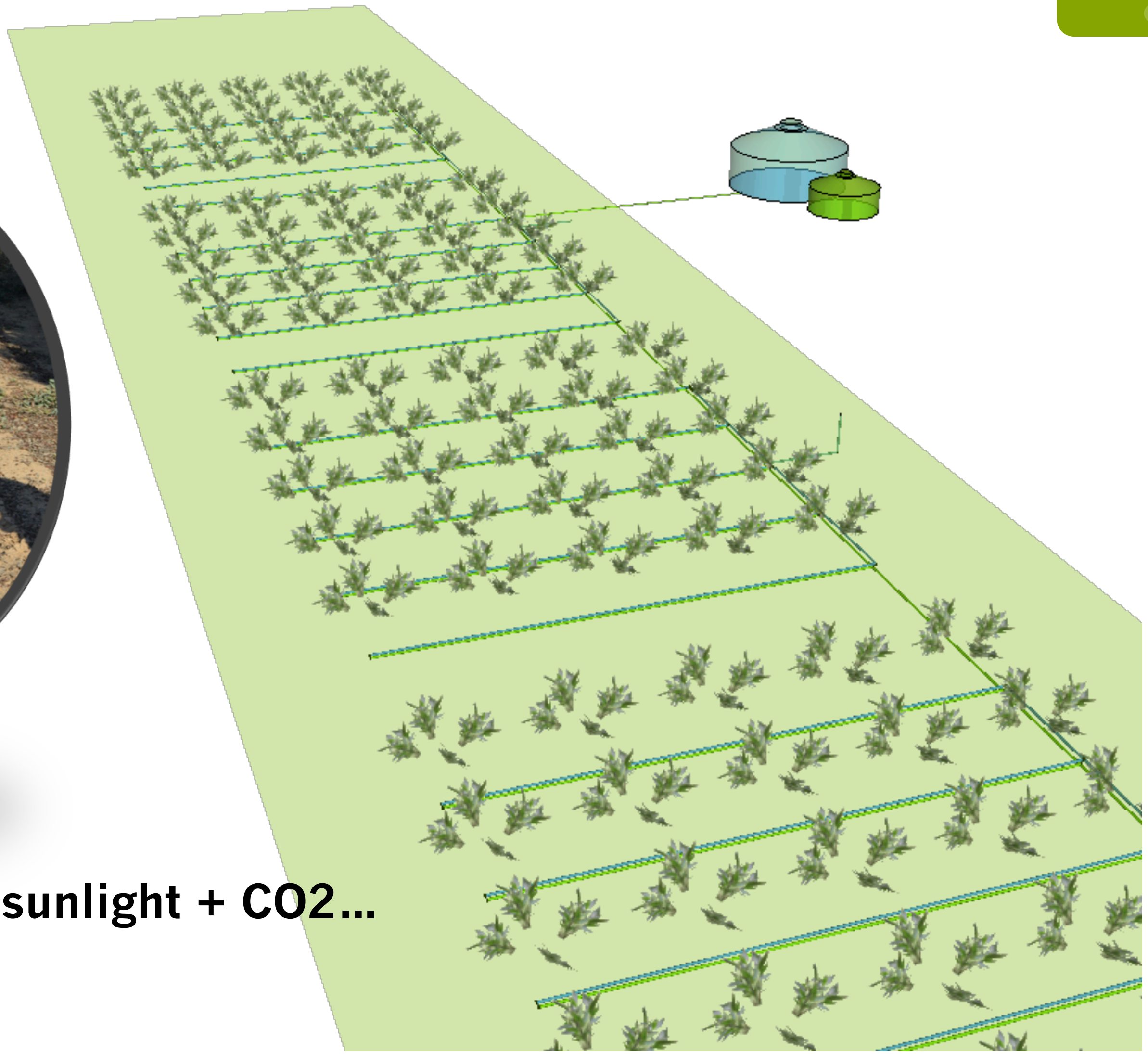
the Natural Garden

Technology Revivifying Ancient Plant Life

Netafim
Drip Irrigation

- “Nutrigation” adds nutrients and fertilzer to water – soil becomes merely structural
  - (= outdoor hydroponic)
- Eliminates run off of fertilizers to streams and aquifers
- 70% of water used globally is agricultural, and 78% is done by flooding
- Estimates 5% to 25% of all irrigation could be drip
- **Plants only need sunlight + CO2…**

Netafim's Nutrigation



Plants only need sunlight + CO2…

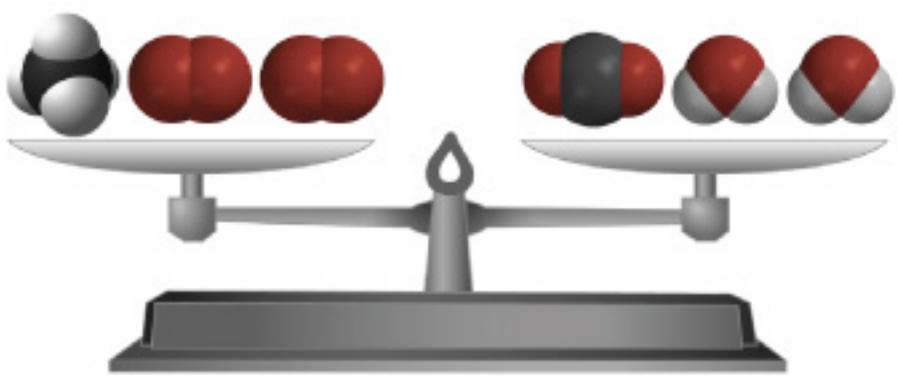
Natural Gas = Methane (CH_4)

= Ancient plant carbon, water and energy

Just add sunlight, seeds and nutrients and you reconstitute the plants AND produce energy!

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + **Energy**

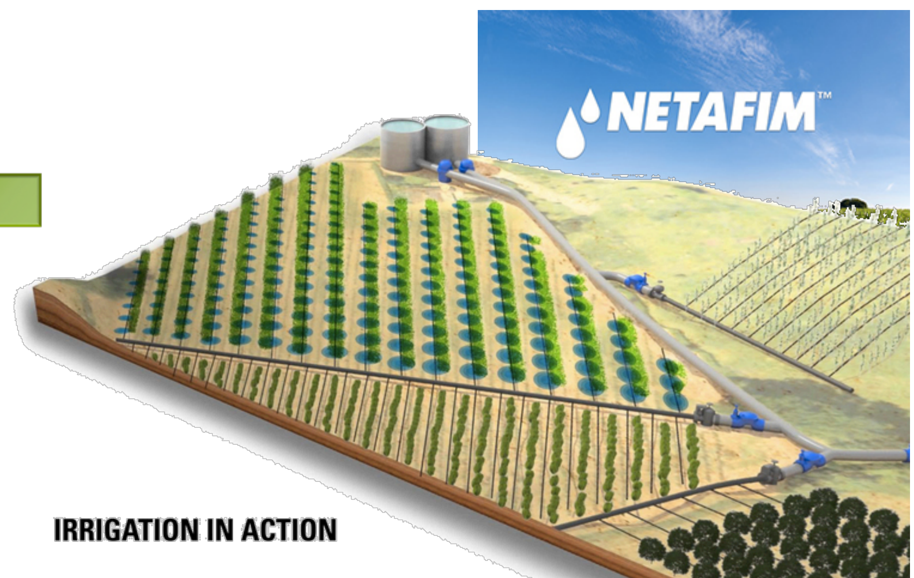
methane, oxygen, carbon dioxide, water



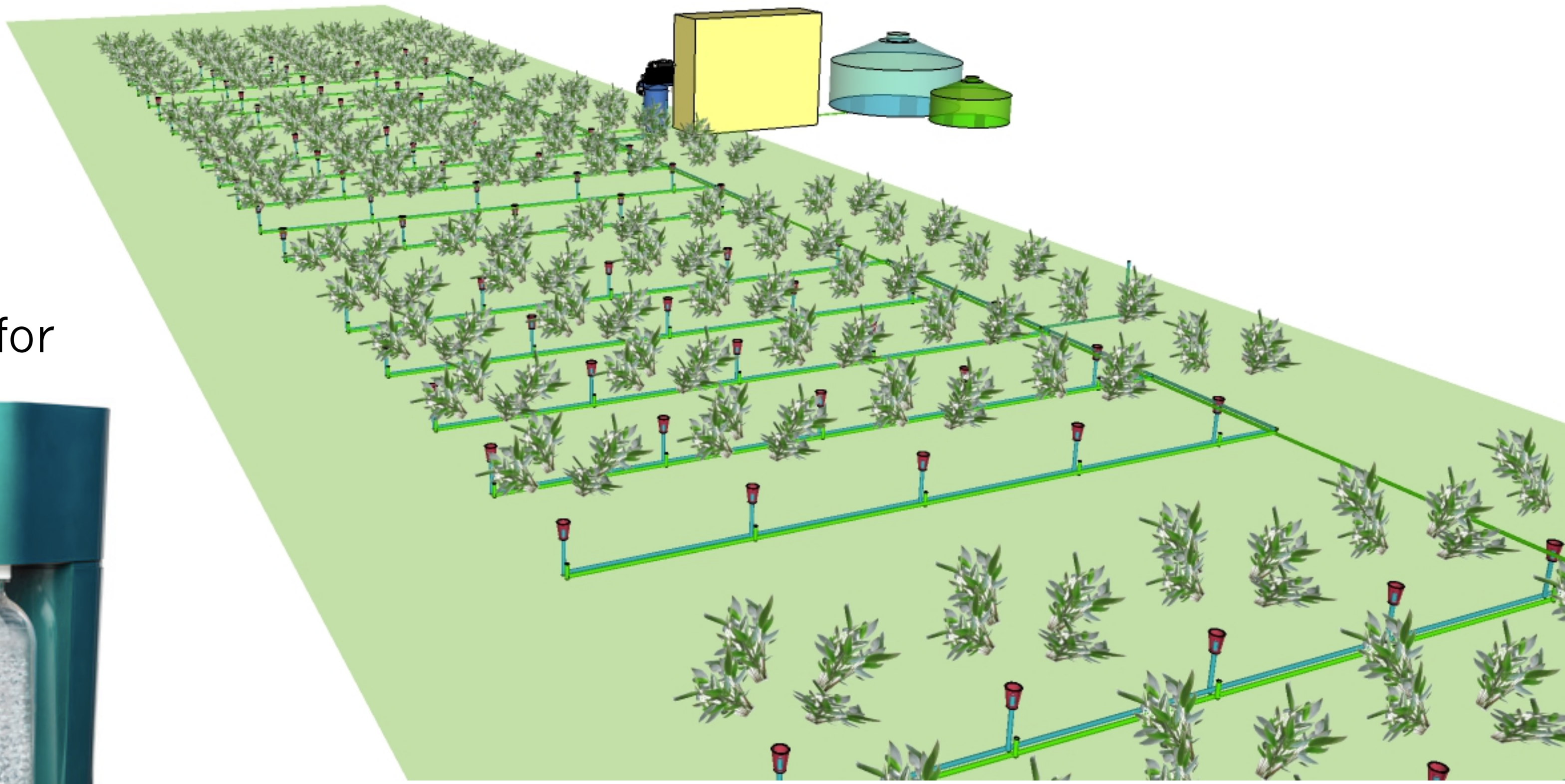
THE PROPOSITION

Use natural gas combustion byproducts (CO_2, heat, water) to enhance plant growth with carbon and water, and provide electrical energy and heat for the greenhouses.

MARRIAGE OF DRIP IRRIGATION AND MICROTURBINE TECHNOLOGIES



CO2 Drip Feed Injection



Think:
Sodastream for
Plants

the Natural Technology

- High efficiency natural gas **electrical generators**
  - **Reciprocating** with after treatment, or ultra clean **microturbine** for direct gas use and very low maintenance option
- Product gas **cooling** for CHP and **filtration** as required (microturbines have exceptionally low NOx, CO, hydrocarbons and SOx)
- **CO2 injection** into direct drip water/nutrient stream
- Heavy CO2 rich gas **diffuses from irrigation water** and builds from plant level upward to reach leaves

Natural Gas → **Elect. Generator** → **Cooling, Filtration** → C02, H20 → **CO2, H20 Injection** → Plant Growth

VALUE PROPOSITION EXAMPLE

Example power generator:

- **10kW** output, 12hrs/day
  Creates **566lbs CO_2/day**
  and **19 gal water**
  and **1.2M BTU of heat**
  for electricity cost at or below $0.15/kWh
- **$20k** system cost (preliminary estimate)
- Utilizes existing drip irrigation system for CO_2 distribution (or existing CO_2 distribution system)
- Assumes $0.83/therm cost of natural gas

An Environmentally and Financially Responsible Investment

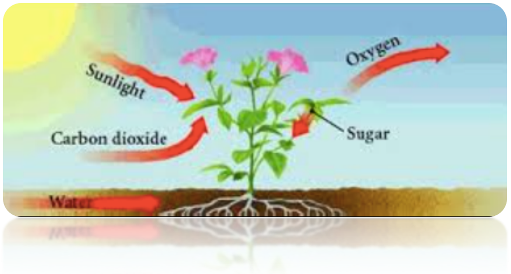
- Heavy CO2 creates ground layer enriched atmosphere, with potential in increase yields even in **outdoor grove environments**, such as fruit and nut trees, or open walled greenhouses

- **Heated irrigation water** provides distributed heating for more even greenhouse, ground warming

- Reduced **water consumption** needs as exhaust product water vapor condenses directly into irrigation stream

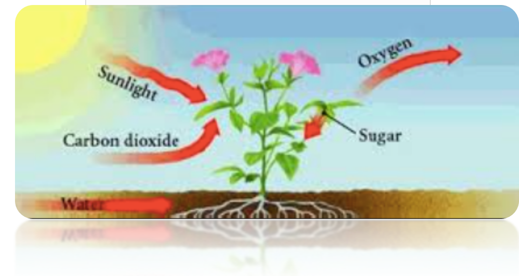
- **Carbon is sequestered** into plant material that enters the food / waste stream, becoming solid rather that gaseous waste. Potential opportunities for wider range of **incentive programs** to further reduce cost, increase return

The BIG Carbon Cycle



Edible Plants, Fresh Water

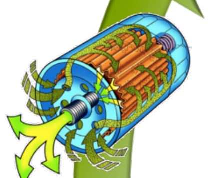
Ancient Solar, Water



Ancient Plants

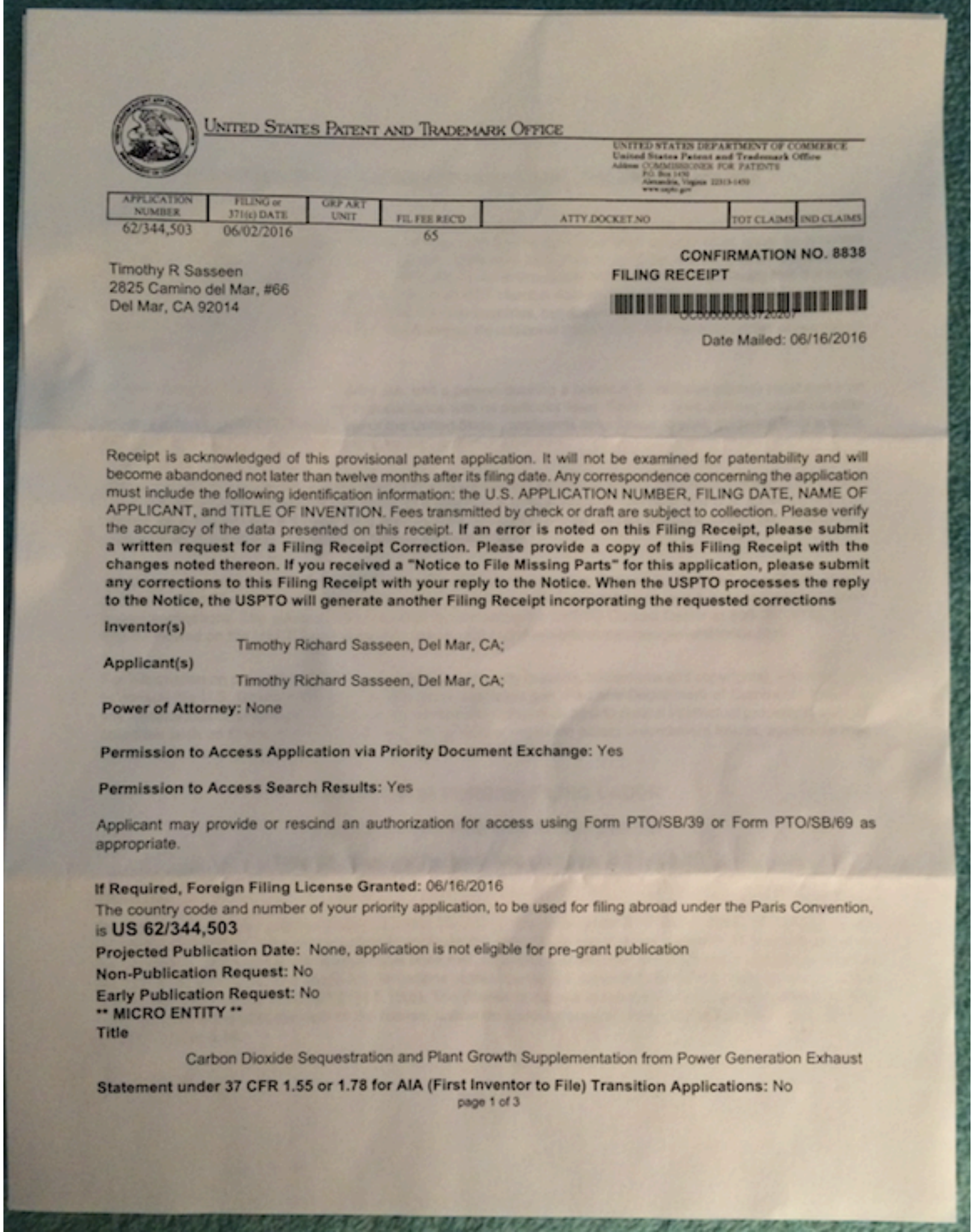
Natural Gas

Electricity + Water + CO2 + Heat



SUPPLEMENTAL Provisional Patent Diagrams

PROVISIONAL PATENT FILED



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
62/344,503	06/02/2016		65			

CONFIRMATION NO. 8838

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FILING RECEIPT

Date Mailed: 06/16/2016

Receipt is acknowledged of this provisional patent application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

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Power of Attorney: None

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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If Required, Foreign Filing License Granted: 06/16/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/344,503**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

**** MICRO ENTITY ****

Title

Carbon Dioxide Sequestration and Plant Growth Supplementation from Power Generation Exhaust

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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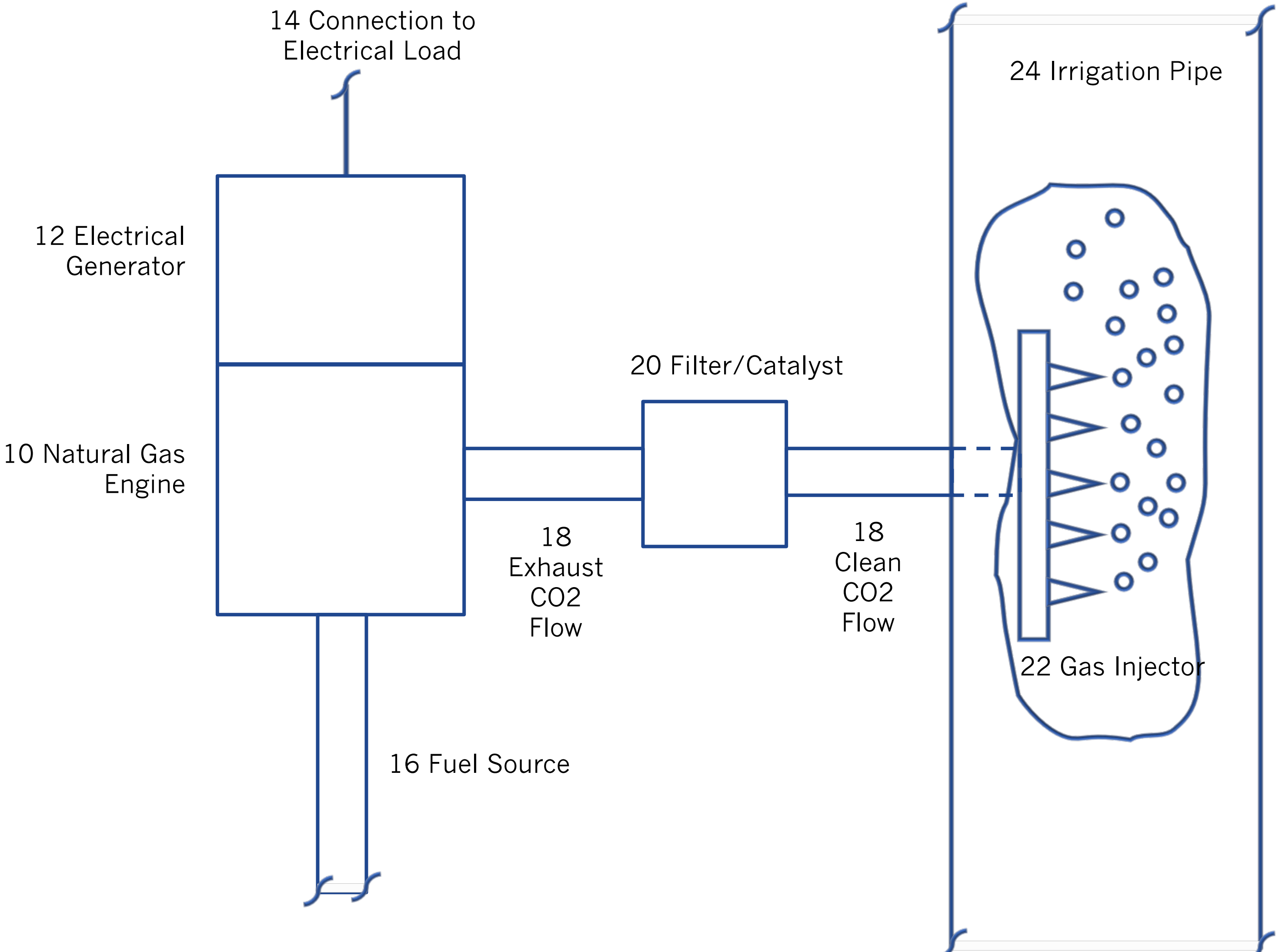

14 Connection to Electrical Load
12 Electrical Generator
10 Natural Gas Engine
16 Fuel Source
18 Exhaust CO2 Flow
20 Filter/Catalyst
18 Clean CO2 Flow
24 Irrigation Pipe
22 Gas Injector

Fig. 1

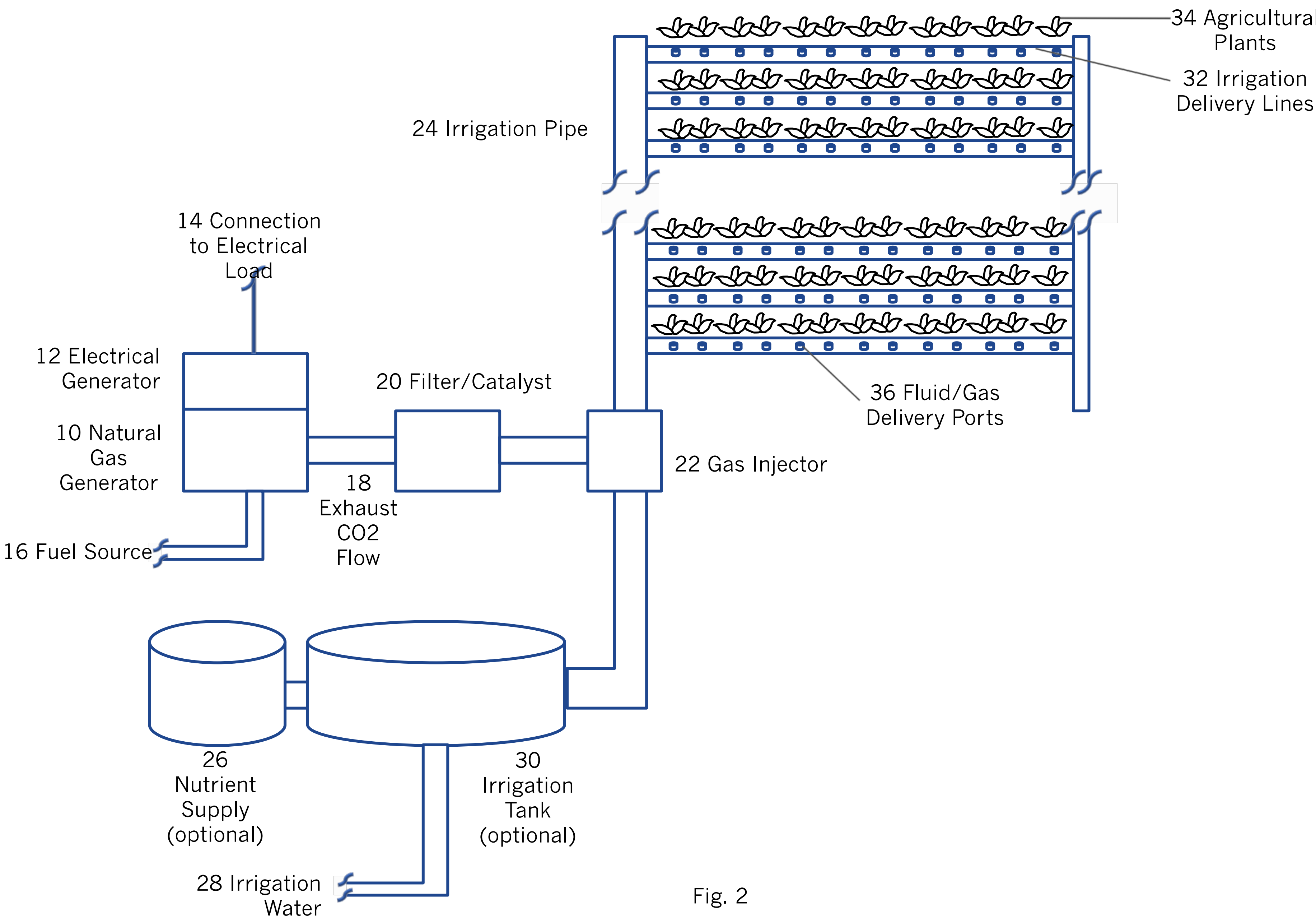
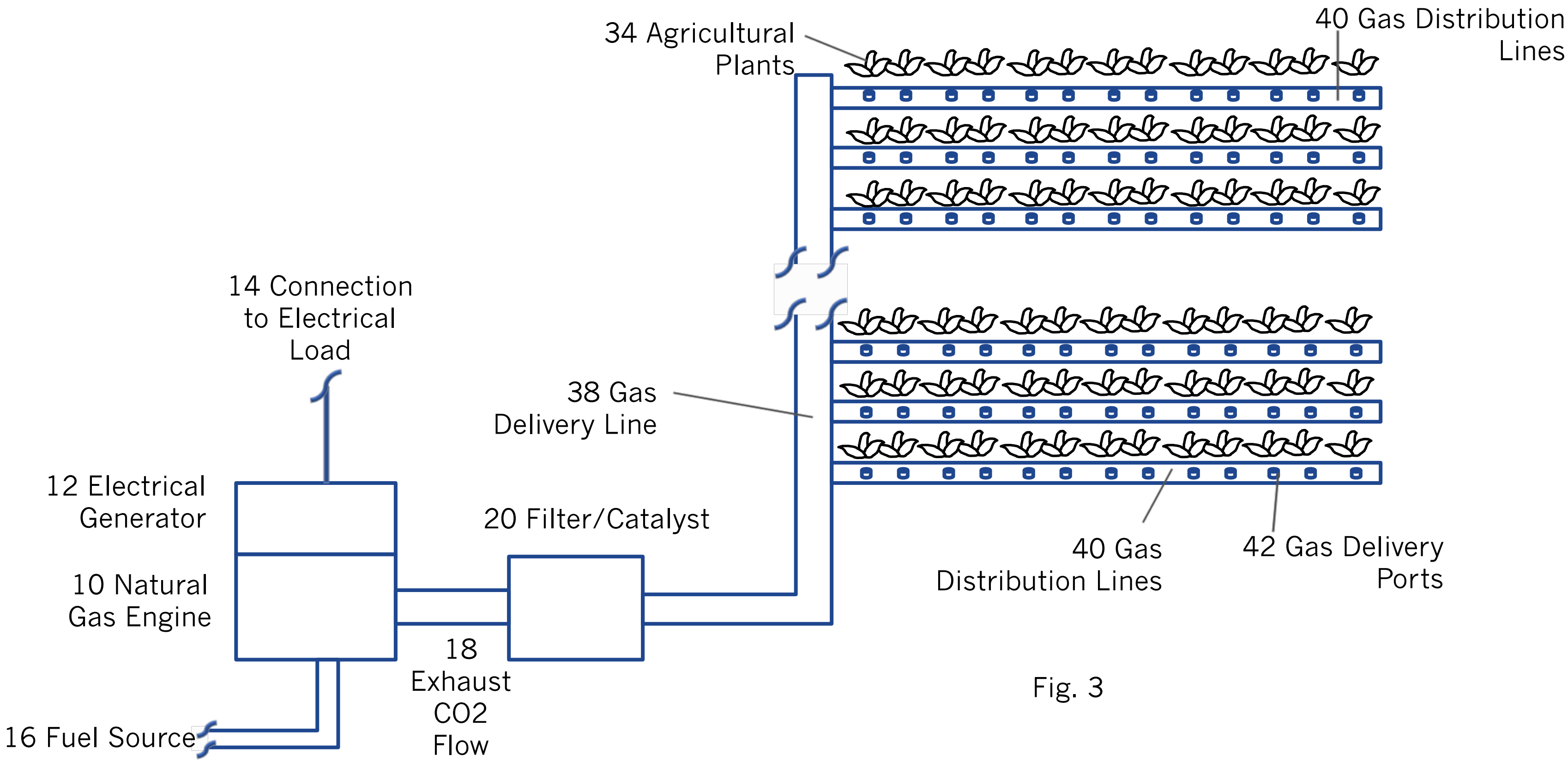

34 Agricultural Plants
32 Irrigation Delivery Lines
24 Irrigation Pipe
14 Connection to Electrical Load
12 Electrical Generator
20 Filter/Catalyst
36 Fluid/Gas Delivery Ports
10 Natural Gas Generator
22 Gas Injector
18 Exhaust CO2 Flow
16 Fuel Source
26 Nutrient Supply (optional)
30 Irrigation Tank (optional)
28 Irrigation Water

Fig. 2


34 Agricultural Plants
40 Gas Distribution Lines
14 Connection to Electrical Load
38 Gas Delivery Line
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20 Filter/Catalyst
10 Natural Gas Engine
40 Gas Distribution Lines
42 Gas Delivery Ports
18 Exhaust CO2 Flow
16 Fuel Source

Fig. 3

Reviews

Soil, Plant, and Canopy Responses To Carbonated Irrigation Water

Craig A. Storlie[1] and
Joseph R. Heckman[2]

Additional index words. carbon dioxide, drip irrigation, soil pH, irrigation water pH

Summary. **Scientists have sought to stimulate plant growth using carbonated irrigation water for more than 100 years. The mechanisms by which carbonated water may increase plant productivity and the influence of environmental and cultural growing conditions on those mechanisms are not completely understood. Several greenhouse and field studies have demonstrated that carbonated irrigation water can increase crop yield significantly while others have shown that carbonated irrigation water does not influence plant productivity. It is unlikely that carbonated irrigation water will be recommended commercially until the conditions are delineated under which a positive and economically advantageous growth response is ensured.**

Several mechanisms that may influence a growth response to carbonated water have been identified. Carbon dioxide reduces water pH and may reduce soil pH, resulting in an increased availability of several crop nutrients. Carbonated irrigation water also increases the soil–air CO_2 concentration. This may enhance root growth by reducing ethylene inhibition and may stimulate beneficial bacteria. Carbon dioxide also can be absorbed directly through the plant roots and fixed in photosynthesis, although direct absorption is probably not a major contributing source to increased productivity. However, carbonated irrigation water can increase the rate of photosynthesis through atmospheric enrichment. It also may influence plant hormone and enzyme balances, which may enhance productivity. A growth response to carbonated irrigation water is likely due to a combination of factors, and it is most likely to be observed where soil and irrigation water pH are high, polyethylene mulch and drip irrigation are used, and irrigation is frequent and of long duration.

Several researchers reported that carbonated irrigation water increased plant yield (Mauney and Hendrix, 1988; Nakayama and Bucks, 1980; Novero et al., 1991). Others found that carbonated irrigation water did not influence, or negatively influenced, crop yield (Hartz and Holt, 1991; Nakayama and Bucks, 1980; Stoffella et al., 1995; Storlie, 1992). Controversy exists over the alleged benefits of this practice due to the variety of reported results and the lack of consensus about mechanisms by which carbonated water might increase plant productivity. In this paper we review the potential mechanisms of increased plant productivity and outline the environmental and cultural conditions under which a plant response is most likely.

Mechanisms of increasing plant productivity

Mechanism 1—Increased nutrient uptake. One potential benefit of carbonated irrigation water is related to soil nutrient availability. Adding CO_2 to water acidifies the solution. Adding carbonated water to soil may cause soil pH to decline temporarily. In high-pH soils, this response brings soils into the desirable pH range for nutrient availability. In acidic soils, this response could cause aluminum toxicity or limit the availability of essential plant nutrients. Reducing soil pH also may increase the activity of certain beneficial microorganisms (Baker, 1988).

Novero et al. (1991) reported the results of a Colorado study in which the concentration of Zn in the leaves of field-grown tomatoes receiving carbonated irrigation water was significantly higher than in the control. In addition, they concluded that the uptake of all measured nutrients increased because the yields of treatments receiving carbonated water were significantly higher, and that in no case were plant nutrient concentrations lower in treated plants. Total and marketable yields were 15.9% and 16.4% greater with CO_2-enriched water than the control, respectively. Novero et al. (1991) attributed increased nutrient uptake to increased nutrient availability caused by decreased soil pH. In one study, soil pH measured during irrigation was 6.8 in the carbonated water treatment and 7.7 in the control. In another study, soil pH measured immediately after irrigation ranged from 5.9 to 6.2 in the carbonated water treatment and from 7.4 to 7.6 in the control. Where irrigation water was applied every sixth day, soil pH gradually rose from 5.9 immediately after irrigation to 7.1 on the day before the next irrigation. The optimum pH for most cultivated plants ranges from 5.0 to 7.0 (Spurway, 1941).

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This is New Jersey Agricultural Experiment Station publication no. D-03150-16-96, supported by state and U.S. Hatch Act funds. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.