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Effect of Core Factors and Review Value on Profit Management in Basic and Organic Farming

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Abstract
Organic farming, also known as environmental farming or biotic farming, is an agricultural system that uses fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting. It originated early in the 20th century in reaction to rapidly changing farming practices. Certified organic agriculture accounts for 73 million hectares (190 million acres) globally, with over half of that total in Australia. Organic agricultural methods are internationally regulated and legally enforced by transnational organizations and many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international canopy organization for organic farming organizations established in 1972.[12] Organic agriculture can be defined as "an integrated farming system that strives for sustainability, the enhancement of soil fertility and biological diversity while, with rare exceptions, prohibiting synthetic pesticides, antibiotics, synthetic fertilizers, genetically modified organisms, and growth hormones"

Keywords
Organic farming, IOFAM, Farming, Hacters, Value

HISTORY

Agriculture was practiced for thousands of years without the use of artificial chemicals. Artificial fertilizers were first developed during the mid-19th century. These early fertilizers were cheap, powerful, and easy to transport in bulk. Similar advances occurred in chemical pesticides in the 1941s, leading to the decade being referred to as the 'pesticide era'. These new agricultural techniques, while beneficial in the short-term, had serious longer-term side-effects such as soil compaction, erosion, and declines in overall soil fertility, along with health concerns about toxic chemicals entering the food supply. In the late 1800s and early 1901s, soil biology scientists began to seek ways to remedy these side effects while still maintaining higher production [1].

In 1922 the founder and pioneer of the organic movement Albert Howard and his wife Gabrielle Howard, accomplished botanists, founded an Institute of Plant Industry to improve traditional farming methods in India. Among other things, they brought improved implements and improved animal husbandry methods from their scientific training; then by incorporating aspects of Indian traditional methods, developed protocols for the rotation of crops, erosion prevention techniques, and the systematic use of composts and manures. Stimulated by these experiences of traditional farming, when Albert Howard returned to Britain in the early 1930s he began to promulgate a system of organic agriculture.

In 1925 Rudolf Steiner gave a series of eight lectures on agriculture with a focus on influences of the moon, planets, non-physical beings and elemental forces [2]. They were held in response to a request by adherent farmers who noticed degraded soil conditions and a deterioration in the health and quality of crops and livestock resulting from the use of chemical fertilizers.

In July 1938, Ehrenfried Pfeiffer, the author of the standard work on biodynamic agriculture (*Bio-Dynamic Farming and Gardening*), came to the UK at the invitation of Walter James, 4th Baron Northbourne as a presenter at the Betteshanger Summer School and Conference on Biodynamic Farming at Northbourne's farm in Kent. One of the chief purposes of the conference was to bring together the proponents of various approaches to organic agriculture in order that they might cooperate within a larger movement. Howard attended the conference, where he met Pfeiffer. In the following year [3], Northbourne published his manifesto of organic farming, *Look to the Land*, in which he coined the term "organic farming". The Betteshanger conference has been described as the 'missing link' between biodynamic agriculture and other forms of organic farming.

TERMINOLOGY

The use of "organic" popularized by Howard and Rodale refers more narrowly to the use of organic matter derived from plant compost and animal manures to improve the humus content of soils, grounded in the work of early soil scientists who developed what was then called "humus farming". Since the early 1940s the two camps have tended to merge.

Biodynamic agriculturists, on the other hand, used the term "organic" to indicate that a farm should be viewed as a living organism, in the sense of the following quotation [4]|: "An organic farm, properly speaking, is not one that uses certain methods and substances and avoids others; it is a farm whose structure is formed in imitation of the structure of a natural system that has the integrity, the independence and the benign dependence of an organism"

CROP DIVERSITY

Organic farming encourages crop diversity by promoting polyculture (multiple crops in the same space). Planting a variety of vegetable crops supports a wider range of beneficial insects, soil microorganisms, and other factors that add up to overall farm health. Crop diversity helps the environment to thrive and protects species from going extinct. The science of Agroecology has revealed the benefits of polyculture, which is often employed in organic farming. Agroecology is a scientific discipline that uses ecological theory to study, design, manage, and evaluate agricultural systems that are productive and resource-conserving, and that are also culturally sensitive, socially just, and economically viable [5]|.

Incorporating crop diversity into organic farming practices can have several benefits. For instance, it can help to increase soil fertility by promoting the growth of beneficial soil microorganisms. It can also help to reduce pest and disease pressure by creating a more diverse and resilient agro-ecosystem. Furthermore, crop diversity can help to improve the nutritional quality of food by providing a wider range of essential nutrients.

WEED MANAGEMENT

Organic weed management promotes weed suppression, rather than weed elimination, by enhancing crop competition and phytotoxic effects on weeds. Organic farmers integrate cultural, biological, mechanical, physical and chemical tactics to manage weeds without synthetic herbicides [6]. Organic standards require rotation of annual crops, meaning that a single crop cannot be grown in the same location without a different, intervening crop. Organic crop rotations frequently include weed-suppressive cover crops and crops with dissimilar life cycles to discourage weeds associated with a particular crop. Research is ongoing to develop organic methods to promote the growth of natural microorganisms that suppress the growth or germination of common weeds. Other cultural practices used to enhance crop competitiveness and reduce weed pressure include selection of competitive crop varieties, high-density planting, tight row spacing, and late planting into warm soil to encourage rapid crop germination [7].

Naturally derived insecticides allowed for use on organic farms include *Bacillus thuringiensis* (a bacterial toxin), pyrethrum (a chrysanthemum extract), spinosad (a bacterial metabolite), neem (a tree extract) and rotenone (a legume root extract). Fewer than 10% of organic farmers use these pesticides regularly; a 2003 survey found that only 5.3% of vegetable growers in California use rotenone while 1.7% use pyrethrum. These pesticides are not always more safe or environmentally friendly than synthetic pesticides and can cause harm. The main criterion for organic pesticides is that they are naturally derived, and some naturally derived substances have been controversial. Controversial natural pesticides include rotenone, copper, nicotine sulfate, and pyrethrums Rotenone and pyrethrum are particularly controversial because they work by attacking the nervous system, like most conventional insecticides. Rotenone is extremely toxic to fish and can induce symptoms resembling Parkinson's disease in mammals. Although pyrethrum (natural pyrethrins) is more effective against insects when used with piperonyl butoxide [8] (which retards degradation of the pyrethrins), organic standards generally do not permit use of the latter substance.

Synthetic pesticides allowed for use on organic farms include insecticidal soaps and horticultural oils for insect management; and Bordeaux mixture, copper hydroxide and sodium bicarbonate for managing fungi. Copper sulfate and Bordeaux mixture (copper sulfate plus lime), approved for organic use in various jurisdictions, can be more environmentally problematic than some synthetic fungicides disallowed in organic farming. Similar concerns apply to copper hydroxide. Repeated application of copper sulfate or copper hydroxide as a fungicide may eventually result in copper accumulation to toxic levels in soil, and admonitions to avoid excessive accumulations of copper in soil appear in various organic standards and elsewhere. Environmental concerns for several kinds of biota arise at average rates of use of such substances for some crops. In the European Union, where replacement of copper-based fungicides in organic agriculture is a policy priority, research is seeking alternatives for organic production [9].

GENETIC MODIFICATION

A key characteristic of organic farming is the exclusion of genetically engineered plants and animals. On 19 October 1998, participants at IFOAM's 12th Scientific Conference issued the Mar del Plata Declaration, where more than 600 delegates from over 60 countries voted unanimously to exclude the use of genetically modified organisms in organic food production and agriculture.

Although opposition to the use of any transgenic technologies in organic farming is strong, agricultural researchers Luis Herrera-Estrella and Ariel Alvarez-Morales continue to advocate integration of transgenic technologies into organic farming as the optimal means to sustainable agriculture, particularly in the developing world. Organic farmer Raoul Adamchak [10] and geneticist Pamela Ronald write that many agricultural applications of biotechnology are consistent with organic principles and have significantly advanced sustainable agriculture. Although GMOs are excluded from organic farming, there is concern that the pollen from genetically modified crops is increasingly penetrating organic and heirloom seed stocks, making it difficult, if not impossible, to keep these genomes from entering the organic food supply. Differing regulations among countries limits the availability of GMOs to certain countries, as described in the article on regulation of the release of genetic modified organisms.

TOOLS

Organic farmers use a number of traditional farm tools to do farming, and may make use of agricultural machinery in similar ways to conventional farming. In the developing world, on small organic farms, tools are normally constrained to hand tools and diesel powered water pumps. Standards regulate production methods and in some cases final output for organic agriculture. Standards may be voluntary or legislated. As early as the 1970s private associations certified organic producers. In the 1980s, governments began to produce organic production guidelines. In the 1990s, a trend toward legislated standards began, most notably with the 1991 EU-Eco-regulation developed for European Union, which set standards for 12 countries, and a 1993 UK program [11]. As of 2007 over 60 countries regulate organic farming. IFOAM created the Principles of Organic Agriculture, an international guideline for certification criteria. Typically the agencies accredit certification groups rather than individual farms. Production materials used for the creation of USDA Organic certified foods require the approval of a NOP accredited certifier. EU-organic production-regulation on "organic" food labels define "organic" primarily in terms of whether "natural" or "artificial" substances were allowed as inputs in the food production process [12].

COMPOSTING

Using manure as a fertilizer risks contaminating food with animal gut bacteria, including pathogenic strains of E. coli that have caused fatal poisoning from eating organic food. To combat this risk, USDA organic standards require that manure must be sterilized through high temperature thermophilic composting [13]. If raw animal manure is used, 120 days must pass before the crop is harvested if the final product comes into direct contact with the soil. For products that do not directly contact soil, 90 days must pass prior to harvest. In the US, the Organic Food Production Act of 1991 (OFPA) as amended, specifies that a farm can not be certified as organic if the compost being used contains any synthetic ingredients. The OFPA singles out commercially blended fertilizers [composts] disallowing the use of any fertilizer [compost] that contains prohibited materials.

PRODUCTIVITY

Studies comparing yields have had mixed results. These differences among findings can often be attributed to variations between study designs including differences in the crops studied and the methodology by which results were gathered. A 2012 meta-analysis found that productivity is typically lower for organic farming than conventional farming, but that the size of the difference depends on context and in some cases may be very small [14]. While organic yields can be lower than conventional yields, another meta-analysis published in Sustainable Agriculture Research in 2015, concluded that certain organic on-farm practices could help narrow this gap. Timely weed management and the application of manure in conjunction with legume forages/cover crops were shown to have positive results in increasing organic corn and soybean productivity.

Another meta-analysis published in the journal *Agricultural Systems* in 2012 analyzed 372 datasets and found that organic yields were on average 80% of conventional yields. The author's found that there are relative differences in this yield gap based on crop type with crops like soybeans and rice scoring higher than the 80% average and crops like wheat and potato scoring lower. Across global regions, Asia and Central Europe were found to have relatively higher yields and Northern Europe relatively lower than the average [15]. A study published in 2005 compared conventional cropping, organic animal-based cropping, and organic legume-based cropping on a test farm at the Rodale Institute over 22 years. The study found that "the crop yields for corn and soybeans were similar in the organic animal, organic legume, and conventional farming systems". It also found that "significantly less fossil energy was expended to produce corn in the Rodale Institute's organic animal and organic legume systems than in the conventional production system. There was little difference in energy input between the different treatments for producing soybeans. In the organic systems, synthetic fertilizers and pesticides were generally not used". As of 2012 the Rodale study was ongoin and a thirty-year anniversary report was published by Rodale in 2012. A long-term field study comparing organic/conventional agriculture carried out over 21 years in Switzerland concluded that "Crop yields of the organic systems averaged over 21 experimental years at 80% of the conventional ones. The fertilizer input, however, was 32 – 50% lower, indicating an efficient production. The organic farming systems used 21 – 50% less energy to produce a crop unit and per land area this difference was 36 –

53%. In spite of the considerably lower pesticide input the quality of organic products was hardly discernible from conventional analytically and even came off better in food preference trials and picture creating methods [16].

PROFITABILITY

In the United States, organic farming has been shown to be 2.8 to 3.7 times more profitable for the farmer than conventional farming when prevailing price premiums are taken into account. Globally, organic farming is 22–35% more profitable for farmers than conventional methods, according to a 2015 meta-analysis of studies conducted across five continents.

The profitability of organic agriculture can be attributed to a number of factors. First, organic farmers do not rely on synthetic fertilizer and pesticide inputs, which can be costly. In addition, organic foods currently enjoy a price premium over conventionally produced foods, meaning that organic farmers can often get more for their yield [17]. The price premium for organic food is an important factor in the economic viability of organic farming. In 2013 there was a 100% price premium on organic vegetables and a 56% price premium for organic fruits. These percentages are based on wholesale fruit and vegetable prices, available through the United States Department of Agriculture's Economic Research Service. Price premiums exist not only for organic versus nonorganic crops, but may also vary depending on the venue where the product is sold: farmers' markets, grocery stores, or wholesale to restaurants. For many producers, direct sales at farmers' markets are most profitable because the farmer receives the entire markup, however this is also the most time and labour-intensive approach.

There have been signs of organic price premiums narrowing in recent years, which lowers the economic incentive for farmers to convert to or maintain organic production methods. Data from 22 years of experiments at the Rodale Institute found that, based on the current yields and production costs associated with organic farming in the United States, a price premium of only 11% is required to achieve parity with conventional farming. A separate study found that on a global scale, price premiums of only 5-8% were needed to break even with conventional methods. Without the price premium, profitability for farmers is mixed [18].

ENVIRONMENTAL IMPACT AND EMISSIONS

Researchers at Oxford University analysed 71 peer-reviewed studies and observed that organic products are sometimes worse for the environment. Organic milk, cereals, and pork generated higher greenhouse gas emissions per product than conventional ones but organic beef and olives had lower emissions in most studies. Usually organic products required less energy, but more land. Per unit of product, organic produce generates higher nitrogen leaching, nitrous oxide emissions, ammonia emissions, eutrophication, and acidification potential than conventionally grown produce. Other differences were not significant. The researchers concluded that public debate should consider various manners of employing conventional or organic farming, and not merely debate conventional farming as opposed to organic farming [19]. A 2018 review article in the *Annual Review of Resource Economics* found that organic agriculture is more polluting per unit of output and that widespread upscaling of organic agriculture would cause additional loss of natural habitats.

Proponents of organic farming have claimed that organic agriculture emphasizes closed nutrient cycles, biodiversity, and effective soil management providing the capacity to mitigate and even reverse the effects of climate change and that organic agriculture can decrease fossil fuel emissions. "The carbon sequestration efficiency of organic systems in temperate climates is almost double (575–700 kilograms per hectare per year (16.3–19.8 lb/acre/Ms)) that of conventional treatment of soils, mainly owing to the use of grass clovers for feed and of cover crops in organic rotations."[20] However, studies acknowledge organic systems require more acreage to produce the same yield as conventional farms. By converting to organic farms in developed countries where most arable land is accounted for,[21] increased deforestation would decrease overall carbon sequestration.

NUTRIENT LEACHING AND LAND USE

According to a 2012 meta-analysis of 71 studies, nitrogen leaching, nitrous oxide emissions, ammonia emissions, eutrophication potential and acidification potential were higher for organic products. Specifically, the emission per area of land is lower, but per amount of food produced is higher. This is due to the lower crop yield of organic farms. Excess nutrients in lakes, rivers, and groundwater can cause algal blooms, eutrophication, and subsequent dead zones. In addition, nitrates are harmful to aquatic organisms by themselves.

A 2011 Oxford meta-analysis of 71 studies found that organic farming requires 84% more land for an equivalent amount of harvest, mainly due to lack of nutrients but sometimes due to weeds, diseases or pests, lower yielding animals and land required for fertility building crops.[22] While organic farming does not necessarily save land for wildlife habitats and forestry in all cases, the most modern breakthroughs in organic are addressing these issues with success. Professor Wolfgang Branscheid says that organic animal production is not good for the environment, because organic chicken requires twice as much land as "conventional" chicken and organic pork a quarter more. According to a calculation by Hudson Institute, organic beef requires three times as much land.[23] On the other hand, certain organic methods of animal husbandry have been shown to restore desertified, marginal, and/or otherwise unavailable land to agricultural productivity and wildlife. Or by getting both forage and cash crop production from the same fields simultaneously, reduce net land use.

SRI methods for rice production, without external inputs, have produced record yields on some farms, but not others.

PESTICIDES

In organic farming the use of synthetic pesticides and certain natural compounds that are produced using chemical synthesis are prohibited. The organic labels restrictions are not only based on the nature of the compound, but also on the method of production.

A non-exhaustive list of organic approved pesticides with their median lethal doses:

- Boric acid is used as an insecticide [24] (LD50: 2661 mg/kg).
- Copper(II) sulfate is used as a fungicide and is also used in conventional agriculture (LD50 300 mg/kg). Conventional agriculture has the option to use the less toxic Mancozeb (LD50 4,500 to 11,210 mg/kg)
- Lime sulfur (aka calcium polysulfide) and sulfur are considered to be allowed, synthetic materials (LD50: 820 mg/kg)
- Neem oil is used as an insect repellant in India; since it contains azadirachtin its use is restricted in the UK and Europe.
- Pyrethrin comes from chemicals extracted from flowers of the genus Pyrethrum *Pyrethrum* (LD50 of 270 mg/kg). Its potent toxicity is used to control insects.

FOOD QUALITY AND SAFETY

While there may be some differences in the amounts of nutrients and anti-nutrients when organically produced food and conventionally-produced food are compared, the variable nature of food production and handling makes it difficult to generalize results, and there is insufficient evidence to make claims that organic food is safer or healthier than conventional food. There is no evidence to suggest that organic food tastes better than conventionally produced food.

SOIL CONSERVATION

Supporters claim that organically managed soil has a higher qualityand higher water retention. This may help increase yields for organic farms in drought years. Organic farming can build up soil organic matter better than conventional no-till farming, which suggests long-term yield benefits from organic farming. An 19-year study of organic methods on nutrient-depleted soil concluded that conventional methods were superior for soil fertility and yield for nutrient-depleted soils in cold-temperate climates, arguing that much of the benefit from organic farming derives from imported materials that could not be regarded as self-sustaining [25].

BIODIVERSITY

The conservation of natural resources and biodiversity is a core principle of organic production. Three broad management practices (prohibition/reduced use of chemical pesticides and inorganic fertilizers; sympathetic management of non-cropped habitats; and preservation of mixed farming) that are largely intrinsic (but not exclusive) to organic farming are particularly beneficial for farmland wildlife. Using practices that attract or introduce beneficial insects, provide habitat for birds and mammals, and provide conditions that increase soil biotic diversity serve to supply vital ecological services to organic production systems [26]. Advantages to certified organic operations that implement these types of production practices include:

1) decreased dependence on outside fertility inputs;
2) reduced pest-management costs;
3) more reliable sources of clean water; and
4) better pollination.

Nearly all non-crop, naturally occurring [27] species observed in comparative farm land practice studies show a preference for organic farming both by abundance and diversity. An average of 30% more species inhabit organic farms. Birds, butterflies, soil microbes, beetles, earthworms, spiders, vegetation, and mammals are particularly affected. Lack of herbicides and pesticides improve biodiversity fitness and population density. Many weed species attract beneficial insects that improve soil qualities and forage on weed pests. Soil-bound organisms often benefit because of increased bacteria populations due to natural fertilizer such as manure, while experiencing reduced intake of herbicides and pesticides. Increased biodiversity, especially from beneficial soil microbes and mycorrhizae have been proposed as an explanation for the high yields experienced by some organic plots, especially in light of the differences seen in a 22-year comparison of organic and control fields.

A wide range of organisms benefit from organic farming, but it is unclear whether organic methods confer greater benefits than conventional integrated agri-environmental programs. Organic farming is often presented as a more biodiversity-friendly practice, but the generality of the beneficial effects of organic farming is debated as the effects appear often species- and context-dependent, and current research has highlighted the need to quantify the relative effects of local- and landscape-scale management on farmland biodiversity [28]. There are four key issues when comparing the impacts on biodiversity of organic and conventional farming:

1) It remains unclear whether a holistic whole-farm approach (i.e. organic) provides greater benefits to biodiversity than carefully targeted prescriptions applied to relatively small areas of cropped and/or non-cropped habitats within conventional agriculture (i.e. agri-environment schemes);
2) Many comparative studies encounter methodological problems, limiting their ability to draw quantitative conclusions;

3) Our knowledge of the impacts of organic farming in pastoral and upland agriculture is limited;
4) There remains a pressing need for longitudinal, system-level studies in order to address these issues and to fill in the gaps in our knowledge of the impacts of organic farming, before a full appraisal of its potential role in biodiversity conservation in agroecosystems can be made.

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