

DDDR:IAR/74/16 Restricted  
February, 1974

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

Seventh Meeting, Rome, 4-8 February, 1974

ORGANIC APPROACHES TO AGRICULTURE

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(Agenda 19d)

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME 1974

WS/E6670

## ORGANIC APPROACHES TO AGRICULTURE

### I. Need For a Rapid Rise in Crop and Animal Productivity in Developing Countries.

1. A vertical growth in plant and animal productivity, an increase in the intensity of farming in high rainfall and irrigated areas to make full use of sunlight and water through multiple and relay cropping techniques and the introduction of new land and water use techniques in the semi-arid and arid areas, are urgently needed to mitigate the food, unemployment and poverty problems of many developing countries. Mr. R.S. McNamara, for example, pointed out in his address at Nairobi last year, that "if Japan could produce 6720 Kg. of grain per hectare on very small farms in 1970, then Africa with its 1270 Kg., Asia with 1750 Kg. and Latin America with 2060 Kg. per hectare have an enormous potential for expanding productivity". It is also known that at lower levels of average productivity, fluctuations in production arising from weather, pest or other problems tend to be much higher than in countries with high average yields. Violent fluctuations in production thus often occur in countries which are least capable of bearing them.

2. The dimensions of unemployment are vast in countries like India, whether measured by (i) the income aspect, (ii) the recognition aspect and (iii) the production aspect. The biggest estimates in India come from the production approach. According to FAO statistics, much of this problem can be solved in India, if the number of workers employed productively in agriculture can be raised from the present average rate of about 96 to 100 hectares to about 190 per 100 hectares, as in Japan. This will imply a doubling in the opportunities for productive and remunerative employment per unit of land.

### II. Productivity improvement and Energy Consumption.

3. How can developing countries achieve the twin goals of improving productivity per units of land, time and water and of enhancing the potential for productive employment per unit of land? Historically, a rise in standard of living has been associated with diversion of labour from agriculture to more industrial pursuits. This in turn has led to a rapid rise in the consumption of energy, mostly from non-renewable resources. The per capita consumption of energy in 1970, expressed as coal equivalent in kilograms, was thus 11,128 in the United States, 8997 in Canada and 5374 in Australia in contrast to 189 in India and 45 in Nigeria. The mechanised and low-labour consuming agriculture has achieved increased productivity on the basis of a high consumption of energy largely derived from the non-renewable resources of the earth. In contrast the agriculture of most poor nations is largely based on sun, air, soil, water and toil of the farmer and his livestock. Thus, while in 1964, about 286 kilo calories of energy were needed in Indonesia and India to produce 1 Kg. of rice protein, 2860 kilo calories of energy were needed to produce 1 Kg. of wheat protein and over 65,000 K calories to produce 1 Kg. of beef protein in the United States. This trend has been discussed in a recent paper in "Science" (182, 443, 1973) by Pimentel and his co-workers. They have shown that among all inputs, nitrogenous fertilizers require a high proportion of energy input for their manufacture.

### III. Can Productivity be Improved Largely on the Basis of Renewable Forms of Energy?

Before the advent of fertilizers, shifting cultivation, conservation and use of all organic wastes and cultivation of legumes were the principal methods of replenishing soil fertility: solar energy, besides its use by plants in photosynthesis, was largely employed in post-harvest technology; wind energy was also used sporadically. With the growth in the exploitation of fossil fuels, the use of solar and wind energy, organic recycling and the planned introduction of legumes in rotations tended to become

unimportant in most countries, with some exceptions like China in the area of organic recycling including the conservation and use of human excreta and Australia, with regard to the cultivation of legumes. In poor countries like India, organic refuse became the most important source of fuel to the rural population and with the growth in population, farm-yard manure and all cellulosic wastes were increasingly consumed as fuel. Hence, productivity remained relatively stagnant until the last few years, when farmers started using fertilizer for food crops like wheat and rice. Just when small farmers had started using fertilizer and pesticides, the current escalation in the cost of petroleum products and the consequent shortage as well as high price of fertilizer have given a serious set-back to their hopes and aspirations. Besides, food production plans in many developing countries which were based on the use of specific quantities of fertilizers are now losing credibility in the eyes of the farmers. How can more food be obtained from hungry soils with reduced availability of fertilizers?

(a) Recycling of Wastes and Human and Animal Refuse:

Farmers in developing countries know the manurial value of all organic wastes and, in the past, they heavily depended on farm-yard manure and compost for meeting the nutrient needs of their crops. In recent years, however, rural families in India have tended to rely heavily on such material for their fuel needs. It is hence obvious that unless arrangements are made to supply them with cheap fuel, animal manures as well as material used in the preparation of composts will continue to be used as fuel. Two solutions have been suggested to meet the fuel needs of farmers.

First, Bio-gas and cow-dung gas plants may be popularised in a big way, so that the animal and cellulosic wastes may provide both fuel and manure. This is certainly a worthwhile approach but if this is to be done on a mass scale, more research is needed in (i) designing low-cost gas plants in which CO<sub>2</sub> can be separated from methane, (ii) developing suitable catalysts which can help to keep gas release high during winter months and (iii) community organisation of gas supply to the marginal farmers and landless labour, having few or no animals.

Secondly, energy forests can be created at appropriate places. Scope for developing quick-yielding fuel trees has not been fully explored. For example, can an annual variety of bamboo be developed?

All urban wastes including sewage can be conserved and used in agriculture. This can be done provided proper precautions are taken from the public health point of view.

On the calculation that one dairy cow or 84 chickens can provide the fertilizer equivalent of nitrogen needed by one acre of maize, Pimentel and his colleagues have suggested that replacement of chemical fertilizers by organic manure could save 1.1 out of 1.9 million K. cal of energy per acre, per year. Therefore, the contribution that a concerted drive to save organic manures for feeding crops could make to ease the serious threat to crop production posed by fertilizer scarcity should not be under-estimated.

(b) Symbiotic Nitrogen Fixation:

Systematic introduction of grain and fodder legumes in cropping systems can help to reduce the consumption of energy from fossil fuels very considerably. While industrial N fixation is now of the order of 30 million tons per year, rhizobium bacteria in root modules of food and fodder legumes alone fix about 14 million tons of N per year on a global scale. This quantity can be greatly increased by developing more efficient cultures of rhizobia, and by finding a place for legumes in all crop rotations. Mono-culture of cereals or

other non-leguminous crops needs to be discouraged. The development of legume inoculant programmes is of great importance to tropical agriculture and work in this field is of the highest priority.

(c) Non-symbiotic Nitrogen Fixation:

Azotobacter, Beijerinckia, blue-green algae and several other organisms can fix nitrogen in a free state in soil provided enough carbohydrates are available. Azotobacter grow in soil and particularly in the root region of plants. Apart from fixing nitrogen, they also produce gibberellins, kinetins and other unidentified growth substances. Much more research is needed on these organisms, particularly with regard to their use in plantation crops and in crop canopies which can facilitate accumulation of organic matter in the soil.

(d) Integrated Crop and Animal Production Systems:

Integrated systems of crop and animal production based on both recycling of animal refuse and the cultivation of leguminous forage crops like clovers and alfalfa would provide conditions where the dependence on fossil fuels can be minimised, without detriment to productivity. The feasibility for popularising such systems will have to be assessed in relation to specific agro-ecological and marketing conditions.

Terrestrial and aquatic culture systems can also be made mutually reinforcing. Recent polyculture techniques may be particularly attractive, if more research is done on the nutritional aspects of such intensive fish production systems with a view to minimising the dependence on fertilizer and supplanting synthetic fertilizers with organic manures derived from other components of the production system, such as ducks.

(e) Phosphorus Problem:

The price of P is rising fast and this, being a non-renewable resource, will have to be husbanded carefully. Here again, more research will be needed on the use of phosphorus solubilising bacteria and on the use of rock phosphates, basic slag etc.

IV. What can TAC do?

In my view, TAC can take the following two steps immediately to inform itself better of the potential for increasing production and productivity on the basis of a diminishing dependence on non-renewable sources of energy. The principal components of such energy will be fertilizer - not only nitrogen but also phosphorus which threatens to become an important economic weapon.

- (1) TAC may convene an expert group to go into this problem critically and develop a clear statement on the problem, together with specific suggestions on gaps in our research efforts in making more extensive use of organic recycling principles in farming. It would be preferable to hold this meeting in a developing country, as an index of the concern of the international scientific community for the future of the agriculture of poor nations.
- (2) Request Directors of all International Research Institutes to indicate at the Centres' Week in July, 1974, the extent to which the shortage and high price of fertilizers and other inputs based on fossil fuels would affect the spread and effectiveness of the technology being developed and recommended by their respective Institutes.