will become unaffordable within 20 years. When the **first** fossil input runs out, industrial food production then will end. When the first nutrient, probably phosphorous, becomes extinct, food supplies will crash.

The demise of fossil agriculture is simple physics — the supply of mined fossil resources is limited. Many of the mined resources on which plants depend such as phosphorus, sulfur, copper and zinc have sparse reserves. Farmers cannot substitute any other element for these key nutrients and there are no practical synthetic alternatives. Mined agricultural chemicals cannot be recycled because they are lost to harvest and erosion. The world needs a food source that can recover nutrients from waste streams.

Magic 21 Fossil inputs for Food

Primary inputs

1. Fertile soil*
2. Freshwater*
3. Fossil fuels*
4. Fine seeds

* Short supply

Macronutrients

5. Nitrogen (N)
6. Phosphorus* (P)
7. Potassium (K)
8. Calcium (Ca)
9. Carbon (C)
10. Oxygen (O)
11. Sulfur (S)
12. Hydrogen (H)

Micronutrients

13. Magnesium (Mg)
14. Boron (B)
15. Copper* (Cu)
16. Chlorine (Cl)
17. Iron (Fe)
18. Molybdenum (Mo)
19. Manganese (Mn)
20. Nickel (Ni)
21. Zinc* (Zn)

Solution— Abundant Agriculture



ZooPoo360
Recover, recycle and reuse energy, water and nutrients from the Zoo waste stream

If one way be better than another, that you may be sure is nature's way.
— Aristotle

Vision. Nature’s first and simplest energy system, algae, uses only sunshine, wastewater and surplus CO₂ to recycle and reuse ZooPoo to produce clean, sustainable, carbon neutral food, feed, energy, fertilizer and freshwater. The Phoenix Zoo becomes the world’s first destination EcoZoo and demonstrates nature’s way for energy storage and harvest – green solar energy in algae. ZooPoo360 enables the zoo to transform a cost to a profit center and become a sustainable living learning center while moving towards a net zero:

- **Carbon footprint** – carbon sequestration and carbon neutral food and fuel.
- **Freshwater footprint** – freshwater production from wastewater.
- **Fossil fuel footprint** – carbon neutral energy production.
- **Fossil nutrient footprint** – fossil nutrient recovery, recycle and reuse.

Can ZooPoo save our Animals from Extinction?

Challenge. Many animals, plants and entire ecosystems are threatened with extinction due to lack of food and freshwater. Food provides the vital energy that enables life. We need food to live but our food supply is unsustainable with modern agriculture because soon we will run out of critical fossil resources needed to grow land-based crops.

When fossil fuels are burned, the energy goes up in smoke. When food energy is eaten, half the energy is burned (calories) as animal energy and half exits to the waste stream. Roughly 80% of the nutrients remain in the waste. Currently, waste streams from animals and people are burned or buried.

ZooPoo360 demonstrates how algae can reuse ZooPoo energy, recover lost nutrients and clean dirty water. Algae transforms ZooPoo to clean products that offer many uses. Algae grows 100 times more productively than land plants so food and fuel can be produced daily rather than yearly.

ZooPoo addresses several of the most critical challenges of our time; food, nutrient recovery and freshwater. ZooPoo shows visitors how to change their own behaviors to save animals and plants while enhancing our communities. "Sustainable You at the Zoo" will provide a take-home checklist to support sustainable lifestyles.

How. Build an energy recovery and recycling demonstration facility that enables visitors of all ages to see, experience and learn how to adopt green behaviors and sustainable lifestyles. ZooPoo360 uses the zoo waste stream, ZooPoo, and recovers and reuses energy and nutrients to produce electricity, freshwater, vitamins, minerals, health foods, animal feed, fertilizers and fine medicines. Algae recover the hydrocarbons and nutrients from ZooPoo and transform them into clean, green plant bonds that store portable energy that can be used in many ways. Algae also cleans the wastewater. ZooPoo will also demonstrate other renewable forms of energy — solar, wind and geothermal.

Transformation. The zoo waste stream creates significant costs plus a large carbon footprint because the ZooPoo and plant wastes must be collected, stored, loaded, transported and buried in public waste dumps. ZooPoo360 will demonstrate the value of waste streams how the components can be recycled and reused.

Goals and Target Beneficiaries

Transform a major zoo cost (ZooPoo) into a profit center while demonstrating carbon neutral food, energy and freshwater production.

ZooPoo360, a green and sustainable energy demonstration facility, will become a destination eco-tour. Target tourists include especially those who currently pay to burn, bury or truck their wastes and will benefit from learning how to recycle their waste streams.

- **Farmers** who will be able to recover value from animal and plant wastes. Farmers will also be able to moderate pollution from run-off and clean polluted water.
- **Municipal waste** facilities that will be able to recycle nutrients and energy from human wastes.
- **Community** (garden and trash) waste facilities that will create value from organic waste streams including nutrient recovery from trash and garden clippings.
- **Power and cement** plants and manufacturers that will create value from their surplus CO₂ to feed algae while avoiding emissions.
- **Citizens** who desire to learn how to minimize their waste streams and ecological footprints.
- **Children** who wish convey the message of conservation and renewal to their peers and parents.
- **Churches** who desire to bring sustainable lifestyles to their communities.
- **Schools** who want engage students in ecologically sustainable systems.

Demonstrate and educate zoo visitors in food and energy security by reclaiming and recycling surplus inputs that are affordable and unlike fossil resources, will not run out. Act as global stewards by moderating pollution and capturing carbon while producing valuable products using no fertile soil, freshwater or fossil fuel.



危机

Biowar I begins with these Earth historical records, the most:

- Food insecure global citizens, 3.5 B
- Hungry Americans
- Aquifer crashes
- Hot years & decades
- CO₂ levels in air
- GHG production
- Fierce hurricanes
- Springs go dry
- Rivers go dry
- Lakes go dry
- Polluted lakes
- Polluted well-water
- Dead zones
- Wild fires
- Acute human pesticide poisonings

Historical lowest:

- US grain stores
- Global grain stores
- Rainfall
- Water tables
- Aquifer levels
- Snow pack

It seems a poor time to self-inflict a costly, unilateral biowar.

Fidel Castro wrote a letter to President Bush and warned about his enthusiasm for his "sinister idea of converting food into fuel that jeopardizes the lives of 3 B people."

Mark Edwards leads fascinating and memorable interactive discussions on Biowar I and sensible solutions.

Mark can be reached at www.biowar1.com.

Biowar I: Solving Hunger

Declare war to save food and peace.

Burning 100 M tons of our primary food for fuel is **unsustainable** and wastes non-renewable resources, especially water. Growing massive amounts of corn creates ecological suicide as it drains trillions of gallons of non-replenishable groundwater, spikes food and fuel prices, decimates food exports and threatens millions with starvation from a food cascade.

Biowar I inflicts costs, casualties and catastrophe in a magnitude far greater than a conventional war. Taxpayers are forced to pay \$43 B annually to subsidize erosion and pollution of our air and water for a tiny, 1.1%, replacement of foreign oil. America has insufficient disposable cropland, water or energy to waste on a policy that fails its objectives.

Compared with biofuel alternatives:

- Corn requires more water, land, fertilizer, herbicides and pesticides
- Severely pollutes air, soils, rivers, lakes and well-water
- Degrades and erodes soils
- Grows slowly and produces a low energy biomass yield, only 3%

Corn ethanol is not sustainable. It takes too much water, land, energy and costs.

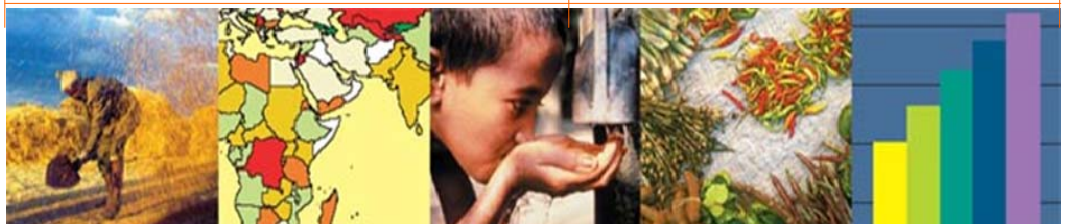


Water is the limiting resource for food.
1 gal of ethanol consumes how much water?

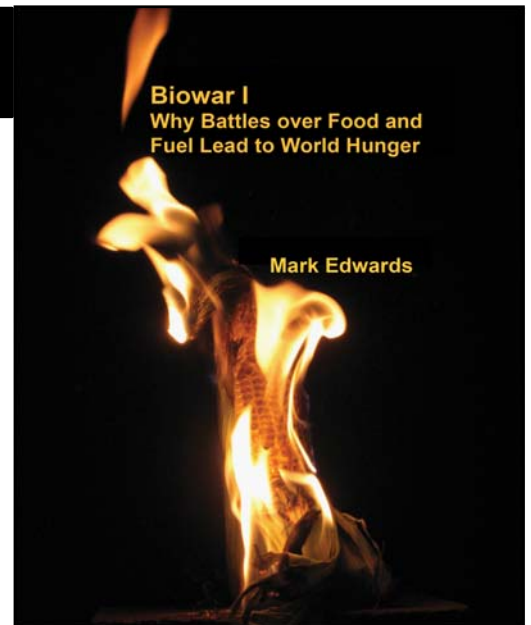
Biowar I Began

The 2005 Energy Policy Act ignited Biowar I with subsidies and mandates to increase food burned for fuel by 300%. Biowar I began at a time when:

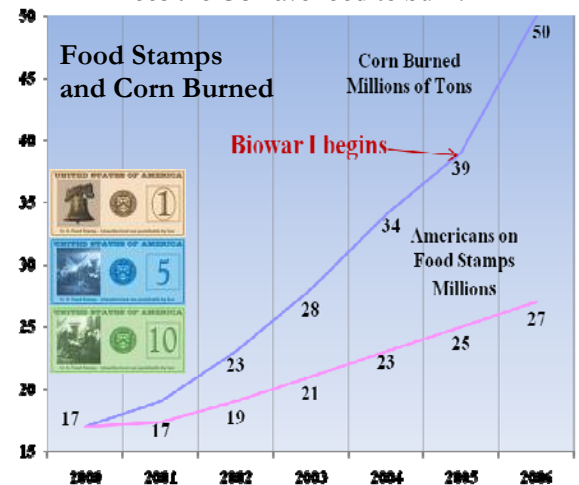
- 3.5 B people globally are food insecure
 - 60 M Americans receive food support
 - 27 M Americans live on food stamps
 - A 500 year drought endangers U.S. aquifers and survival for cities such as Atlanta and Aurora
- Over production of corn, from subsidies, threatens to drain non-replaceable U.S. groundwater dry.



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1 in 5 Americans receives food support. Does the US have food to burn?



Biowar I Must End

Biowar I must end with a peace treaty promising to withdraw not soldiers but subsidies that are ecologically destructive such as water and ethanol.

America needs a sustainable foods and fuels policy.

A shift in subsidies to ecologically smart actions will enable a strong American economy that uses sustainable technologies for food and fuel.

Food



Sierra Edwards holds 3.6 lbs of corn, enough to fuel the Hummer for 1 mile. A Hummer consumes 33 tons of corn a year running on ethanol, enough **food to feed 400 children**.

This year while the Hummer gobbled corn, 11 M children died of starvation, 30,000 child deaths each day.



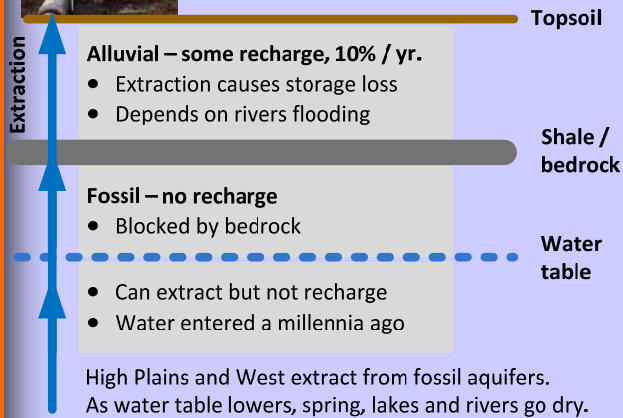
The World's Apple — shrinks by 40%

1. Over 150 countries must import food
2. Countries depend on supply and a stable price
3. The US supplies 50% of world grains
4. Only four other countries export much grain
5. Drought and heat toasted 15% of the other countries exports in 2006
6. The US will burn 50% of our half of world grain exports in 2008
7. Assuming a good US and world crop, the world's apple shrinks by 40% in 2008
8. Food prices spike, meat growers are forced to slaughter their animals and US exports tank
It's hard to imagine self-inflicting this damage.

Water

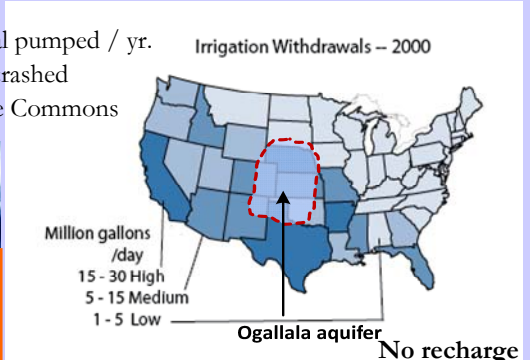


Aquifer – underground water storage; rock, sand, gravel.
Water table – top level of underground water.

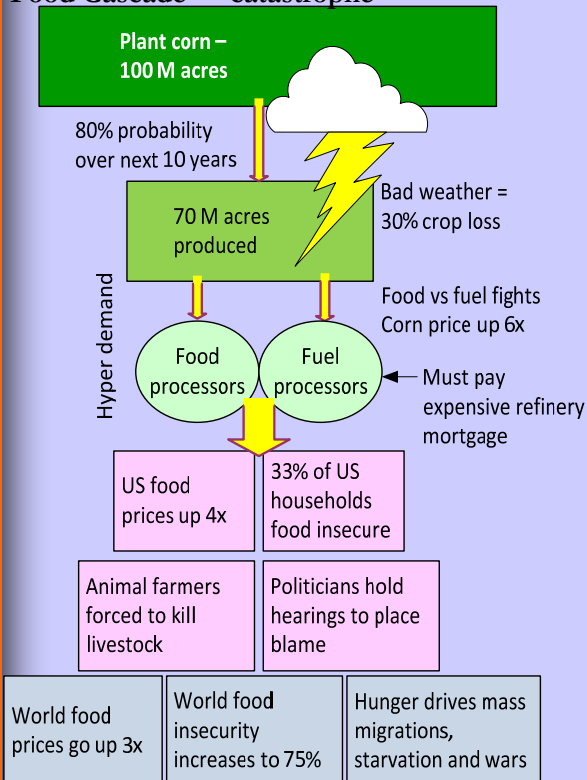


- > 5 Trillion gal pumped / yr.
- Parts already crashed
- Tragedy of the Commons

1 gallon of ethanol takes 3,000 gallons of water, 12 tons



Food Cascade — catastrophe



A **Food Cascade** operates like a bank run. It starts with a modest crop loss and then access swing begins as refineries search for corn. Then:

- Food fights
- Price spikes + spikes + ...
- Exports crash
- Meat producers slaughter their animals
- Mass hunger and global food destabilization
- A psychology of fear causes people to horde food.

What might create crop loss?

Bank runs are awful but less fierce than a food cascade because people are only fighting over money. The costs and casualties from a food cascade are catastrophic.

We must end Biowar I and save 30 M lives.

End subsidies!

Our path forward; we need your help:

1. Write congress to end water and ethanol subsidies and waste
2. Extend Biowar I content — post
3. Send Biowar I to a friend
4. Update or correct sources
5. Enhance our network of people and sustainable food and fuel knowledge
6. Use Biowar I content for local presentations (Yes, you may.)
7. Contribute to surveys on sustainable foods and fuels policies
8. Add your quote to the world's voice!

Algae Case Study

Algae offers a renewable biofuel source that compared with corn is:

- 28 times more energy productive
- Takes 0.001 as much water
- Requires no cropland
- Gives a positive ecological footprint

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www.biowar1.com

30 million people die of starvation due to food instability.

Mark Edwards

Mark pursues three goals through his social networking site <http://GreenIndependence.org>:

- End malnutrition in hunger in the U.S. and our world.
- Free America from oil imports and eventually from fossil fuels.
- Adapt to climate change and mass extinction of fossil natural resources by transforming animal and human waste streams into usable freshwater, food, feed, fuel, fertilizers and fine medicines.

Vision: engage 10 million Green Masterminds globally who have the knowledge and capability for growing nutritious food and high-energy, carbon neutral biofuel locally with green solar energy captured in algae. Algae's green promise, storing carbon while producing food and biofuel offers green independence from oil imports for America and engineers hope for millions of global citizens who lack access to affordable food, feed, freshwater, fuel and fine medicines.

Consulting and speaking. Mark speaks and consults globally with governments, NGOs and corporations on sustainable and affordable food and energy. His specialty is sustainable business models that create a minimal eco-footprint and use minimal or no fossil resources including fertile soil, freshwater, fossil fuel, fossil fertilizers or fossil agricultural chemicals.

R&D. He has written over 100 academic articles and a dozen books, including a business and a science bestseller. The four recent books in the *Green Algae Strategy Series* focus on saving our planet with sustainable and affordable food and energy, SAFE production. The second book in the series, *Green Algae Strategy: Engineer Sustainable Food and Fuel* won the 2009 Independent Publisher Gold Medal for the "Best Science Book of the Year." Mark believes the message of SAFE production is so important to our society's future that he enables free downloads of his books at www.GreenIndependence.org.

Training. Mark graduated from the U.S. Naval Academy where he studied mechanical engineering, oceanography and meteorology where he was mentored by Jacques Cousteau who motivated a passion for the oceans, algae and global stewardship. He holds an MBA and PhD in marketing and consumer behavior and has taught marketing, leadership, sustainability and entrepreneurship at Arizona State University for over 30 years.

CEO. Mark served as CEO of TEAMS Intl. for 24 years, the software and assessment firm he founded based on his research on advanced assessment technologies, talent and leadership assessment. He served as lead consultant for more than 400 firms globally, including Disney, GE, HP, Intel, 3M, Bank of America, J&J, GM, Coca-Cola and M&M Mars. He was retained by many U.S. departments and the military, including DOE, DOD, Special Forces and the National Labs.

Mark was a Director for a Fortune 50 food and transportation company and has done extensive R&D on new foods, novel food sources and consumer behavior. He has consulted for Monsanto, Pioneer Seeds, DuPont, Nabisco, Quaker Oats, General Mills, Frito-Lay and many other agribusiness companies. He has worked with senior executives at 15 large U.S. energy firms as well as BP and Saudi Aramco.

Mark serves on several boards and advises renewable energy companies on entrepreneurial growth and technology. He works with zoos with his ZooPoo project designed to recover and reuse zoo waste streams because if we can do the doo doo at the zoo we can do the poo anywhere. He also chairs the Science Committee for the Arizona Science Center whose mission is to motivate young people chose careers in science and math.

Contact: drmetrics@cox.net 480.235.8488 www.GreenIndependence.org