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Original Research Article

THE POTENTIAL REFLECTIONS OF NATIONAL AGRICULTURAL RESEARCH ON THE SOLUTION OF GLOBAL AGRICULTURAL ISSUES

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ABSTRACT

Global warming and water availability, loss of biodiversity, impacts of climate changes on agriculture, environmental pollution, food security and safety and renewable energy are worldwide problems affecting agricultural sustainability. In this respect, food safety, climate change, system management and risk management are becoming hot topics in agriculture. Increasing productivity and creating economies of scale, intensive technology and renewable energy use, establishing regional agro-industrial ecologies of life cycle assessment, networking marketing and trade and reducing risk are some proposed solutions. International organizations have been focusing on national and international research projects in order to determine global problems in agricultural sustainability and to diversify proposed solutions. Unfortunately, databases of research projects in the world are not connected for data, data mining, and big data processing purposes yet. Moreover, basic research, applied research, and experimental development do not complement each other. Projects are funded by national scientific and technological research councils. Due to the fact that project final reports and results are mainly published in native languages, such material cannot be utilized for the benefit of global issues. The objective of this study is to examine final reports of some national projects results of Turkey in order to understand well whether they are valuable to translate for international uses or not. We recommend that international organizations; such as OECD, FAO, etc. should collaborate on translating project final reports into English, which would be helpful in coping with global agricultural problems. Long-term surveys in agriculture should also be conducted by all nations to understand agricultural changes and technological development.

Keywords: Agriculture, Development, Meta Data, Big Data, Science, Agricultural Economics

INTRODUCTION

The development of agriculture is part of a process to establish data, data analyses, and big data in agricultural movement. Communication of agricultural data from every country over the world contributes the improvement of global agriculture. International organizations are creating research networks in order to gather and disseminate research outputs. Unfortunately, outputs of some national research are not translated into internationally- recognized languages, which increases the chances of that particular research's contribution to the solution of global agricultural problems. The current problems in agricultural sustainability are global warming and water availability, losing biodiversity, impacts of climate changes in agriculture, environmental pollution, food security and safety and renewable energy. IAASTD (International Assessment of Agricultural Science and Technology for Development) synthesis report explains problems highlighted in agriculture across the world in ten questions as follows [1];

1. What challenges does agriculture face today?
2. What are the pros and cons of bioenergy?
3. Can biotechnology help meet the growing demand for food?
4. How is climate change threatening agriculture?
5. How is food production affecting health?
6. How can agriculture make better use of

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natural resources? 7. Why have not small farmers benefited more from global trade? 8. Can traditional knowledge contribute to agriculture? 9. What is the role of women in agriculture and development? 10. What are the options for action?

In Turkey, The Scientific and Technological Research Council of Turkey (TUBITAK) is the official governing body for science and technology. TUBITAK is the leading agency for management, funding, and conduct of research in Turkey. It was established in 1963 with a mission to advance science and technology, conduct research and support Turkish researchers. As a governmental scientific board, TUBITAK, whose members are selected from among prominent scholars from universities, industry, and research institutions, is responsible for promoting, developing, organizing, conducting and coordinating research and development in line with national targets and priorities. TUBITAK is the secretariat of the Supreme Council for Science and Technology (SCST), the highest S&T policy making body in Turkey. TUBITAK provides funding for research projects carried out in universities and in other public and private organizations, conducts research on strategic areas, develops support programs for public and private sectors, publishes scientific journals, popular science magazines and books, organizes science and society activities and supports undergraduate and graduate students through scholarships. More than 1500 researchers work in 15 different research institutes of TUBITAK where contract research as well as targeted and nationwide research is conducted. The vision of the National Science, Technology and Innovation Strategy is to provide new knowledge and develop innovative technologies, improve the quality of life by transforming the knowledge into products, processes, and services for the benefit of the country and humanity. TUBITAK is a pioneer in national energy R&D and innovation strategy, national water R&D and innovation strategy and national food R&D and innovation strategy and it supports projects in these areas [2]. TUBITAK also governs international scientific cooperation under three general topics; bilateral cooperation, cooperation with the regional and international organizations, and cooperation with the European Union. Moreover, TUBITAK reflects the relevance of S&T work to the broader OECD agenda [3]. The objective of this study is to help increasing the system efficiency of National Scientific and Technological Council on how agricultural knowledge, science and technology can be used in reducing hunger and poverty, improving rural livelihoods and facilitating equitable, environmentally, socially and economically sustainable development in the world. The local and national knowledge has to address productivity, multi functionality of agriculture, and multiple perspectives of nature as processes of data, data mining, and big data. The goal of creating global sustainability in agriculture requires data about social, economic, and ecological inequities, on sustainably production and accessing food, on increasing uncertainties of world's future food prices, and on risks faced by natural resources. The main challenge of agricultural research projects, then, is to increase the productivity of agriculture in a sustainable manner. The outputs of local and national level research projects are important in this regard since projects on bioenergy, biotechnology, climate change, human health, trade and markets, traditional and local knowledge may generate new ideas for research and innovation in agriculture that can be reflected globally.

METHODOLOGY

The materials were collected from the website of The Scientific and Technological Research Council of Turkey (TUBITAK). TUBITAK is the main official donor for research projects in Turkey for every branch of science. Some completed projects funded by TUBITAK on global problems such as food safety, climate change, system management, urban system, and risk management via TUBITAK support are investigated with the purpose of identifying their possible contribution to the solution of global agricultural problems.

RESULTS AND DISCUSSION

Some Outputs of Turkish Research Projects on Highlighted Problems in Agriculture

During the last two decades, a new phenomenon has taken shape in Turkey; national government helps local initiatives for establishing regional agencies which set out directive and funds at different regional layers. The local leadership began taking confident steps on their own, in order to design

their own plans and implement these plans to make their localities self-reliant. Political, institutional, economic, social, and environmental contexts of research have been covered in these locally-formulated plans. An important outcome of this new policy approach has been the improvement of local research layers involving experimental stations and research institutions. The amount and percentage of research funds has been increased. The amount of research on villages, farms, and households has therefore increased. In addition, institutional (legal) infrastructure for rapid rural surveys, informal surveys, reconnaissance surveys and rapid rural appraisal were established. Access to information from research institutions in Turkey has been facilitated and made easier. As a result, an increasing number of quality research projects are formulated and implemented by universities, research institutions, local administrations, private research bodies and individual scientists and entrepreneurs. Establishing a link between global and local issues, such projects generated results that can be applied to the solution of national agricultural problems as well as the global issues. However, because of the language barrier, communication of the results of some research may be problematic. In order to make up for the broken link, some outputs of Turkish research projects that may contribute to the solution of highlighted problems of the world agriculture are investigated and the results of this investigation are summarized in this section.

As a country of diverse resources for plant production, many fruits and vegetables are produced and consumed in Turkey. Since fruits and vegetables have a short shelf life, that is, since their price elasticity of supply is rather low, farmers use chemical material to supply fruits and vegetables timely. On the other hand, use of such material has a negative effect on consumers since it has adverse impacts on food safety. Therefore, the focus has been on the analysis of input usage for improving safe vegetable production in greenhouses [4]. The project was completed mainly on food safety. The use of non-hazardous inputs and production technologies has become imperative in food production in recent years due to human health and environmental concerns. Nowadays, the production in greenhouses is becoming dependent upon ecological conditions, and some efficiency and quality losses in production are occurring because of this dependency, since the greenhouses are intensive agricultural lands, and synthetic chemicals are intensively used to counter the losses in production. These substances, which cause environmental pollution, harm natural balance and threaten human health, are plant growth regulators (hormones), commercial (chemical) fertilizers, and pesticides. The objective of the study was to improve food safety. The study specifically aimed at determining safe ways of vegetable production in greenhouses in Antalya, Mersin, Muğla, and İzmir Provinces of Turkey. Good Agricultural Practices was selected as the method of the study. The results of study were prepared as a guidebook on the input use and application of alternative producing techniques. The intended target group of this publication was greenhouse farmers. Furthermore, a registry system was created for each producer to record farm data in production periods.

Farmers' adaptation tendencies to sustainable agricultural techniques were also investigated [5]. The project was carried out in 9 different districts of three different provinces (İzmir, Manisa and Aydın) of the Aegean (*Ege*) Region. In total, 270 farmers, 30 from each district and 193 public extension officials were applied questionnaires. The priorities of sustainable farming were ranked as next generations, water pollution, product quality, easy marketing, erosion, biodiversity and productivity in the region. Knowledge levels on sustainable farming increased with higher education.

Another vein of research projects focused on the impact of climate change on agriculture. Another study focused on economic analysis and policy development dimension of the impact of climate change on agricultural production in Cukurova and Middle Anatolia regions of Turkey [6]. Global warming, climate change, its effects on agricultural production, food security, starvation and famine are integrating issues. The impact of climate change on agricultural production needs to be managed carefully for not endangering sustainability. Necessary policies and institutional action to cope with global warming must be identified. The objective of the study was to identify necessary policies and institutional action to deal with global warming. The specific objective of the study was to understand the farmers' perception of and behavior concerning climate change, to carry out an economic analysis of the effects of climate change on agricultural production in Cukurova and Middle Anatolia

regions. Regression analysis was applied to data collected by 72 questionnaires applied in Adana province of Cukurova region and 62 questionnaires in Konya province in Middle Anatolia region. Questionnaires are applied to farmers conducting farming activities under irrigated and rain fed production conditions in 2006. The results of study showed the majority of the Adana and Konya farmers (both irrigated and rainfed) agree that the cropping pattern has not changed due to climate change in the last 20 years and it tends to increase in the future. Similarly, most of them think that the precipitation has decreased and it tends to decrease in the future. Different options are available concerning humidity for Adana and Konya farmers. According to Adana farmers, humidity has increased but Konya farmers claim that humidity has decreased. All Adana and Konya farmers (irrigated and rainfed) agree that the cropping pattern has not changed due to climate change in the last 20 years. Changes that occurred in the cropping pattern in the research area were found to be related to the profitability of the enterprises. Similarly, most of the farmers in Adana and Konya stated that the production technique had not changed due to climate change in the last 20 years. Farmers are not very sure about cropping pattern if temperature rises and precipitation decrease in the future. Many farmers stated that they would produce heat and drought resistant crops such as cotton in Adana and barley in Konya. Majority of Adana and Konya farmers think that soil cultivation methods, seed quantity and variety, pesticide quantity and type will not change. Farmers stated that number of irrigation would increase and method of irrigation would change. Farmers also agree that the quantity of fertilizer in production would decrease under rainfed conditions. In Turkey, there are several governmental and nongovernmental organizations dealing with certain aspects of climate change. It should be mentioned that there is not a satisfactory cooperation between these organizations. Therefore, there is a need to set up a unit (Institute or Center) that will deal with global warning issues to institutionalize this important issue. It should also be noted here that there is a Climate Change and Air Management Coordination Council in Turkey, a multilayered body consisting of members from public bodies. Observations show that the existence of a policy measure is not important as long as it is applied and monitored properly. Finally, it should be mentioned that training is very important. To understand the importance of global warning training is needed for people of all ages and different categories. Governmental and nongovernmental organizations could collaborate in training general public as well as producers.

Product behavior in absence of rainfall under climate change is a concern of all countries around the world. Product yield of different plants under arid conditions is also studied in Turkey. Such a project was carried out to investigate the some agricultural techniques to increase seed yield and oil ratio of sunflower in arid areas by using agronomic and physiological parameters [7]. The experiment was established at the Research and Breeding Farm of Central Research Institute for Field Crops in Haymana during summer seasons of 2010 and 2011. The experiment was designed in a split-split plot of randomized complete blocks with four replicates. According to the results of the research, seed priming resulted in higher in germination percentage but lower in mean germination time. Hydropriming and plant arrangement of 60×35 cm were found to be effective to increase seed yield of sunflower cultivars. Among the sowing directions investigated there is no effective direction to enhance seed yield. It was concluded that the effect of row direction on agronomic traits and yield of sunflower was scarce and fluctuant. However, it is advised that plant arrangement of 60×35 cm and hydropriming should be preferred to increase seed yield of sunflower especially in arid conditions regardless of sowing direction.

Health and ecological effects of agricultural production and agricultural industries were the subjects of another research project [8]. General objective of this study was to measure personal PM10, PM2.5, and PM1 exposures in 1) tractor and combine operations (tillage, planting, baling, harvesting), 2) agri- industry (textile, ginning, feed mills, and pepper processing). Personal samplers and continuous measurement devices were used and ambient climate factors were also measured. Only pepper processing facilities found out to have non-harmful concentrations.

Turkey's bioenergy policies were investigated in another study [9] which concluded that bio-fuel production in Turkey can be done only by using more sunflower and sugar beet, if Turkey does not

change the current crop pattern. Under the same condition, production of bio-fuels by utilizing soybeans and rapeseed does not seem possible unless some policies targeting the use of these two products are implemented.

Poultry production is another economic activity which has been increasingly attracting rural entrepreneurs in Turkey. Data on possibility of modifying of housing and indoor details systems in laying henhouse for Turkey conditions in another project [10]. The project was focused particularly on system management. The European Union has released eight directives for increasing animal welfare. These directives include system management in livestock. Currently, agricultural systems, especially housing systems, are not matching basic animal welfare requirements. The study objective was to help creating alternative housing systems that match basic animal welfare requirements and increase business profitability. Another specific objective of the study was to compare the performance of laying hens in conventional and alternative housing systems, which were designed according to above-mentioned directives of the European Union on the welfare of laying hen, as well as determining possibilities of using modified alternative housing systems in Turkey. 460 domestic white (ATABEY) and 460 domestic brown (ATAK) layers were divided into six different (conventional cage, enriched cage, aviary system, 2/3 slat system, 2/3 slat system and litter system) housing systems. This experiment was conducted to determine the effects of housing systems on egg production-quality, physiological and biochemical properties of hens and housing system in comparison with the egg production per m² floor area and possibilities of modifying housing systems in some laying henhouses. Egg production characteristics were found to be higher in aviary system, followed by enriched cage system. However, feed consumption with conservation ratio was higher in aviary system when compared to other systems. Because of feeding expenditures, a major proportion of poultry production costs in large-scale production companies consist of installing, if necessary, enriched cages while the majority of costs consist of installing aviary systems in conventional cages in small-scale enterprises.

Food safety issues and change in lifestyles are important factors that have been changing the consumer behavior in food consumption in Turkey. With the increase of per capita income, more and more Turkish consumers are seeking organic products in the market. As a result, the number of organic producers and outlets selling organic food are increasing. A project on organic production was implemented to compare economic benefits of organic and conventional enterprises in Erzurum province [11]. When the background of the study was taken into consideration, it could be said that organic farming has offered a new opportunity for small scale enterprises in rural area. Farmers were hoping more than doubled for organic products, especially for the European market. In addition, they believe that the production cost of organic is less than conventional. The study objective was to determine profitability of organic farming by using conventional farming as a control. The specific study objective was to reveal cost-benefit analyses of organic production in Erzurum province. The results of the study estimated the best capital structure for the farms performing organic agriculture from a sample of Eastern Anatolia Cattlebreeders' Association members in Erzurum. Efficiency of production factors was compared for organic and conventional enterprises. The capital of organic enterprises, such as land, building, stock size, tools and machineries were estimated to be more than that of conventional enterprises. Organic enterprises were more successful than inorganic enterprises in terms of gross product, input productivity, agricultural income and gross profit. In general, organic potato production had the highest gross profit, which was followed by strawberry, bean, sunflower, wheat, sugar beet, barley, triticale, silage corn, chickpea, and sainfoin. The study highlighted that the control and certification organizations certified by Ministry of Food, Agriculture, and Livestock do not have sufficient knowledge on the European Union organic agriculture legislation or practices. Local herbal production was recommended as an alternative source of income for area farmers for European Market.

Another project focused on socio-economic effects of organic certification process [12]. 314 organic certificate holders and another 86 farmers who have Good Agricultural Practice certificates and 1 organic company in İzmir, Aydın, Antalya and Adana provinces were applied questionnaires. This

research premised from the hypothesis that certification does not always create positive externalities. Focusing on types of certificates, the size of agribusiness, and the features of institutions involved in certification process. Accordingly, the basic findings of the research are: 1) The choice of certification is largely dependent on the location of the land. 2) Regional associations and municipalities are effective in utilizing small producers' access to certified production. 3) Agricultural consulting companies also have an important role for small producers. 4) Access to market is the major problem for organic producers. 5) GAP certificate is generally adapted by large producers and companies due to strict regulations. It is emphasized in the study that if organizations as cooperatives and unions structured with a bottom-up and participatory approach, social and economic benefits of the certification to the producers are more likely to occur.

Effects of possible Turkish accession to the European Union on meat prices were also investigated [13]. It is concluded that net producer prices will increase about 3-5%, beef prices will decrease about 30% while the demand for beef will increase an estimated 5-6% as a result of price decline as baseline projections suggest. As for the supply side, production of cattle meat is projected to increase by about 17-18% in accordance with the decline in feed costs and increasing gross margin with the EU membership. Consumption will reach to about 10 kg/year with the average annual increase of 0.6 kg. As a result, cattle meat supply will not be able to match the increase in demand and net meat imports will increase. Both beef cattle producer and consumer welfare will also increase with the possible EU membership.

In a different study, genetic factors affecting cattle were investigated [14]. The objectives of this study were to detect leptin gene polymorphisms, to determine genotype and allele frequencies for the polymorphisms and to investigate their effects on milk yield and composition in culture (Holstein, Brown Swiss and Jersey) and native (Anatolian Black and East Anatolian Red) cattle breeds raised in Turkey. For this purpose, a total of 480 blood and milk samples were collected from Holstein, Brown Swiss, Jersey, Anatolian Black and East Anatolian Red cattle breeds. In addition, milk production records of culture (Holstein, Brown Swiss and Jersey) cattle breeds were obtained. In conclusion, the effect of C1180T polymorphism on milk yield was found significant in early lactation period. The association between C1180T polymorphism and milk yield suggested that C1180T polymorphism might be a useful marker for genotypic selection such as marker assisted selection. It was recommended that selection of T allele for C1180T polymorphism could provide considerable economic advantage for increasing milk yield.

Urban farming was the subject of another project [15]. Urban and Peri-Urban Agriculture (UPUA) is discussed comprehensively in the world and is claimed to be the hottest topic of debate of the third millennium. UPUA has also been widely practiced in Turkey. The study's objective was increasing awareness on urban farming. The specific study objective was to identify the current structure in urban farming in Izmir province of Turkey. The results obtained from the study produced a knowledge base on urban farming accessible by Turkish researchers. The study reported food safety issues related to urban farming and benefits of urban farming to low-income producers in urban and peri-urban areas. Urban farming is particularly important as a source of healthy food supply and easily-marketable farming products, as a sector increasing employment and as a factor increasing morale and physiological health. The study also reported that in 2005, an estimated 30% of all food production and 50% of food consumption in urban areas would be supplied via urban farming. It was also reported that using agricultural land for non-agricultural purposes is a major reason of degrading or destroying agricultural land. Urban farming is recommended to be one of the factors that should be considered in modern city planning.

Integrated use of agricultural areas in tourism regions creates alternative sources of income for the local rural population. A study designed for well-known tourism region of Bodrum aimed at preparing a management plan for rural tourism areas which have rich archaeological and traditional heritage as well as agricultural production [16]. The Bodrum Peninsula which possesses high tourism potential is one of the leading regions that have severe tourism and conservation problems. In order to provide sustainable development and conservation of natural, archaeological, and traditional cultural values

of Aspat and its Territorium, which is one of the unique conserved areas within the whole Bodrum Peninsula that has been subjected to severe development and mass tourism impacts, the study sought to formulate an integrated model financial self-sufficiency, with agro-tourism at the center. Although the Project is defined as a Research Project, a feasibility report analyzing visions, missions, strategies, implementation, product activity, organizational structure and legal and administrative issues has been prepared in order to help the intervention phase through an implementation project for following studies.

Determining agricultural supply under uncertainty was also studied in Turkey [17]. In a project on this subject, one of the objectives was to examine the existence of chaotic structure in agricultural production in Turkey by using "Chaotic Dynamic Analysis (CDA)" and to provide accurate forecasts of agricultural production. In order to help formulating effective policies to prevent supply disequilibrium, and excess price fluctuations. The analysis showed that the selected agricultural products have chaotic structure. Dynamic system constructed in the research predicted current supply of year 2010 with %5 error for barley, % 0.5 error for wheat, and % 2.5 error ratio for rice. The second aim of this study was to explore the factors effecting efficiency in crop production in Turkey. For this aim, data was collected by interviewing about 2000 farmers in different regions of Turkey on 6 different products (wheat, barley, rice, sunflower, vetches and clover). The results obtained by using "Stochastic Frontier Analysis (SFA)" showed that fertilizers are used improperly in agricultural production in Turkey. The results also showed that soil analysis and using certified seed positively affect agricultural efficiency in wheat, barley, and rice production.

Another project on risk management aimed at determining behavior and attitudes of farmers in coping with risk and uncertainty in agriculture in Antalya province of Turkey. It can be said that risk management is always important in agriculture where natural and economic risks occur [18]. The identification sources of risk faced in agricultural production is the first step of risk management strategies. Determining farmers' attitude and behaviors in coping with risk and uncertainty in agricultural production provides a powerful tool for management. The main objectives of the study were to develop risk management in agriculture and to determine sources of risk and farmers' attitude and behaviors in coping with risk. Stratified sampling and Neyman Distribution were used to determine the sample size of the study. Multivariate analysis (factor analysis) was used in the statistical analysis of the data. According to the results of the study, there are three risk attitude groups: risk-seeking farmers, risk-averse farmers and risk-neutral farmers. Risk sources and risk management strategies were estimated. Risk sources were labeled as catastrophe, diseases and pest, economic and politic situation, weather conditions, debt and technology, finance, personnel factors, rainfall and production costs. Risk strategies were determined as debt management, marketing management, diversification, off-farm work and capital management.

Social matters concerning agricultural labor, especially seasonal laborers, have been attracting interest from all layers of policy and science recently. A descriptive study on educational problems of the children of seasonal laborers aimed to provide a background and insight for the primary school attainment issues faced by these children, particularly by the girls [19]. Labor intensive character of seasonal work and financial issues faced by mainly poor laborers make educational needs of the children a matter of lesser importance for the seasonal-laborer families. This creates a situation in which school-age children do not get proper education due to discontinuous enrollment caused by moving between cities and living conditions created by continuous migration. This situation distorts the children's already bumpy relation with education and contributes to the continuing of their socially-disadvantaged status, resulting in drop-outs and social problems. The research was carried out in five different seasonal labor sites in Ankara, Adana, Ordu, and Manisa provinces. A structured questionnaire was applied to 500 seasonal laborers and semi-structured interviews with laborers, teachers and public officials and field observations were also used in the study. The study recommended improving of social policy measures for developing life standards of agricultural workers.

In another study, poverty in agricultural enterprises in Konya's Hadim district was investigated with

an emphasis on gender dimension of poverty [20]. 112 families (men and women) from 112 agricultural enterprises were interviewed. Research results were also analyzed according to the 2 different ecological regions. The study revealed that although women are active participants in family enterprises with additional social roles within the family, their level of ownership is low as well as their level of education. Women in the region affected by poverty more than men, 61.61% of the women interviewed were not happy with the life in the village, and if given the opportunity, they will rather prefer to live in the city; opposite to the men who mostly prefer to live in the village. As a result, supporting of agricultural activities to reduce poverty as well as infrastructure investments to raise the quality of life in rural areas were recommended.

The effects of change in agricultural policy on the structure of agricultural production and rural life in 2000s in Western Mediterranean Region were the subjects of an extensive study [21] which provided valuable information for formulation of future policies. The data is obtained from face to face interviews from 486 farmers in the Western Mediterranean region and 53 village surveys and village focus group interviews. In addition to this, 19 focus group interviews with 189 people from 13 districts and from 3 provinces were utilized. Multiple statistical methods including descriptive tests, multiple regression model, factor analysis, analytical hierarchy process (AHP) and social impact analysis (SIA) were used in this study. An important result of this study was the bilateral causal relationship between change in the structure of production and social change. The study revealed that crop production supports has no statistically significant effect on crop production value while animal production supports has a significant statistical effect on animal production value. In general, total agricultural support revealed to have no significant effect on total agricultural production value. However, AHP study of the project showed that input supports are still preferred by producers and product marketing is the primary indicator of success for producers.

CONCLUSION

This study provides a review of some agricultural research projects implemented in Turkey for the solution of problems in agricultural production. The outputs of Turkish research projects seem to have some important implications for the solution of global agricultural problems. Such results may be useful in elsewhere around the world showing similar production patterns or experiencing similar problems. There are more than twelve thousand completed projects supported by TUBITAK. Final reports of these projects are easily accessible at TUBITAK's online database. However, the fact that reports being published in Turkish prevents dissemination, and consequently, scientific discussion of the results of these studies at a global level. There may be other research reports elsewhere around the world, written in different languages, which may provide bits and clues for the solution of global agricultural issues. In order to communicate such resources to a greater public of international scientists and policymakers, we recommend an international institutional structure in which results of research conveyed bottom-up, from local or regional level to global level. In this structure, international organizations such as OECD, FAO, etc. should collaborate with local and national levels in translating valuable research into internationally-recognized scientific languages, such as English. Such an institutional structure would increase involvement of local- and/or grassroots-level involvement in the quest for seeking solutions to global problems. Circulation and extension of innovative ideas and techniques would be much faster within this system. As knowledge flows become much faster, regional and global solutions facilitated or extended by international and domestic donors would result in ideal models for regional and national development.

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