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Historical perspectives of the management of food and land resources within the context of sustainability

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Abstract

This paper attempts to look at issues as enumerated in the title of this paper. This is done from the perspective of recalling and remembering the gains made in these issues in an era that has passed and that, the world and many countries of the developing world are even today grappling with these issues. The paper will look at some perspectives of the world food situation, land resources and food issues. The paper will be concluded by discussing managing water resources for food production. The article will borrow heavily upon the work of authors such as Mathew Drosdoff, Armand Wambeke, Gilbert Levine, and Walter Coward. The paper exemplifies the importance of these issues within the ambit of agricultural development and sustainability.

Keywords: Management; Perspectives; Food; Land Resources; Production; Water; Agriculture; Sustainability Climate; Environment

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1. Introduction

The general consensus is that despite present surpluses in many countries, the world food situation will remain fragile for the foreseeable future into the 21st century. "In this regard the major food production countries have been able to meet the minimum needs of food deficit countries through exports. In many instances developing countries are heading for huge deficits in major food crops and animal products" (Drosdoff, 1984:3). Population increases play an important part coupled with wars, uncertain political circumstances and further exacerbated by predatory elites that are involved in the accumulation of capital and by the same token the inability of many governments to deal decisively with poverty, inequality and unemployment. "The question arises food for how many people? How much land will be needed to feed an increasing world population and, many countries in the so – called Third World? There are no simple answers. Considering the complexity of agriculture, the economic analysis of world food production, will have to be satisfied with approximations. For example, no satisfactory global inventory of soil and water resources is available, and experts and many countries are still arguing and discussing the methods required to evaluate the potential of land to produce food crops" (Wambeke, 1984: 7).

During the early 1970's severe food shortages occurred in many parts of the developing world. These shortages were due to the expanding world population and adverse climate conditions. "In recognition of the critical role that water plays in the production of food, the United Nations (UN) World Food Conference in 1974, adopted a special resolution urging governments and international organizations to make new efforts to expand irrigation rapidly and urgently" (Levine and Coward, 1984: 17).

2. The world food situation: Some perspectives

With increasing food demands due to increasing incomes and a shifting toward greater consumption of livestock products and increasing demand for food because of drought, the world food situation requires a substantial increase in terms of metric tons of food required by the world population. Many of the developing countries have serious food shortages and often do not have the resources to buy the food that may be available on the world market. According to Drosdoff (1984: 3) "the middle East and North and Sub – Saharan Africa, for example, where food shortages are chronic, a projected food deficit will not only go on into the end of the 20th century, but will be carried through into the 21st century." Any projections are hazardous and will depend on certain assumptions made with respect to rates of population increase, income growth, and food production. Food deficits may vary from year to year depending on weather conditions, political stability, war, and other unforeseen variables. These deficits have been met by food aid in the past and commercial imports from the surplus – producing countries. To what extent these deficits will be met in the future will depend largely on dealing with the current recession and economic meltdown, on population and income growth rates in the developing countries and in the developed world in respect of countries like Portugal, Italy, Ireland, Greece and Spain, as well as the growth rate of agricultural production and the economic health, political stability, and government policies in both developing and developed countries.

One can either be optimistic or pessimistic about future world food supplies to meet the demand, depending on the assumptions made with respect to the issues involved. "The Global 2000 report issued by

the US government in 1980 had a rather pessimistic outlook on future world food supplies. It concludes that food production will have increased at only 2.2 percent in terms of the annual rate and predicted a 95 percent increase in food prices and rapid rises in costs of fertilizers, pesticides, and fuel. Because of accelerated erosion, loss of soil fertility and irrigation damage, the Global 2000 report forecasted diminishing returns; cropland will only increase 4 percent because the better lands were already under cultivation. It quoted the World Bank estimate that the number of malnourished people in developing countries could have risen by 1.3 billion by the year 2000 and the position will worsen in the 21st century; a substantial increase in the share of world resources for food production will be required to meet the demand for food." (US Government, Global Report, 2000). The issue arises, has anything changed today in terms of the above appraisal or if the situation has worsened? "A more optimistic appraisal is provided in the book (1981) called Global 2000 revisited that consisted of papers by 23 distinguished professionals and edited by Herman Kahn and Julian Simon. The paper on food and agriculture in this book reports that the FAO (Food and Agricultural Organization of the United Nations) forecasted an annual rise of 2.8 percent in food production in developing countries, a rate sufficient for nutritional improvement."

However, given the above analysis, it is necessary and essential that world governments and particularly the developing world governments address the issues of greater efficiency in the use of fertilizers, pesticides, and irrigation water to increase crop yields which will reduce the need for bringing new lower – quality land under cultivation. There are promising ongoing research activities in plant breeding to increase crop yields. New techniques, such as tissue culture must be enhanced together with greater emphasis on genetic engineering and expanding the extension outreach programmes for marginal and subsistence farmers. The above issues offer some additional future possibilities for substantial crop and, general agricultural improvement. It also offers some hope for the processes of sustainability. This may assist in dealing with hunger by means of increased food production.

It is now generally agreed that on a global basis there is now enough food produced to provide an adequate diet for the world population, if only the food can be equitably distributed. But the disparities are enormous between surplus – producing and food – deficit countries. Whether or not there will be growing numbers of malnourished people in the world and particularly in developing countries will to a large extent depend on government policies in the food deficit countries to allocate greater resources to the development of agriculture. Larger crop yields and their more equitable distribution, along with an effective programme to reduce population growth, are now needed. To implement these policies will require an efficient system of market incentives to stimulate food production, availability of technical packages of production inputs to farmers, investment in training and education and infrastructure, and improvement in organizational and administrative capabilities. Many of the developing countries and some of the developed countries will need greater international assistance to accomplish these objectives.

3. Population and food supply

Several writers have postulated that technologically, enough food could be produced in the world to support many times the present population. Other writers believe that the world is already over populated and there

needs to be a reduction in population. Both these propositions are unrealistic. A more generally accepted postulate is that the world is not over populated and that it is feasible to produce enough food to support at least twice the present population. The United Nations' World Population Prospects as assessed in 1980 (New York, 1981) projected a population of 6.1 billion at the end of the 20th century and a leveling off by 2050 at 9 or 10 billion. These projections were woefully accurate. According to the UN the world population growth rate appears to have decreased from its peak of 2.0 percent about 20 years ago to about 1.7 percent at present. To what extent the decline in birth rates will continue in the high – population developing countries depends on a complexity of factors that make projections difficult. The reliability of much of the census data is open to question. An important factor in the decline of birthrates in developing countries has been the success of family planning programmes. Many have adopted a broad approach in their population policies, which recognize the social, cultural, an economic factors that have to be considered such as social reform including the change in the status of women, educational and communication programmes, sociological and medical research, and increased production and distribution of contraceptives.

In Africa and Latin America, there are countries with a population growth rate of 2.5 to over 3 percent, but food production has declined on a per capita basis. An important issue is whether or not it is possible for these countries as well as other developing countries to reduce population growth without the precondition of an improved economy. Some have argued that to improve the economy it is necessary first to control population growth, whereas others believe that economic development must precede any substantial reduction in population growth rates. China and Brazil, both BRICS group of countries are examples where both approaches appear to have succeeded in reducing population growth. Brazil has focused on economic development and has not made family planning a priority. Though most economists agree that population growth rates need to be reduced in the high growth rate developing countries in order to improve the economy, Julian Simon argues in his book the Ultimate Resource (1981) that "a high population – growth rate may be beneficial in the long run. The ultimate resource, humankind, will be able through ideas and ingenuity to devise ways and means to use the increased population to make the world, a better place to live." His theory uses historical trends and focuses on long – range development but since we must concern ourselves with the near future, his arguments have not been persuasive.

4. The potential for increasing productivity of land under cultivation

Some of the most serious problems confronting these issues in the developing world are the economic, political, and social constraints that limit the application of available technology in the 21st century. The green revolution has played its part but agricultural development in the developing nations has to be taken to a higher trajectory of sustained development and interaction. The success of the green revolution has been spotty. Many developing countries or regions within countries have increased food production greatly, but a large segment of low – income farmers without access to modern technology has been bypassed. The equitable distribution of gains from the green revolution to increase productivity of large numbers of poor farmers is one of the most critical issues facing many developing countries in the 21st century. This will

require far – reaching political, social, institutional, and organizational changes. A policy issue facing many developing countries is how much resources to allocate to their more – modern agricultural sector to produce as much food and as rapidly as possible, in order to meet the demands of their growing urban sector versus how much to allocate to raise the production of large numbers of rural population involved in subsistence and near subsistence farming.

5. Some considerations on world food issues

The discussion thus far has not been all encompassing or exhaustive. In general the moral and ethical questions have not been discussed, for they are beyond this paper. The issues of technology transfers, nutrition, education, communication, land tenure, export of agricultural products from food – deficit countries, international food aid, and organization and administration of agricultural institutions are issues that concern policy. The cardinal issue if rethinking the role of agricultural extension must propose the use of new systems in the analysis, design, and operation of extension programmes to assure coherence and efficiency of effort and relevance and effectiveness of effort. The different meanings of agrarian reform must be defined and understood within the realm of beneficiaries of reform and their effects on agricultural productivity and employment. The issue of the problems that bureaucracy and bureaucratic agencies of government, privately owned commercial enterprises and association of farmers and other rural people as vital factors in rural development must be reexamined urgently. These are a few issues that must be looked at amidst a host of other important variables.

6. Land resources and food issues

Agro – ecological studies have been completed on certain continents and the climatic components integrated in the descriptions of the environment as far back as 1978 (FAO, 1978). The primary aim of these maps was to assess the suitability of land to support the world's population. Given the situation today and as we approach the second decade of the 21st century, a more dynamic assessment of the adequacy of land resources must be developed. The question now must centre on what really is arable land and how it may contribute to food production without destruction of the land resource.

7. Burings global estimates

On the basis of a study of land and water resources in the world, Buring and associates several years ago calculated that modern agricultural technology applied to all potentially agricultural land could produce approximately 30 times the present food quantity:" (Wambeke, 1984: 7). The essential components of this thesis and the criticisms advanced are enumerated hereunder:

- "The maximum use of resources with optimal farm management, mechanization, effectiveness of pesticides, and fertilizers.
- It was considered impractical for most planning processes because worldwide introduction of high – technology farming could not be achieved in the future and that the rate of improvement could not keep pace with the steady increase in food demand.
- The approach most certainly offered a perspective of legitimate optimism, a wide margin of safety, and a feeling that land resources will have theoretically not been a limiting factor in the human quest to meet the needs of a rapidly growing world population" (Buring, 1975).

Buring and van Heemst (1977) repeated their computations, assuming more modest theoretical 'labour oriented' agriculture, with minimal inputs from outside the farm. They now said (1977) that:

- Land would be optimally utilized through appropriate crop rotations on cultivated areas, grazing on grassland, and use of forest products.
- This system would be more productive than most traditional farming actually practiced in less developing countries but less productive than modern agriculture.
- The objective of the model was to evaluate the food quantity that can be obtained without sophisticated technology.
- The model was assumed to produce projections more closely related to the normal growth of the world economy and social institutions.
- In the model only two – thirds of the land suitable for cultivation was cropped and only half of the production was used for human nutrition, the rest being lost, used for seed, or fed to cattle.
- A further assumption was made: cropland was in fallow and, one – third of the time to restore soil fertility.
- The final estimate of the production potential of each soil region was then expressed in what is called consumable grain production" (CGP).

The reason for explaining in some detail the rationale of models for the computation of world agricultural production potential is to illustrate their fragile structure, stress their limitations, and estimate the error margins, which are often concealed in computational fine print. Additional factors need to be introduced to estimate the optimum or maximum world population that can be sustained by given types of agricultural systems. One of them is the question of an adequate per capita consumption of grain. Buring and van Heemst (1977) mention that "developed countries consume far larger amounts of food per year and as per capita. In spite of the deficiencies identified in the Buring model, it calls for an analysis by governments and their agricultural policy – makers to consider the uneven distribution of suitable land for crop production in all continents, the imbalance between the supplying power of land for each commodity and the demand in each of these areas, and the impact of land types on the quality of life of farmers, who are the major decision makers in the production of food.

8. World food perspective

Wambeke (1984: 7 and; Karodia, (2008) state that "global averages seem to indicate that the present world population is very close to the number sustainable by a labour – oriented type of agriculture that could live in equilibrium with a low–energy–input type of farming." The authors acknowledge the high level of generalization of this conclusion, which conceals many discrepancies. It is therefore, obvious that "from this expose that the difference between the models and reality can be explained by adjustments through hunger and malnutrition, or higher grain yields obtained through more modern and intensive technology or imports from surplus – food producing countries (Karodia, 2008).

9. Regional variability within continents

It must be acknowledged that within each continent, there is a tremendous variability in the potential of land to produce crops. It strongly affects the distribution of hunger by setting ceilings for food production, and it distorts opportunities for nations not generously endowed with land resources. Wambeke (1984: 8) points out that "hungry nations cannot be independent nations, although the will for independence may be a stronger motivation than hunger for policy decisions. Regional variability in land resources within continents and within countries is an important factor in the geography of food supplies and hunger patterns." "All of this places a tremendous economic burden on the development and maintenance of regions deprived of good land. They are not able to compete in world food markets and are progressively eliminated from them because of price fluctuations. These regions therefore, remain economically marginal" (Karodia, 2008).

Population densities vary according to factors other than land quality. Climate, for example, is a strong determinant of population densities. Many other factors such as transportation systems, markets, and mineral resources tend to concentrate population in areas not necessarily good for food production. There are several ways to restore the equilibrium, or to avoid the disadvantages of the unbalanced ratios between actual and potential population densities. If world population is to grow in the next decades and into the middle of the 21st century, food production must increase and land use must be intensified, both on existing cropland and in new areas to be opened for cultivation. This implies large investments either in capital or labour. Consideration must be given to not destructing the natural soil resources. Virgin land will have to be tapped. Management inputs will therefore have to be nurtured and developed. Conservation will and must become a prerequisite. Pressure on land has the risk of overuse and this must be addressed to protect land for the future.

10. Land and farmers

According to Wambeke (1984: 9) "food production is dependent not only on biological and physical resources. Beyond the subsistence level, the success of agriculture depends also on social and economic factors. Good land is land that not only produces large yields; it should also, in most political systems, produce returns attractive to farmers." What then is a workable definition of arable? Plucknett and Smith,

(1982: 17 – 20) state that arable land "must be capable of producing optimal returns to farmers under given market conditions where crops grow on different types of land compete for the best price. The return may be expressed per unit land, capital or labour. Management should be such that the soil resource is conserved. The returns may be measured in different units. If alleviation of hunger is the only goal, then physical yield is an adequate yardstick. If the aspirations are different, other units of measurement of returns are needed. Profit is one of them."

11. Conclusions

- On a global scale, the world has sufficient land resources and technical knowledge to produce food for a growing population, even it is to be doubled. This is qualified as follows:
- The inventory of soil resources is still incomplete because some areas have not been explored and data provided are also incomplete to make reasonable estimates of potential.
- Not all soils can be used for agriculture.
- Modern agricultural planning must adapt and combine crop requirements with land qualities in order to produce at the lowest cost.
- More information must be generated for purposes of prediction for purposes of innovation technology.
- Research must be intensified to incorporate more marginal soils into permanent farming systems because; this has not received the attention it deserves.
- For each soil type management packages should be developed (Sanchez and Salinas, 1981: 280 – 398).
- Several research institutes could be mobilized in joint efforts for integration of marginal land into the world economy (Revelle, 1976: 165).

12. Managing water resources for food production

This section only makes fleeting reference to a very important issue. It enumerates a number of issues that are cardinal to managing water resources for food production. Levine and Coward (1984: 17) state that "during the early 1970's severe food shortages occurred in many parts of the developing world. These shortages, caused by the expanding world population and adverse climatic conditions, resulted in the United Nations World Food Conference in November, 1974. In recognition of the critical role that water plays in the production of food, the conference adopted a special resolution urging governments and international organizations to make new efforts to expand irrigation rapidly." The investments made in irrigation from 1974 have undoubtedly contributed to an improved food situation in many of the developing countries. However, Downing and Gibson (1974) indicate that "the performance of many of these systems, from both production and economic perspectives, had fallen short of expectations, sometimes in major ways." On the other hand Karodia (2008: 352) states that " as the cost / ha of new systems increases and as the problems with the existing systems become more apparent, there is a growing recognition of the need to improve the

management of the systems and greater interest in other options for increasing production become crucial and necessary."

Options other than investing in irrigation to increase production are explored both implicitly and explicitly in other discussions by various authors and falls outside the purview of this narrative. However, a few issues are considered in this article that bear significance upon the discussion, given the place that irrigation has in the food policies of many of the developing countries and in the international development community. At least three major issues can be identified:

- How can the performance of existing and new irrigation systems be improved?
- How can the benefits from the investment in irrigation be shared more equitably?
- How can undesirable environmental effects be minimized?

In discussing these questions no attempt is made to provide answers, but we try to provide a sense of the complexity of the inherent issues and some of the efforts that have been made to address them. Some understanding of the physical basis for irrigation and of the historical pattern of irrigation development, in various parts of the world becomes important, for purposes of our understanding.

13. Physical basis for irrigation

According to Worthington (1978) "four terms can be used to characterize the physical bases for irrigation (at least for our purposes): water, variability, uncertainty, and site specificity. These are discussed generally hereunder as identified by Worthington (1978):

- "Water: the developing countries are mostly located in the tropics. In the tropics the major climate variable is water, and it is the lack of water during otherwise suitable growing periods of the year that constrains agricultural production. In the temperate zones the major climatic variable constraining crop production is temperature.
- Variability: precipitation in the tropical regions has major variation, spatially and temporally. This variation, coupled with variation in other important physical characteristics of the environment, such as soils and topography, results in a wide variation in irrigation objectives and practice. Where the absolute level of precipitation is low, for example, in some countries irrigation is used to provide essentially all the water to meet crop needs. Where the annual precipitation is relatively high and variation is seasonal, irrigation can be used to supplement the natural rainfall in one season and to substitute for it.
- Uncertainty: climatic variation is such that there is an element of inherent uncertainty. In the developing countries, however, this uncertainty is greater than in most of the temperate regions because of the lack of historical data, especially for those areas that serve as the source of water for irrigation. In addition because the farming units in many of the developing countries are small in comparison with the farms in the temperate regions, the detail about information in respect to topography and soils, as well as the climate, that is significant for the small farmer is much greater. The scale of the information that is available is such that a great deal of uncertainty exists. This means that systems designed technically, that

is, using relatively 'formal' information sources, in contrast to those that 'evolve' traditionally, are likely to have significant errors at their initiation.

- Site Specificity: Because the ultimate objective of irrigation is to improve the production of crops grown in specific settings, each irrigation system must adapt to those specific conditions. These conditions are not only physical, but also include the economic, social, and cultural environments within which the irrigation system must function. To some extent, therefore, each system differs from all others; there may be relatively large differences even within one country or one region, within a country. The answers to the three questions posed earlier must be applicable to these different situations but sufficiently general to be applied regionally or more broadly."

It is beyond this paper to discuss other salient issues such as:

- How the performances of existing and new irrigation systems be improved (See Asian Development Bank, Survey in the Philippines. (1977).
- How can the benefits from the irrigation investment be shared more equitably? (See Coward, 1977).
- Minimization of Undesirable Environmental impacts (See Thomas, 1975; Trewartha, 1968).

14. Historical perspective

Having delineated some important aspects in respect to the subject matter, it is important to briefly discuss the historical perspective, in order to situate the subject matter in terms of an important historical perspective and analysis, for purposes of greater clarity and intellectual understanding of the issues raised about managing water resources for food production. The physical bases for irrigation do not convey the critical importance of the interaction of socioeconomic factors with the physical factors in determining success of irrigation systems. Irrigation in system form, that is, where more than one farmer is involved, requires cooperation in the capture of the water resource, in its distribution, in the maintenance of the facilities for distribution, and in the management of conflicts that arise, not infrequently, during all these activities. Some understanding can be gleaned of the patterns by considering the historical development of irrigation, which takes significantly different rates and forms in different countries and regions, but which have substantial similarities.

Development proceeds from the capture of relatively easily diverted resources. The growing understanding of the nature of the land and water resources permitted the development of allocation and distribution rules and techniques that reflected both production and equity improvements. "Institutions and organizations of diversity reflect the tailoring of the solutions to the location – specific nature of the socioeconomic conditions, as well as to the nature of the physical environment" (Levine and Coward, 1984: 18). The recent emphasis on irrigation as the major vehicle for improving agricultural production in many of the developing countries is to a large extent, given by the government sector. Downing and Gibson (1974) point out that "accelerated development has resulted in the incorporation of many of the village or communal systems into extended and elaborated government systems and, therefore the irrigation system is characterized by three systems: those derived from and controlled by local communities; those initiated by

government action with major portions controlled by the government and; the third representing a form of mixture." It is obvious from the narrative as discussed earlier that the complexity of the present picture and situation, adds to the difficulty in arriving at effective answers to the problems.

15. Conclusion

This paper introduces relevant scenarios that were discussed in a bygone era which are still relevant to modern agriculture in the 21st century. It is a call to governments worldwide and particularly in the developing countries to revisit these priorities that have been paid scant reference to in the past. It is hoped that sustained debate and conversation will be entered into by developing countries, in order to address the manifest problems that confront agriculture and development as concerns the perspectives of the world food situation, land resources, and managing water resources for purposes of dealing decisively with the world food situation. The growing emphasis, if not dependence, upon irrigation as an essential component of the food production systems of developing countries suggests that the issues considered in this paper will become increasingly important and relevant in the 21st century development dynamics of particularly developing countries. Appropriate answers must be found in spite of the issues being complex and major efforts have to be made to find solutions to address the evolving food crisis in so – called developing countries. To this end it is the responsibility of the governments of the developing nations to address these vexing and important issues.

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