CAN ORGANIC AGRICULTURE FEED THE WORLD?

ParakramaWaidyanatha[1]

Environmental pollution, apart from other causes, is blamed on modern (conventional}agriculture, and some argue that we should turn back to organic or traditional agriculture, free from synthetic chemicals, for pollutant –free food and water. The quest for toxin- free food amongst, especially the affluent people, has given a boost to the production organic food, though usuallycostlier than conventional food. Much has been discussed in The Island's Opinion Column latterly in this regard. Facts rather than rhetoric and emotions should guide our thinking. An attempt is made here to examine the pros and cons of organic farming vis a visconventional.

Organic farming to Conventional farming - some history

Organic farming (OF) may be broadly defined as production of crops and animals without the use of synthetic agrochemicals and sewerage sludge. Natural minerals such as rock phosphate, potash and dolomite are allowed for use in OF, but not any synthetically altered productsthereof such as superphosphate. Nitrogen is to be provided via organic matter or biological nitrogen fixation in legume cover crops, green manures, rotations or relay cropping with legumes.

The transition from traditional agriculture where fertilizer comprised essentially farmyard manure(FYM) and green manures, to conventional agriculture(CF), as we know it today, took place in the mid 19thcenturywith two ground breaking inventions, the synthesis of soluble (super) phosphate and chemical nitrogenous fertilizer by two great scientists cum entrepreneurs. One was John Lawes(1814 to 1900), an Englishman, who was later knighted. He was also the founder of the prestigious Rothamsted Experimental Station in England, regarded as the senior of all agricultural research institutions, which he set up in his own farm. The other was a German, Justus von Liebig(1803-1873-later, Professor of Chemistry).Lawes' invention of soluble phosphate was considered as a one of the greatest inventions in agricultural chemistry. He commenced his soluble phosphate research in his bedroom mixing sulphuric acid and rock phosphate, but was fortunate to come out unscathed! Similarly, Liebig was an outstanding chemist and discovered nitrogen as a plant nutrient, apart from many other inventions such as chloroform. In 1909, another great German scientist, Fritz Haber successfully synthesised ammonia by combining atmospheric nitrogen and hydrogen which revolutionised the production of commercialnitrogenous fertilizers.

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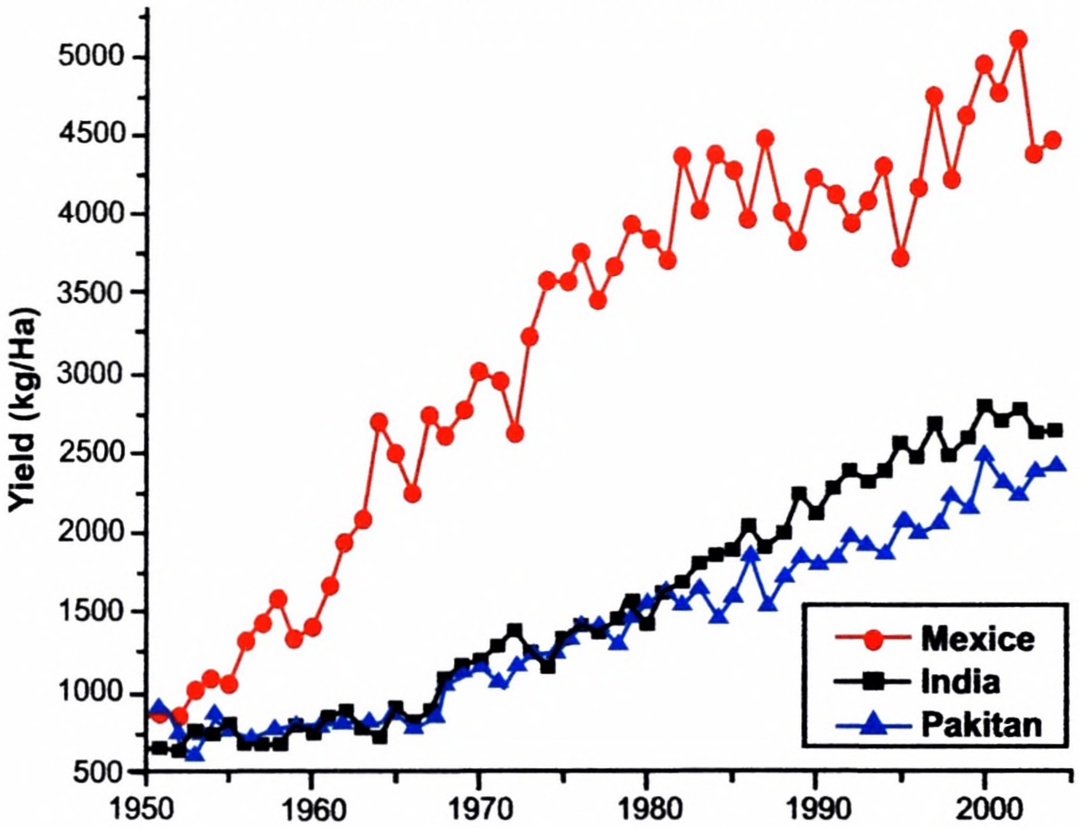
[1]Former chairman coconut Rereard Board

These inventions and therapidly growing knowledge then in plant chemistry lead to the substitution of chemical fertilizer with natural dung. The third important element, potassium, wasprovided largely by potash, a substance that had been known from antiquity. It has been said that without these inventions, the industrial countries of Western Europe could not have supported the dense population growth of the 19th century. It is the same reason that later led to the Green Revolution. A later Director of Rothamsted, Sir John Russell (1942) in an article titled British Agriculture states that: "it is difficult for us in this distance in time to recapture the feelings with which the farmers received the information that a powder made in a factory and applied out of a bag at the rate of only a few hundred weights per acre could possibly act as well as farmyard manure put on the land as dressings of tons per acre". This is ironically the fundamental question that we should ask. Is there adequate organic matter to meet the nutrient demands of crops, on a global scale today, if it was inadequate then?

Wheat Yields in selected countries, 1950-2004



Source: FAO

In Britain, the introduction of chemical fertilizers and the consequent changes in farming practices that lead to dramatic increases in crop productivity has been hailed as the British Agricultural Revolution comparable with the Green Revolution. Ideally, it should have been called the' European Agricultural Revolution, as it spread across the entire Western Europe.

In the mid 20th century, one hundred years later, came the 'Green Revolution' where emphasis shifted from crop nutrition to crop breeding – the synthesis of high yielding, short-statured, fertilizer-responsive crop types, especially cereals, without which the world food demand could not have been met today. The pioneering efforts of breeders such as the Nobel Laureate Norman Borlaug, described as the father of the green revolution and 'the man who saved a billion lives' stand out in this regard. High productivity of these new varieties demanded more fertilizer which made the crops luscious, inviting pests and diseases leading to the need for use of pesticides without which the high yields could not be achieved. Breeding for pest resistance in the new varieties followed. Resistance breeding, for example, in the new rice lines yielded many breakthroughs and greatly mitigated pesticide use in rice, but pesticides continue to be widely used in many crops. That traditional varieties are more pest and disease resistant than the new varietiesis a myth! For example, some of our traditional rice varieties such as Murungakayan and Pachchaperumal have been susceptible to the main pests and diseases - Gallmidge, Brown Plant Hopper and Blast. In the recent past there have been alsoclaims of some traditional rice varieties yielding 80 bushels per acre (near national average yield) under traditional farming' (TF)methods, and this as justification for return to TF. The TF technology used here has not been defined but such yields may well be achievable in isolated,well managed plots. Large scale cultivation is a different matter!Ideally, there should also have been a comparison of performance with at least a few new varieties under similar crop management technologies.

Environmental pollution

Undoubtedly, conventional farming is more detrimental to the environment than organic. For example, it has been reported that agricultural pollution is costing the USD 12 billion in environmental and health care and soil erosion, USD 45 billion, annually. There is growing evidence that the overwhelming issue is the indiscriminate and profligate use of agrochemicals, and their application with the use of protective gear. The case of serious phosphate pollution of water bodies in the Rajarata, due to profligate and wonton use of phosphate fertilizer is a classic example. The vegetable farmers in the hill country are applying 5-10 times the recommended doze leading to serious pollution of water bodies downstream in the Rajarata. Cadmium an impurity in phosphate fertilizer is implicated in the kidney disease afflicting some 200,000 people in the region.Excess P also causes algal blooms which hinder the use of water apart from secreting toxins very harmful to health. The government, to date, has done nothing to restrict phosphate application in the upcountry.

Judicious and knowledgeable useof pesticide with appropriate safety measures should greatly mitigate pesticide pollutionSome programmes in Sweden, Canada and Indonesia have also demonstrated that pesticide use can bereduced without loss of crop by as much as 50 to 60% (In Pimental et at al , Bio Science , 55 (7), 573-581 :2005). As regards toxicity of pesticides, over the last half century, there has been a gradual evolution from highly toxic pesticides to less toxic ones; the process continues. There is also now wider recourse in bio-pesticides and integrated pest management. The problem, however, is that the pests mutate into more virulent forms faster than the invention of remedies.

As serious as the scourge of pesticide pollution is that ofheavy metal pollution. There is nowworldwide concern overheavy metal contamination in both fertilizers and pesticides. Unlike most other toxins, they can accumulate in biosystems including the human body, so that even in minute quantities in food, water or air, thehealth risksover time can be serious.

This concern can be no less seriousin OF than in CF, given the factthat, though organic manures may carry relatively small concentrations of heavy metals,large quantities areusually applied.The writer has had no access to any data on heavy metal analysis in organic fertilizers in Sri Lanka. but using, as an example, the cadmium(Cd) value of 0.38 mg/kg of dry (20% moisture) FYM given in a British publication (Nicholson et al, 1999 Bio Resource Technology:70:23-31), and assuming similar levels are found in local FYM, the probable levels of Cd in a comparable DOA vegetable fertilizer recommendations of organic and inorganic fertilizers of 30 tonnes and 325 kg of triple super phosphate (TSP) per ha respectively are 2.28 and 1.62 mg/kg. The maximum permissible Cd level of 5 mg/kg in TSPby the Sri Lanka Standards Institute is used as the amount of Cd in TSP. Organic fertilizers arethus no less heavy metal- polluting than inorganic.

There have also been reports of pesticides detected in alternative (fake) crop protectants (so called herbal formulations) recommended for organic farming. Dr Naoki Motoyama (Tokyo University of Agriculture – 2012) has reported the detection of at least eight toxic pesticides including Abamectin (LD50 = 1.0mg/kg), an insecticide!

Organic or inorganicfertilizer - crops have no preference!

Crops have no preference for one or the other type of fertilizer! Organic manures should breakdown in the soil through microbial action to provide the nutrients in the soluble (ionic)form for the cropsto be able to take up. So should the inorganic fertilizers dissolve in the soil (into ions) for crop uptake. The advantage with inorganic fertilizers is that the exacting requirements of individual nutrients to crops can be provided by application asindividual chemicals or mixtures because crops differ in their nutrient requirements. For example, whereas cereals such as maize, rice and wheat require relatively more nitrogen that P or K, banana, coconut and manioc require twice or more of K than N or P. Nutrient adjustments to suit specific crops is difficult with organic forms unless supplemented with inorganic fertilizers.

Organic farming (OF) – productivity, economics and soil fertility

The writer is not aware of any evidence on long term experiments comparing organic and conventional food crop production systems in Sri Lanka. However, a classical experiment carried out for over 15 years in Pennsylvania, the Rodale Institute Farming Systems Trial (400 ha) provides evidence on the productivity and profitability of three cropping systems, namely, conventional cropping based on inorganic fertilizers and pesticides, organic /FYM and organic-legume based cropping(relying entirely for N from legume N fixation by green manure and cover crops).Rotations of corn and soybean were the main cropping systems. After a 5 year transition period from conventional cropping to the trial, the corn yields were comparable in the three systems but the soybean yields were marginally lower for the legume based system.

However, in the 5 dry years of the trial, the organic systems out yielded the conventional system because of the better soil moisture retentively in the organic plots. Over the 10 year period, organic corn was 25%more profitable even without adjustment for price premiums because the cost of production was 15% less despite 35% higher labour costs.

The organic corn and soybean prices were 20 to 140% higher than the conventional in the market during this period.By contrast, organically grown wheat and other cereal yields were30 to 50% lower than those grown conventionally grown in some European field trials (Mader*et al*, Science: 296, 1694-97). The returns from the Rodale Institute trial appears exceptional in that OF is usually more costly, because of higher manureand labour costs. This is especiallytrue in developing countries where use of farm machinery and equipment is limited. Some argue this to be an advantage in situations of rural unemployment.

The greatest benefit of OF, however, is the improvement of soil physical, chemical and biological properties as against CF. In the above trial,the organic plots, as to be expected, had significantly higher organic matter, nitrogen and earth worm activity than the conventional.

Sustainability

Apartment from the benefits to the environment, an argument for OFis sustainability as it involves production systems that use only naturally occurring (non-synthetic), ideally renewable inputs. On the other hand, two of the natural mineral fertilizer resources, potash and rock phosphate allowed in OFare non-renewable. For example, the total world potash reserves add up to some 9500 million metric tons of which currently 37 million tons are mined annually implying that the reserves theoretically can last only for 257 years. Rock phosphate resources are much larger, about 290billion tons and about 160 million mined annually according to one estimate.

Theoretically possible?

Organic matter availability need not always be a limitation in organic farming given the fact that mineral rock phosphate and potash can be used. The main limiting factor then is nitrogen. A team of scientists from the University of Michigan, USA (Catherine Badger et al, 2006:'Organic agriculture and global food supply'; Renewable Agriculture and Food Systems: 22 (2) 86-108) examine the theoretical feasibility of supplementing nitrogen by biological nitrogen fixation in legumes. They argue, using published data on legume nitrogen fixation thatthe entire nitrogen demand for global food production can be met by legume nitrogen fixation, and the global food needs by organic agriculture. They apply yield ratios of crops from organic and conventional farms to current global food production values(FAO statistics) for 20 general food categories.

Two models are used, one based on food production data for the developed world and the other for the developing world. According to the first model, the estimated conventionally and organically produced food suppliesare comparable, whereas according to the second, the latter exceeds the former. This difference is explained on the basis that, in the developing world, yields from resource-poor conventional farms are lower than those from relatively better maintained organic farms. As said above, the assumption is that phosphorus and potassium are supplied as mineral fertilizers and nitrogen is provided by biological fixation in legumes through green manures, cover crops, crop rotations, intercropping and relay cropping with legumes.. This may sound exciting to organic farmers, but practicality and economics in many farming situations arequestionable. Nitrogen supply and weed management are considered the biggest constraints to. The economic feasibility of the reduction of food cropping intensity as a result interventions of legumecovers or green manures, especially in small farms of the third world countries, needs consideration.

Global organic agriculture

'The proof of the pudding is in the eating'! The total world extent under organic farming yet remains less than 1% (0.9% in 2012) of the total farm lands. Of this, two thirds are grasslands, only 19% arable crops and 8% horticultural crops. Organic farming is thus a minor phenomenon in many countries and is yet a long way from feeding the world. There are, however, 1.6 million producers in 84 countries ('World Agriculture Statistics and Emerging Trends - 2012').OF has expanded substantially especially in Europe(10 million ha) and Oceania(12.1million ha), Latin America (8.4 million ha)at a growth rate of over 50% annually in recent times. On the other hand, extents in Asia (2.8 million ha) North America (2.7 million ha)and Africa (1.1 million ha) have remained relatively small. There has been a slight decrease recently in the total world extent, due largely to marginal decreases in extents in India and China, some farmers reverting to conventional farming.. However, years of resource exploitive and polluting conventional agriculture has done substantial damage to the environment, man and animals. Taking the good things from both systems and developinga less polluting and more sustainable agriculture is the need of the day. This needs new thinking and innovative research.