THE HIGHER ECONOMIC IMPACT OF TRANSFORMING AGRICULTURE PRODUCTION FOR INDUSTRIAL APPLICATIONS AND INDUSTRIAL ECOLOGY

Abstract

Yield per Acre is more restricted to measuring productivity of the standing crop alone. Most analysts restrict their Agronomic Models to micro-economics measurements ignoring the macro-economic drivers that can transform Agriculture to becoming suppliers to Industrial Applications. Alongside an example cited, based on the Authors own Case Study and Trials conducted, the Paper proposes an Agronomic Theorem that demonstrates the higher Economic Value from an acreage that factors Global Industrial Demand and demonstrates Scale. The paper also includes an diagrammatic framework that is useful to applying to any Industrial Application makes a case to review the underlying economics of farmers incomes.

Introduction

A controversial topic within agricultural stressed countries, such as India is that a truncated definition of Crop Diversity has contributed towards the economic debilitation of farmers.

Advocating a relook at Crop Diversity, a seminal paper[1] posits that broadening the definition of Crop Diversity from merely agricultural produce or Yield per Acre and expanding it to include industrial applications of agriculture or Industrial Ecology would raise marginal farmer's incomes.

Whilst the transformation of agriculture into Industrial Applications are discussed, that paper also alludes to the underlying economics of this transformation into super High Value Agriculture (HVAs) uncovered though pilots that were conducted in India. Such agricultural residues could be transformed into a higher Economic Value Add (EVA) by serving as raw material inputs to Industrial Applications.

This paper introduces this economic model and the transfers of wealth to the farmer by firstly indexing prices to an end product price, or the output of the Industrial Application, rather than an outright over the counter (OTC) purchase of feedstock. By doing it in this way, it creates a seamless flow of cash from market to suppliers i.e. the farmers; with no middle men to eat into profits.

The paper cites an example of a simplified application of industrial ecology by discussing the problem of deforestation and how agri-residue could solve many of the problems associated with it.

Part of the case study is used to uncover the simplified theorem and Industrial Ecology's impact on farmer's incomes; which may be extended to any industrial application if the raw materials are from agricultural sources.

Problem

The World has lost 15% of its forest cover to the wood industry since 2000 and unless this trend is reversed, the main contributor to the broken Carbon cycle would remain unchecked. The potential environmental damage that a wood economy could include problems of reduction of

[1] James, D., (2014). Redefining Crop Diversification in India in Terms of Industrial Ecology.*Indian Botanists.*http://www.indianbotanists.com/2014/08/redefining-crop-diversification-in.html

the biodiversity due to mono-culture forestry - the intensive cultivation of very few types of trees and CO_2 emissions.

The total size of the wood industry is estimated to be about the size of the petroleum industry per annum, but since most of this lies within an oligarchy and is tightly controlled, discussion on this main contributor of Climate Change is hard to quantify. For example, By 2001 the rainforest areas of Brazil were reduced by a fifth (respect of 1970), to around 4,000,000 km²; the ground cleared was mainly destined for cattle pasture - Brazil is the world's largest exporter of beef with almost 200,000,000 head of cattle. The booming Brazilian ethanol economy based upon sugar cane cultivation is likewise reducing forests area. Canadian forest was reduced by almost 30% to 3,101,340 km² over the same period [2].

This destruction of forests gives rise to several problems, however this paper focuses on one, to draws-out the economic solution for the farmer who can mitigate them. Namely:

- Provide an alternative to wood panels, built as fallout from deforestation. By using such sustainable alternatives it should lower the higher energy and carbon footprint of building materials currently used such a Portland cement, Steel, and Lumber.

To mitigate this carnivorous stripping of forests by the lumber and furniture industry, bio-composites from agri-fiber emerged as a reasonable solution. The science and process of making bio-composites is not new and well established since the 1940s. However, the world was not excited about biocomposites since it had little visual differentiation to conventional wood panels. Consequently, hard wood forests continue to be consumed at a frenetic rate as suppliers to the wood industry.

India has a unique problem: Not only does India have little to no forest resources for the wood and furniture industry, subsequent laws after the colonial era[3] strictly regulate the use of forest timber for commercial purposes. Unfortunately, illegal logging continues. Further, to exploit the lack of wood in India, India has exported deforestation to neighbouring countries like Thailand, Indonesia, Myanmar, and Papua New Guinea amongst others. The total agri residue in India, (indeed any country where forests are needed to be preserved) can meet the structural needs of the panel industry but for reasons cited below, it lacks market adoption.

- True economies of scale could not be achieved because producers lacked sufficient raw materials with low input costs that would make such bio-composites competitive.
- The second major challenge is that no one till date has gone beyond a bio composite and into bio mimicry. The bio-mimicry of a panel analogous to hardwood must have the following (i) ligno-cellulite (ii) bio-resin (iii) most importantly, must have a unique veneer or grain that it can stand alongside the natural aesthetics of a hard wood. *It is the absence of this natural veneer or signature that stifles bio-composites from has a higher market adoption. Additionally true green engineered panels could command a premium pricing that is inelastic to supply.*

2 Canadian Forestry Research 2001,
3 India Forest Act, 1927

The technological break-throughs[4] that addresses these points are beyond the scope of this paper.

However, by introducing the economics of the potential of Industrial Applications of Agriculture would allow governments, policy makers to relook at their agronomic models in new light.

Industrial Ecology and Agricultural Monetization Theorem:

The important parts of the theorem are this:

a) Index the price paid to the final price of the end product instead of buying agricultural residue outright at a negotiated price from the farmer =[R] price paid to farmers and [Q] = Quantity of units of end product produced, not tonnage of raw material. Axiomatically this inflates the price paid to farmers or higher economic value. Some would argue that the lower the price paid to farmers the better margins the producer receives. ***This is a monolith perception and naïve at best.*** Our experience has showed that the negotiations of agricultural prices in all countries between farmers and off takers are adversarial. This must be redressed to achieve economies of scale and consistent supply. There is a price premium to be paid for trust and co-opting farmers are part of the production process instead of mere suppliers. In our experience if farmers are not co-opted in the process, supply is cut off. We feel this is a true manifestation of a Farmer's Cooperative between Seller(s) and Producer. **Formula for paying to farmers is [R]x[Q] - (i)**

b) Where **Demand > Supply** and where sustainable products are used, end users are willing to pay a premium against typical commodity prices. Prices will remain inelastic. This is an important variable in investing in technologies that are building solutions that mitigate Climate Change through renewable resources and technology. **Demand-Supply = [µ] - (ii)** For Convenience, assume Supply=0; Producers in that Industrial Application = 1

c) Economic Value or Scalability **EV=[R]x[Q] + [µ] - (iii)**

This theorem that addresses the challenge as described in the introduction combines the **macro-economic** drivers to conventionally narrowly focused micro-economic analysis. This paradigm encourages marginal farmers to be co-opted, (not merely compensated) for identified agricultural residues that can address Industrial Applications such as the case study discussed below.

It important to note that if farmers are burning their agricultural residue, then any income received above their normal harvest must be considered a bonus. **This assumes that no incremental costs are incurred by the farmer to produce these residues and the supply of which does not in any way disrupt the food or fodder cycle.**

Case Study (Pilots)

Sorghum stalks are considered a rapidly renewable resource, which not only can compete as a wood substitute but performs as a wonder crop as well. It can be the best food, fodder and fuel provider for marginal farmers. (India is one of the largest growers, and in Tamil Nadu one can get 3 harvests

[4] ChloroEarth's™ is the only company in Asia if not the world to go beyond a bio-composites and into bio mimicry merging different disciplines: Green Chemistry, Material Science and Physics.

per annum easily). We had selected purpose grown Sorghum whose lignin-cellulite would compete even with Teak.

Discussion: Incremental Income Potential for farmers from Sorghum Residue[5].

Assume,

- Conventional particle board (8ftx4ft) is sold for 12-25 dollars [US$1.28-US$2.66 per sq.ft.] (In the USA, however green boards like wheat board is sold at a premium multiple (12$-13 $ a sq ft!).

- Similarly, a Sorghum Board (6ft x3ft) that uses a synthetic isocynate as a binder is "green washed" currently retails at US$200-US$450, depending on its thickness. Such applications currently have a demonstrable demand with inelastic pricing.

- We assume a transfer price say US$1 (one) back to the farmer for every board produced against the feedstock he delivers to the plant. For 100 boards he would get $100 per acre, per harvest. This is proved to be a conservative estimate as the AgriResidue produced in India was far more and it allowed the farmer to raise his income by atleast 50%.

Consider[6] :

- A marginal farmer may have 1-2 acres (say one hectare) a hectare will produce about 180K-200K of stalks.
- For convenience assume we use 1000 stalks per board, so we will produce 200 board or 400 boards amount of stalks delivered depending on the variety of Sorghum or length of the stalk.
- Per hectare may yield 400 boards at harvest day or harvest cycle.
- Multiply this production by US$1 provides approximately ₹ 24,000 per holding.

The Table below is descriptive and does not reflect actual production or final output:

	Conventional Agriculture	Industrial Application
Village Name:	PilotVillage, Andhra Pradesh/North Karnataka.	
Acreage:	2 Acres	2 Acres
Stalk supplied:	49.7 tones	500,000
Total Income	₹ 29,874	₹ 15000
Input cost	₹ 1874	₹ 0
Net gain:	₹ 28000	₹ 15000

[5] Conducted as Incubatee with TNAU but trials and purchases were done under the aegis of UAS, Dharwad.

[6] Demonstrative only, IP rules in force and active

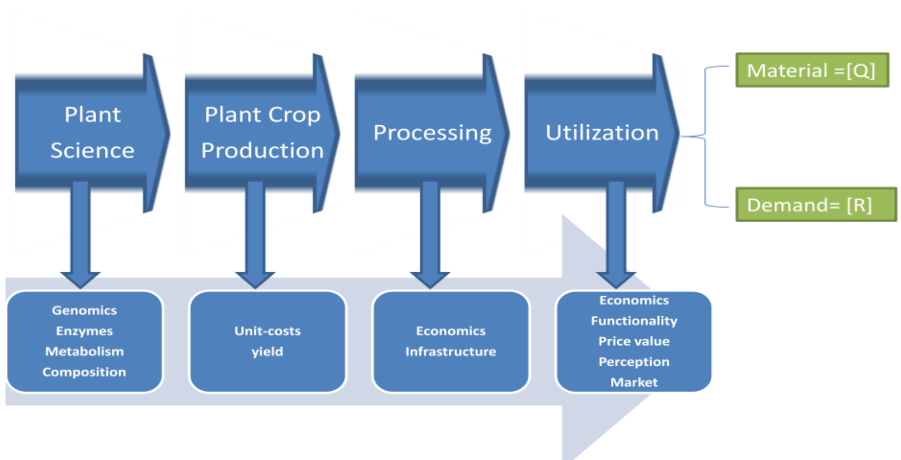
The pilot's assessment shows that at even lower yield a marginal farmer can easily compete with other crops like wheat/rice and farmers can be incentivized to grown more Sorghum. This is a tiny effort and can be easily managed by and contained by a CAD[7] programme. Even resins that India produces is an agricultural residue that India has not monetized to supply polymers at true industrial scale till date. These resins can easily be converted to bio-polymers to replace toxic adhesives used by the wood industry.

This is the "second harvest" or incremental income from Industrial Ecology that merits examination as way to raise their income.

Population Impact:

300 hectares per annum will be supported by say 5000-6000 agri persons. We assume this population is a family unit of 5 per farmer. If this programme is correctly implemented, the multiplier impact to the rural population will be around substantial for every micro plant that are installed rural India.

The economic impact by the transformation of Agricultural Produce into industrial applications is shown below and Agriculture should be examined as the *de facto* resource in evaluating raw material inputs to Industrial Applications.



An example of Industrial Ecology more familiar to the Indian Subcontinent has been the contribution of Guar Gum to the US Fracking industry. The Guar or cluster bean *(Cyamopsis tetragonoloba)* is an annual legume that is drought and heat tolerant and grows well in areas like Kutch, Gujarat and Thar, Rajasthan. Traditionally, it has been used as forage, feed, or as green manure in farming. The other industrial application is the production of guar gum from the guar seeds which can be used as an additive in processed foods. Recently the demand for guar gum for Fracking of oil and gas formations has led to a sharp increase in demand worldwide and this has provided an added source of income to guar growers. The inflated prices of guar due to this success story is rarely discussed as an example of a non-food contributor to raising farmer's incomes; despite the fact that the supply of Indian guar gum to kick start the US Fracking industry is now well appreciated.

7 Command Area Development.

Additional Examples that merit citing in the Indian context of which the reader may extrapolate as their higher income potential, and indeed the GDP contribution from Agricultural output are:

Bio-Polymers, Bio-Urethanes, Bio-Plastics from Agri Residues

- ✓ **Furfuryl alcohol**, Furfuryl alcohol is manufactured industrially by the catalytic reduction of furfural which is obtained from corncob and sugar cane bagasse. India imports about US$ 1.4Bn of Furfural and derivatives per annum when all of India's requirements can be met and even exported by India's agricultural sector.

- ✓ **Cashew Shell Nut Liquid (CSNL)/Cardanol:** Cardanol is a phenolic lipid obtained from anacardic acid, the main component of (CSNL), a byproduct of cashew nut processing. Cardanol finds use in the chemical industry in resins, coatings, frictional materials, and surfactants used as pigment dispersants for water-based inks. Despite all these uses, only a fraction of the Cardanol obtained from cashew nut processing is used in the industrial field. Therefore, there is still interest in developing new applications, such as new polymers.

- ✓ **Natural oil Polyols**, also known as NOPs or biopolyols, are polyols derived from vegetable oils . The primary use for these materials is in the production of polyurethanes. Castor oil is the only commercially-available natural oil Polyols that is produced directly from a plant source: all other NOPs require chemical modification of the oils directly available from plants. India's castor stock is one of the largest and is a very resilient crop to grow and maintain. India's farmers can be a global supplier if this castor production is purposefully grown to extract Polyols.

- ✓ **Bio Plastics**: Today we have innovative manufacturing process for the production of polylactic acid (PLA)-based bioplastics from agricultural waste such as the inedible parts of plants, such as seeds, husks, bagasse, grasses, etc. (PLA) is created from fermenting and polymerizing sugars harvested from plants. Bioplastics have a myriad of uses, including food packaging, beverage containers, disposable medical applications, and electrical applications to name a few.

Most industry experts opine the global demand for agriculature produce that can serve as inputs to industrial applications is inestimable, but the real need or solution is no longer seen as being monetary alone. These applications are meant to replace toxic non renewable resources that are taxing the planet. It should be the primary motivation or intervention to scale and fund such operaions till commoditization of the product is achieved.

Another example that merits serious discussion and highlights this problem of the tunnel vision of funding "valuation" rather than "value chain creation" is the unwillingness to fund the scaling of production of an urgent sugar substitute in India.

India is suffering from pandemic of diabetes that most medical experts attribute to an unhealthy consumption of sugar by the Indian public. The overall consumption of sugar in India is about 30Kgs per capita! [8]. The author found it impossible to convince a VC to provide what is termed as Intervention Capital to either raise the output of Stevia[9] in India or even willingness to fund conversion of available Stevia stock into fully acceptable table replacement to Sugar.

This unfortunate situation demonstrates the EV potential wasted for the only reason that Banks, Funders and even the Government fail to understand or will not factor the **Demand-Supply gap or [µ] in their risk analysis**.

Unless both private and public constituents improve and broaden their agronomic models to include this income potential, crop diversity will continue to be truncated to Product Yield per Acre. Marginal farmers in emerging markets will continue to struggle to compete with agricultural innovations that are emerging in developed markets and will remain impoverished.

8 http://www.thehindu.com/features/magazine/the-bitter-truth/article5308306.ece
9 http://en.wikipedia.org/wiki/Stevia

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