THE STREGTHENING AGRICULTURAL RESEARCH FOR DEVELOPMENT (ARD): SITUTION AND STRATEGY, RESEARCH AND TECHNOLOGY

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Abstract

The paper focuses on the current development and future potential of the agricultural research. Since the World Food Summit – Five Years After (2002), the World has seen a clear affirmation of the Millennium Development Goals (MDGs) as the central aim of the international development policy for the poverty mitigation and food provision. In spite of the above commitment at the national, regional and global levels, the progress has been rather slow and uneven. It is true that the number of people living in the extreme poverty has dropped, however, in some regions like (and especially) in Sub-Saharan Africa there has been little prospect for achieving dramatic changes. On the other hand there are encouraging symptoms that national governments and international donors are decided about supporting agricultural development as the only way to achieving a real food security. It is enabled thanks to the agriculture that has a potential to make significant progress through the growing productivity and enhancing new technology approaches. It is a very important fact because the agricultural sector in many low-income countries accounts for 60 – 80 percent of employment and more than half the national income and it is constrained by years of underinvestment and absence of the basic infrastructure. New (modern) technologies are also not contributing much because they are mostly area specific and not proper for the low-income farmer. They are rarely supported by advanced forms of the inter-economic use of the technologic inputs. The proper strategies covering main development potential and solving the most important constraints must be worked out and regularly reconsidered in tune with changing needs and challenges. However, while the research capacities of some developing countries have evolved into a factor featuring a strong national-wide regulating impact, a large number of other countries have limited declining capacities to address the emerging challenges. On the other hand, the emerging globalized research issues can compensate the lack of local research capacities and encompass the whole value chain. This respects a global concern that nearly 2.5 billion people are still engaged in small-scale agriculture and that in the world-wide scale there are more than 100 million small-scale farms relying upon the hand-tool and draught-animal technologies.

Key words: millennium development goals, World Food Summit, globalized research, low-income countries, small -scale agriculture, hand-tool and draught-animal technologies

INTRODUCTION

Global challenges

There are many challenges which carry a global character. Just in brief: 20 percent of the world's population is very poor; over 800 million people are malnourished.

In fact the overall summary of global challenges is given by the World Food Summit: Six Years After held in 2002 at the UN Food and Agricultural Organization (FAO) in Rome whose main objective was to evaluate the effort of the World Community towards elimination threats of hunger and malnutrition worldwide. As we know this World Meeting focused on progress achieved from the *World Food Summit* (1996, Rome) and refined the outlook for the first 20 years of the new millennium.

During the above *World Food Summit* the highest representatives of respective governments from 185 countries declared their political willingness to reach a worldwide food security for the total of the world population. They especially committed themselves to strengthening effort at removing hunger and diseases in all countries, specifically to reducing number of hungry people at latest up to 2015 on *one half of the presently existing number* (approximately *800 million people*). Important documents and programmes have been formulated too, such as "Rome Declaration on the World Food Security" and "World Food Summit Plan of Action", both documents being approved by the Summit in 1996.

The World Food Summit

The Summit raised some facts and formulated couple of important conclusions:

More than 800 million people all over the world from which about 300 million children, suffer from every day's hunger (*chronic shortage of food*), diseases and invalidity caused by malnutrition. Estimations speak of 24 000 people that are daily dyeing due to the mentioned problems; there are several African countries that face a very probable famine that could blow up in a couple of months; hunger and poverty are linked to one another. The hunger makes man more prone to diseases and brings reduction of capabilities of people to live and work and to provide their families with food; the progress made in reducing number of starving people is

not satisfying. A real need exists to implement an actually effective "Programme Against Hunger" which should become a "*Mobilizing Factor*" of respective global, national as well as local authorities – a tool for struggle against hunger and malnutrition; six years after (the World Food Summit 2002) the dying poor inhabitants of our Earth is still ongoing for reasons of hunger, famine and malnutrition. The given promises have not been met and the political willingness as well as available funds do not correspond with the declared solidarity; the hunger has a crushing impact on the economy of the affected countries, it generates (by rough estimations) losses on the level of one percent of the overall economic growth which is influenced by a reduced labour productivity and nutrition diseases; the state and private support to agriculture have decreased within the group of LDC countries (low developed countries). During the decade of 90's (1990 – 2000) this decrease reached 50 percent, e.g. in the sector that provides livelihood for 70 percent of the world poor population; the number of malnourished has been decreasing yearly by six million instead of the needed 22 million (in order to reach the aim given in 1996). If this trend survives the goal to reduce the number of starving by one half by 2015 would be reached about 45 years later, i.e. in 2060; the global market is still far from equitable one. For instance, the OECD countries yearly redistribute into their agrarian sector more than 300 billion $ US, which means that they directly provide support for each farmer amounting to 12.00 $ US per one ton of his production. On the other hand they provide for the LDC group a development assistance amounting to 8 billion $ US yearly, e.g. only 6 $ US for one peasant in those countries; access to markets in developed countries is limited by number of restrictions that on average go up to 60 percent of the price of agricultural commodities, which cannot be compared with industrial products (4 percent).

And its main conclusions: all countries should strengthen their effort to solving the global "hunger" problem that is one of the most destructive factors of the mankind; the farmers should get better access to land, credit, modern technologies and knowledge, and all the hard- and software that would enable them to better grow more resistant varieties and produce ecologic food-stuff; the role of women is steadily growing on all levels of foodstuff production; the women work more in the agricultural sector than the men; the developed countries should continue opening their markets and removing all obstacles limiting trade with agricultural commodities, especially imported from developing countries. For instance, custom tariffs imposed on typical production from developing countries (chocolate) make competitiveness of food-processing industries in those countries very weak; the struggle against hunger has economic and social dimensions. It is a key step towards meeting all objectives formulated by the UN Millennium Summit; the ambitious "Program Against Hunger" needs an addition of funding on the level of 24 billion $ US per year. It should reduce the number of starving people by one half. The developed countries and international financial institutions should cover the half of the above sum while the other must be covered by the LDC group itself.

Millenium development goals

Generally

The above conclusions created base for eight Millennium Development Goals and Targets to be reached by 2015. As very often technically soluble targets interfere with nature capacity. For instance, the Millennium Ecosystem Assessment warns that in meeting current demands for ecosystem services we have seriously damaged two-thirds of the ecosystems upon which we all are depending. This assessment identifies current agricultural, land and water use and waste management practices as both the cause of degradation and where the future solutions must lie. *Business as usually is clearly not an option*.

The challenges are huge and will grow as being driven by the needs of 8 billion consumers, global interdependence, trade reform, strife, mega-cities, the scourge of HIV/AIDS, climate changes, water scarcity, increasing energy demands and costs, tectonic shifts and the loss of biodiversity and natural habitats.

Over the next generation the production of food must double so that the average DES (Daily Energy Supply) from the present average of 2 520 increases *up to* 3000 *Kcal/caput/day.* In low income countries where the category with the DES rate up to 1700 *Kcal/caput/day* represents more than 90 percent of the food production it must be more than tripled (Havrland, et al., 2003).

Despite of some (recent) reconsideration of the future development (retarding the population growth even in the Third World) the agricultural and related food production sectors must deliver more, for more people, more fairly, using fewer resources and causing less ecosystem damage.

In detail, many developing countries will have to graduate to more nutritious average diets in order to eliminate chronic undernutrition. Partly because of uneven food availabilities among the population inside countries, this process could require: *30 percent of increase in food energy availabilities in Africa (but 40 percent south of the Sahara), 15 percent in Asia* and *less than 10 percent in Latin America.*

In order to reach a well-balanced diet, people will have to diversify their food intake. For example: adopting for the year 2050 a level of diversification similar to that projected by FAO for the world in 2010, Africa would have to improve its plant-derived energy by another 25 percent (46 percent for countries consuming mainly roots and tubers) and Asia by 21 percent.

As a result of the combined effects of the preceding three factors, developing countries would have to increase their plant-derived energy by 174 percent. This means that, while the countries of Latin America and Asia would roughly have to double their plant-derived

energy, Africa would have to multiply it by five (multiplying it by seven for the root- and tuber-consuming countries).

For Asia or Latin America, such a perspective requires further productivity growth, but at a rate lower than that seen in the last 15 years. In contrast, Africa would have to accelerate drastically the growth of its productivity. The demographic transition in Africa would facilitate the process of achieving food security: the annual growth rate in available plant-derived energy would be 2.6 percent in the low variant instead of 3.3 percent in the high variant of the United Nations' population projections.

Millennium Goals Formulation

The Millennium Development Goals (Millennium Summit, Sept. 2000) are an ambitious agenda for reducing poverty and improving lives that world leaders agreed on at the Millennium Summit in September 2000. For each goal one or more targets have been set, most for 2015, using 1990 as a benchmark.

1.Eradicate Extreme Poverty and Hunger

Target for 2015: more than one billion of people living on less than a dollar a day and those who suffer from hunger. Special focus on sub-Saharan Africa, Latin America and the Caribbean, and parts of Europe (Southeast) and Central Asia (Afghanistan and part of the former Soviet Asia).

REMARK: *over the period 1985 – 95 the population growth has declined and from 2000 the decline is continued. However, in the period 2015 – 2020 there will be still 69 million people added each year.*

2. Achieve Universal Primary Education

Target for 2015: *ensure that all children complete primary school.* As many as 113 million children do not attend school, but the target is within reach. India, for example, should have 95 percent of its children in school by this year.

3. Promote Gender Equality and Empower Women

Targets for 2005 and 2015: *eliminate gender disparities in primary and secondary education preferably by 2005, and at all levels by 2015.* Two-thirds of illiterates are women, and the rate of employment among women is two-thirds that of men.

4. Reduce Child Mortality

Target for 2015: *Reduce by two thirds the mortality rate among children under five.*

Every year nearly 11 million young children die before their fifth birthday, mainly from preventable illnesses, but that number is down from 15 million in 1980.

5. Improve Maternal Health

Target for 2015*: reduce by three-quarters the ratio of women dying in childbirth.*

In the developing world, the risk of dying in childbirth is one in 48, but virtually all countries now have safe motherhood programmes.

6. Combat HIV/AIDS, Malaria and Other Diseases

Target for 2015: *halt and begin to reverse the spread of HIV/AIDS and the incidence of malaria and other major diseases.* Forty million people are living with HIV. Countries like Brazil, Senegal, Thailand and Uganda have shown that the spread of HIV can be stemmed.

7. Ensure Environmental Sustainability

Targets:

- *Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources.*
- *by 2015, reduce by half the proportion of people without access to safe drinking water.*
- *by 2020, achieve significant improvement in the lives of at least 100 million slum dwellers.*

NOTE: *more than one billion people lack access to safe drinking water and more than two billion lack sanitation. During the t990s, however, nearly one billion people gained access to safe water and the same number to sanitation.*

8. Develop a Global Partnership for Development

Targets:

- *Develop further an open trading and financial system that includes a commitment to good governance, development and poverty reduction - nationally and internationally.*
- *Address the least developed countries' special needs, and the special needs of landlocked and small island developing States.*
- *Deal comprehensively with developing countries' debt problems.*
- *Develop decent and productive work for youth.*
- *In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.*
- *In cooperation with the private sector, make available the benefits of new technologies - especially information and communications technologies.*

The above challenges can be met, but they are beyond the scope and resources of individuals, governments, communities, civil society and industry working isolated. The WFS formulated it as the main principles of further problem solution: *good governance; respecting laws; respect of human right; wider participation of the LDC (less developed countries) in the Global Economy and World Trade.*

What kind of agriculture

There still exists a question: what sort of agriculture will meet these challenges - what types of agriculture and ecosystem management we are going to promote?

Some Basic Facts

Agriculture provides employment for over 70 percent of the world's poorest people and 9/10 food for us all. Investment in agriculture is one of the most efficient ways of reducing poverty. Small farms have an essential

role to play in managing ecosystems, reducing poverty, supplying local and niche markets and providing social safety nets. But will they feed the mega-cities and why have many governments reduced funding for this sector, research and tertiary education?

We are crushed with an infinite set of agricultural classifications - factory, intensive, low-impact, low-input, natural, traditional, organic, fair, sustainable, integrated, conservation, eco-agriculture, minimum tillage, zero-tillage, traditional and modern, etc. Many of these terms are synonyms and essentially used as brand names aimed at segmenting the market or wooing or alarming the consumer and general public-or even donors!

The agri-food sector is fragmented which is due to its worldwide (countrywide) character. It responds to different demands and constituencies, natural and social conditions and circumstances with different local ´power´ to influence policies and markets. In fact (generally) it has a considerable socially and politically reduced position in comparison to its unchangeable role in the human life in both developed as well as developing countries on regional and national levels. The producer (farmer) is usually the latest to make decisions on policy and prices.

In the value chain, producers and agribusiness capture only 13 percent, the processing sector 47 percent, and food services and retail 40 percent of the consumer price. Recently, many consumers give higher priority to the leisure and cultural services from the landscapes in which they live - preferring to see their food imported.

Research and Technology in Agriculture: Driving Forces and Constraining Factors?

At down of the Africa liberation there were ideas about a rapid technologic progress of the African agriculture by means of supplying machines newly liberated countries. The hope in a fast increasing food and raw materials production and growing labour productivity was shared in both the capitalist and socialist blocks and declared by researchers, extensionists and politicians. Nothing but total economic and social destruction of the rural areas and hunger was the response of these tentative.

The only way how to achieve agricultural production growth and avoid environmental problems (which are already immense) is a proper agricultural research encompassing relative sectors, too. Improved and appropriate (sustainable) site-specific technologies are necessary to be implemented with training carried out as much as possible. Both of them – proper technology and training need to be based upon scientifically framed surveys and backed by research on availability, fittingness and sustainability of all production components. A real gear lever of the development is extension service which uses results of the research and organizes trainings.

Agricultural research to be productive, we should be clear and consistent on what sort of agriculture we are aiming to develop, where and how the farming systems of the future will pass the ultimate test of sustainability - that farmers can make a reasonable living and that their children want to farm. There has been a considerable progress made in the approach to the agricultural research and also its funding is much better than some decades ago. In the 60 – 70ties only research on modern (more likely large-scale) farming provided with mechanical power means and intensive varieties and breeds was considered. The concepts of appropriateness and sustainability have changed much the policy approach and implementation of the research.

Agricultural research has the task of helping to inform decision-making, solve problems, increase choice and opportunities, monitor impacts, develop new technologies and engage and win the trust of society. Scientists must consult and communicate so that the priorities and ethical parameters within which they work are informed by evidence, not by alarmism. The current debate over the use of transgenic technologies is absorbing huge amounts of time and resources. It detracts both from the funding of all agricultural research and the benefits that they could bring to society. Those technologies that are destined for paying markets will be developed by industry.

Science and Technology

At the time of the green revolution and up to the present day, science and technology have occupied a position of paramount importance in providing tools for *increasing food production*. Today, as part of a continuing and ongoing learning process, it is also possible to address a *range of social, economic and environmental factors* that affect the food production process. Experience and knowledge accumulated during the last 30 years confirm the strong influence that market forces, government policy and prevailing social and cultural forces have on technological packages. These must be addressed if progress is to be sustained.

In fact, the research focus has already begun to be broadened to more varied crops and animals (including cropping systems), increased emphasis on integrated pest management and plant nutrition, and adoption of eco-regional approaches to research to reflect prevailing biological and physical constraints.

In Africa and Latin America increased food production has partly been *based on expanding the cropping area*, often *into marginal areas with lower sustainable yield potential*. Incentives for farmers to increase their productivity have been minimal as a result of low labour productivity, dysfunctional markets and limited access to mechanization and energy sources.

Recent Research Priorities

They can be formulated as follows:

- Research institutions can still achieve *sizeable yield increases* with conventional research tools, although

new tools are becoming available (geno-engineering); *many more crops and animal breeds can still be improved*.
- More important objective is to *narrow the gap* between the yields achieved in research programmes and those realized by the farmers in their fields. This can be achieved by: *concentrating* on new ways of communicating with farmers, *rejuvenating* extension systems, *conducting* more participatory research and *organizing* constant training.
- The role of biotechnology is still the subject of intense international debate concerning "*ethics*", "*safety*" and "*intellectual property rights*". Experience suggests it may be a further ten to 20 years before the full benefits are realized by farmers in developing countries.

The following characteristics will be central to the continuing evolution of the green revolution:

- *Restructuring* of the *linkages between international and national research centres and extension services* in order to have greater involvement of stakeholders and sensitivity to national and community food security priorities;
- *Continued Advances* in *science and technology* to produce the basic foods that people need but with stronger emphasis on mixed farming systems, staple crops, livestock, poultry and fish;
- *Policy Reform* that addresses access to *capital, incentives* for investment in research and *productivity-enhancing* farming systems;
- *Promotion of More Equitable Distribution of Benefits* by devising productivity-enhancing strategies that exploit the comparative advantage of different gender groups and benefit lower-income food-insecure groups.

The Need for Purposeful Partnerships and Consensus

The stale and complexity of the challenges will only be met though consensus and partnerships. There are many opportunities for partnerships between the public sector, civil society and with business and industry, but there are also some constraints suspicion, risk, liability, an absence of incentives and a lack of leadership. Foundations have a unique opportunity to work at the interface between the public and private sectors and to help build partnerships and alliances.

Controversy sells newspapers but kills people in poor societies - it is an indulgence we can no longer afford.

Agricultural research for development (ARD) in response to global dneeds

Scientific Capacity in Developing Countries

While the research capacity of some developing countries has evolved into very strong national systems, a large number of developing countries have limited and declining capacity to address the emerging challenges to agricultural development, as they do for research in general. Research partnerships have to take into account these growing disparities between different countries.

The density of researchers per population on average is 65 times smaller in the South than in the North. Government support to ARD in many countries, especially in sub-Saharan Africa (SSA), has dwindled considerably, and universities are weak and under-funded. Low salaries and poor working conditions, coupled with limited scope for professional advancement, have led to a `brain drain' as scientists seek better opportunities in developed countries.

Centers of Excellence: Solution or Gesture?

In order to encourage scientists to remain in their countries and to contribute more effectively to national and regional development, career opportunities must be improved and new incentives put in place. A recent report of the InterAcademy Council (IAC, 2004) made a strong recommendation that `Centres of Excellence' should be set up to stimulate and promote innovations. The associated IAC report on African Agriculture came to a similar conclusion and suggested that Centres of Agricultural Research Excellence should be established to address both continental and regional priorities. These recommendations are in line with the current strategy of the *New Partnership for African Development* (NEPAD) in which regional Centres of Excellence will be established and will help build capacity in a network of linked institutions. One such centre, the NEPAD Bioscience Centre based in Nairobi, has already been set up and has begun to implement training programmes for scientists in priority areas of research. Another initiative is the *`Nelson Mandela Foundation for Knowledge Building and the Advancement of Science and Technology in SSA'6´*.

In Europe EFARD and worldwide GFARD play an important role in facilitating linkages between research institutions and the new Centers of Excellence so that the expertise can be harnessed in response to emerging needs. For example, in the agricultural research domain, Europe has a comparative advantage in agro-ecology and under-utilized crops on the one hand, and on genomics and applications of biotechnology on the other. Anyway, Europe has considerable experience in bio-safety framework and other regulatory issues.

Emerging Global ARD Issues

Global expertise can contribute many emerging priority areas of ARD. There has been an important shift in recent years towards orienting agricultural research to encompass the whole value chain. This reflects a move to more market-driven approaches to production and recognition of the need to generate greater income for producers and processors through

adding value to basic commodities. In order to achieve this, greater attention is being paid to improving post-harvest and processing technologies and to issues of quality and compliance with standards and marketing.

Of global concern remains the fact that nearly 2.5 billion of people are still engaged in small-scale agriculture, including variable levels of subsistence. Agricultural development may therefore consider that a part of these people are shifting away from primary production of commodities to out-of-farm sectors, e.g. to jobs in food/material processing. ARD in its widest sense should thus also include assessments of economic changes at the farm and market level, as well as of shifts in agricultural policy, changes in demography and trends in development.

Cross-sectoral Issues

The research also has much to offer developing countries in elaborating and applying approaches to address cross-sectoral issues. There is a growing recognition that, in order to achieve the MDGs, issues must be tackled across a range of sectors and should take into account the important linkages between sectors. In the case of agriculture, links with the health and environment sectors are particularly important. For example, ARD can deliver positive impacts on health by enhancing incomes and producing nutritious and affordable fond. In order to help deliver positive outcomes, there is increased support for new approaches such as bio-fortification and a greater focus on integrating horticultural crops and animals into production systems.

Cross-sectoral approaches can also provide health benefits in other ways. Efforts are under way to develop labour-saving production technologies to mitigate the effects of HIV-AIDS in rural areas. Similarly, ARD is playing a role in identifying the ecological determinants of major vector-borne diseases such as malaria. However, much more needs to be done in these areas before widespread benefits can be obtained. ARD can also contribute to improving the sustainability of natural resources management, including soils, water, and biodiversity.

Research and technology

Adequate Solution of the Situation in the Technology Issues

Matching the global demand and supply situation may not seem unduly difficult in view of the rapid and sustained improvements in food production, processing, and marketing that have occurred thanks to progressive development in technologies in the developed countries and some enclaves of the developing world (Alexandratos, 1996). However, it is important to ensure that food provision imbalances existing at the regional and local levels are effectively erased by extending productive capacities, increasing purchasing power and distributing facilities to all people who need food. On the other hand, the projected need is too great and the purchasing power of the people needing it is too inadequate to be met by aid or by trade (SOFA, 1996).

The long-term solution of the food problem must, therefore, be sought in improving the productive capacity of farms in the food-deficient regions. But the real problem resides in the fact that the bulk of these primary food producers are small-scale farms, averaging less than 10 hectares (FAO UN, 1998). Majority of the modern technologies that are readily available in the developed countries is prima facie either unsuitable for or beyond the reach of such farms. All present forms of modernization of production in developing countries (for instance, creation of bigger and thus economically more viable units) generate rural unemployment and seem to be unsustainable.

Position of the Productive Technology

Fortunately, a considerable part of the modern technology is either area neutral or can be made area neutral with certain (cheap) adaptations (Sen, 1978). Besides, modern technology needs not ultimately to be the most sophisticated one with much mechanical power. Concept of “appropriate technology” is used to describe such technologies proper for the given natural, social and economic situations.

Prima facie, biological and chemical technological parts of technological processes are more applicable to small farms than are their mechanical components (or sometimes even animal drawn implements). But it is to mention that thanks to the (really) sustainable development based upon the modern purpose-oriented research, miniaturization of the farm mechanization (Japanese model) manages to balance the tendencies for heavy duty machinery use. It enables the small-scale farms to access the mechanical power (Havrland, Kapila, 2002).

Some technologies that are not area neutral (provided with large-scale machinery) in itself may be made available to small farms through custom work or rental or hire purchase. It makes accessible for small-scale farmers especially the machinery component of the technology increasing its efficiency by renting a relatively large peace of equipment for a limited period of time. Schemes for promoting the above custom work and rental or hire purchase are well known but they have not yet been given the attention in most developing countries. However, forms of inter-economic use of agricultural machines (IUM) as well proved in developed countries merit a special interest for many developing regions and can be designed as area neutral. Machine Joint-Use Society (MJUS) and Machine Equipment Co-operative (MEC) are forms of purpose-oriented inter-farm cooperation with a certain market component (Havrland, Kapila, 2004).

A few countries have experimented with a chain of state operated and state funded machine-tractor stations but it has almost failed. The main shortcoming of this has

been the bureaucratic and reduced private interest projected in the lack of enterprise and flexibility. In other countries, efforts by private enterprises (private contractorship) have been either prohibited or haphazard and isolated.

Labour and Capital Intensive Appropriate Technologies

It is rather common to contrast labour intensive and capital intensive technologic methods when small farms are considered.

In fact, both labour and capital intensive methods may play a very useful complementary role in bridging the space between rather primitive technological stages and their sophisticated forms. But the labour intensive technologies are not replaceable under conditions of the basic scarcity (in some regions) land that the small-scale farmers face. Intensive labour application on a scarce land unit helps to increase yields.

However, it is to mention that the labour alone does not by itself improve the productivity or wage of labour – it occurs only when intensive use of capital accompanies intensive use of labour in such a way that yields per unit of both land and labour increase in order that every increase in production is accompanied by a growth of per capita income too.

The sustainability of the above need resides in consequent steps phased so that the rural economic balance is maintained and some funds are allocated for the rural infrastructure building whereby increased production helps reduce the food deficit and increased income helps modernize the village.

Nonetheless, the capital intensive technologies are rather large-scale ones proper for larger-size farms. They are usually constrained (under conditions of developing economies) by inadequate servicing and spare parts supply and lack of knowledge and accompanied by the increase of the rural unemployment when improperly deployed. The same is true for small-scale capital intensive technologies (small mechanization model) that are more applicable and more sustained for small-scale farms in land-deficient regions except for the rural unemployment that manifests itself (in this case) as a smaller problem.

Importance of Capital Investments into Technologies

Increased production is generally possible by intensive use of labour only, however the result is always a short spurt - not a sustained progress in the agricultural development. It can be concluded that the agriculture needs progressively intensive use of capital as a base for its further expansion. Intensive use of manpower accompanied with a positive production response is possible in regions of lack of acreage and fertile land.

Deeper analysis of the above relationships shows that intensive use of labour will be helpful for the adoption of many biological and chemical innovations supplied by the research or is about to make them available to small-scale farms. But intensive use of capital will be needed to get the best results of this effort by, especially, provision of the degree of mechanization and chemisation required for optimum efficiency of labour and for progressive improvements in its remuneration.

Modernization and Supportive Innovations – Barriers and Expectations

Modernization and supportive innovations implementation are a real must for the future if a sustained development is to be met. But these processes are not as fast as it is required. The problem resides in various technological, economic and social barriers that usually must be faced. If the optimum use of a given area neutral technology is dependent on specific conditions or other technologic processes that are not so, it may pose problems for small-scale farmers. Then, the only solution consists in providing services on private (custom) or public (collective) basis (Hassing, 1998).

Unsatisfactory a real barrier may be seen in the profit margin which is not large enough or a perceived risk is too great. The consequence is that the farmers can not adopt a desirable innovation. Marketing services, price or income supports and supervised credit may reduce this barrier. Non-formal education, extension services closely supported by research and feedback arrangements, and geographical and social mobility reduce the above barriers. It will, therefore, be useful to orientate the research and education to well defined target groups or areas, to identify special needs for new technology or product promotion (Riedijk, 1986).

The mechanization innovations can create rural unemployment if not dealt with as a practical policy. I.e., if machines are introduced suddenly, on a large-scale and without adequate safeguards for the transitional period, the amount of labor may become surplus. The rural policy approach consists in phasing development steps when the direct loss of unemployment becomes more than offset by an indirect gain in unemployment. Furthermore, many machines help make the labour less irksome and more productive instead of making it redundant.

Technology and Income Distribution

It is sometimes surprising that along with the technologic changes towards more sophistical technological levels the rural incomes grow but they are becoming more skewed with time. It means that a substantial number of people within the rural population have not benefited from these incomes at all. The figures are alarming in view of the ILO market-basket poverty line based on the nutritional standard that points out a real contradiction of the rural economic growth. Usual explanation is that it is result of the unemployment generated by the machinery use.

However, the problem resides in the income distribution system management and is not caused by the technological level itself. Furthermore, it cannot be argument against modernization and economic growth.

But it is a reminder that growth by itself, given the social structure prevailing in many developing countries, has left far many people behind as economic dropouts. Moreover, they are not more supported by the solidarity tribal structure. It is for sure that the technology required for economic growth is displacing job holders to an unacceptable degree.

Whether the modern technology displaces workers seems to depend somewhat on which constellation of factors is found and how it is changing over time. I.e. which crop is grown (some are more amenable to the machine process than others), diversity of the farming process followed, kind and amount of machinery (heavy duty) and in which practices it is used, whether double cropping is practiced, pattern of land tenure and presence of tenants, occasional labour, resident farm labour and so on.

Reason for Modernization and Its Social Effects

The reason for modernization (higher-level technology introduction) seems to accompany the use of high yielding crops and animals that would recuperate higher investment costs. On the other hand, in the case of higher technologic level, qualified labour must be dealt with in a personal manner lest it can damage or disrupt the harvest. The chain of events is likely to be cumulative and one operation (ploughing or seeding, for instance) is mechanized and the mechanical power source becomes available at the farm, it will be relatively inexpensive to mechanize other field operations.

Not the only effect of substantial rural unemployment but also increased rural inequality is created by the modernization of the agriculture. However, the net effect of mechanization to date in developing countries is not to create unemployment and underemployment and it is not to say that technological changes cannot be utilized in a more imaginative, socially beneficial manner in the future. It seems, even, that each step toward modernization in rural areas and especially in the field, brings about unwanted social costs in the form of reduced incomes of a part of the rural population caused by the unemployment. The way out from such a social deadlock can be found in "appropriate technology" as already mentioned.

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