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Analysis of Production Efficiency and the Use of Modern Technology in Crop Production

A Study of Smallholders in the Central Highlands of Ethiopia

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Wissenschaftsverlag Vauk Kiel KG
1995

8 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary

Ethiopia has one of the lowest per capita income levels in the world and is, therefore, classified as one of the poorest countries. Its economy is overwhelmingly dominated by a traditional agricultural sector which accounts for about half of the country's GDP, supports more than four fifths of the population and provides more than ninety percent of the total exports. Rainfed crop production is the basis of almost all subsistence farming in Ethiopia and accounts for over 95 percent of the land area cultivated annually. Given the proportion of the total population dependent on agriculture for its livelihood, and given agriculture's contribution to the national accounts and to the export earnings, the key to the economic development of Ethiopia is primarily held by agriculture. Without an efficient and dynamic agricultural sector, the country would be unable to alleviate the chronic food shortage problems and will remain unable to feed the growing population. Therefore, formulating and adopting strategies that would help to raise agricultural production can be seen as the most important key to any future progress in Ethiopia.

Small scale peasant farming is the dominant form of production both in terms of cultivated area and total agricultural production. The smallholders farming system also accounts for more than 98 percent of the livestock production in the country. Most of these small scale farmers are found in the highlands which have the highest concentration of both the human and livestock population and which represent about 40-50 percent of the total land area. The peasant farmers use traditional farm tools; sickles, hoes, wooden ploughs, and some winnowing items being the most important farm implements of a farm household. Power for agricultural production and transport comes mainly from humans and from draught animals such as oxen, donkeys and horses. Recent estimates put the total cultivated land in the country at a little more than 15 percent. With respect to its animal population, estimates show that Ethiopia possesses close to 20 percent of the total Africa's livestock population. Since most of the agricultural production comes from the smallholders and since smallholders make up the largest segment of the rural population, promoting smallholders' agricultural development would bring the greatest overall benefit in terms of total agricultural

production. It is these small agricultural producers that will have to be mobilized in Ethiopia on a massive scale.

Nonetheless, agricultural growth rates in Ethiopia have been less than satisfactory compared with the population growth rate. While the population has been increasing by almost 3 percent per year agricultural per capita has been declining. Ethiopia's agriculture is generally characterized by low productivity. The average yield per hectare in crop production has been less than 12 quintals which is very low compared to similar output figures for other countries. As a result, the agricultural sector has been unable to satisfy or meet the growing demands for agricultural and food products in the country. The farming systems in the highlands have often remained largely unchanged and they are now unable to sustain the ever increasing population resulting in frequent famines. Agricultural per capita production also declined because of the recurrent drought, shortage of traction power, inadequate supply of production increasing technologies and sometimes because of shortage of labour. Other constraints to increased agricultural production includes inappropriate and biased agricultural policies. Farmers lacked appropriate incentive mechanisms to increase their output or improve their productivity. The land reform of 1975 was, of course, one of the most important steps taken to enhance peasant agricultural development. But, because of subsequent distribution and redistribution of land farmers lost their security on the land which led to resource degradation and decline in agricultural production and productivity.

Other factors which hindered increased agricultural and food production include weak infrastructure, poor co-ordination between research, extension, and the farmer, complete dependence on rainfall and low level of modern technology usage. Improved seeds, chemical fertilizers and modern agricultural implements are not available to a large number of Ethiopian peasants. Although it is more than three decades since fertilizer and improved seeds have been introduced, the pace at which the consumption of modern inputs had been growing was very slow. Proven package of high yielding and disease resistant varieties, farm inputs and agricultural practices adapted to the needs of Ethiopia's varying agro-climatic zones have not been made available to peasant farmers in sufficient number. Even where they have been developed their diffusion and adoption has been slow because in many areas the agricultural extension service has not been effective or because of poor transport and inadequate supplies. Irrigation practice is virtually non-existent. Proper grain storage facilities are also absent and as a result it is estimated that the amount of crop losses due to lack of storage facilities could be as high as 30 percent of the total crop production.

The crucial problem in the agricultural sector is, therefore, how to increase output per unit of input. One way of approaching the problem of increasing production is to examine how efficiently the farmers are using their resources. If resources are efficiently used another way of increasing production could be the adoption and use of modern inputs and improved technology of production in an optimal way. On the basis of this situation, the critical analysis and evaluation of the agricultural development policies and their impact on smallholders' agricultural production, the examination of the degree of technical efficiency of small scale farmers and their use of modern technology have been the main aims of this study. Moreover, attempts have also been made to examine the spatial variations in technical efficiency and to identify the factors explaining the technical efficiency variations. The intensity of input use at the farm level has been also analysed in terms of the consumption of mineral fertilizer.

A multi-period field level survey was conducted during the 1992/93 crop season in two selected areas, Ada sub district and Baso and Worana sub district of the central highlands of Ethiopia. The Ada sub district is located about 45 km south east of Addis Abeba and the Baso and Worana sub district is located 120 km north east of Addis Abeba. The selection of these two sub districts was based primarily on their representativness of the central highlands, their experience with the use of modern inputs, their proximity to major central markets, and their accessibility. Ada sub district represents the lower elevation limit of the central highlands, with wider experience in the use of modern technology and located closer to the central administrative and market centre, Addis Abeba. On the other hand Baso and Worana sub district represents the upper altitude level and is less exposed to the use of modern technology, and is far from the main centre. A total of 192 smallholders were identified and selected from the two areas and information about the different agricultural activities during the season was collected. Additional data were obtained from different government and non-government institutions as well as from published and unpublished sources. The sampled farm households were grouped into different farm categories based on several criteria such as farm size, modern technology usage, crops planted, etc., to create as much as possible homogenous farm groups for the analysis.

The production function approach has been adopted for the analysis of the technical efficiency of the sampled farmers. A production function specifies the maximum output attainable from the input combinations given the technology available to the farm. One important issue in such analysis is the problem of finding an appropriate analytical tool for measuring technical efficiency that is consistent with the definition of the production function. The frontier production function approach has been adopted here because it is

consistent with the definition of the production function. Within the frontier approach the stochastic frontier production function has been selected as the analytical tool for the analysis. This analytical tool was preferred for the analysis because it is consistent with the theoretical definition of a production function and because unlike other frontier models it allows the decomposition of the error term into two components i.e. technical efficiency parameter and other systematic random factors. Additional quantitative tools such as regression analysis, percentages and graphs were also utilized.

Apart from natural calamities such as the recurrent drought, most of the constraints to increase agricultural production over the last three decades at the macro level have been mainly of institutional nature. Prior to 1974 smallholders' agricultural production has been severely hampered by the then land tenure system which was feudalistic characterized by landlord and tenant relationships. Although some comprehensive package projects were formulated and launched to carve the problem of low agricultural productivity in the peasant sub sector, the pre-1974 agricultural development strategies have generally been unfavourable for small scale farmers. The government before 1975 failed to tackle the land tenure problem properly and adequately and thus rural development strategies have had limited impact on agricultural production and productivity.

After 1975 there was a major departure in agrarian policy and a land reform which abolished landlordism, tenancy and peasant exploitation was undertaken and rural land was nationalized and distributed to small scale farmers. Since 1975 three different modes of agricultural production namely individual farms, state farms and co-operative farms emerged and existed side by side. State farms and co-operatives were created with the hope of maximizing the benefits from economies of scale. An investigation of the different groups of agricultural producers over the last two decades reveals that the share of co-operatives and state farms both in terms of cultivated land and total output has been very low compared to the individual peasant farms. Moreover, both state farms and co-operatives have often been found to be less efficient than private small scale farmers. The 1975 land reform did ensure access to land to the peasant farm families but excessive emphasis on the state agricultural sector and on co-operatives and hence the neglect of the peasant sector has resulted in low farm output and low farm input consumption by the sector. The socialized sector has been favoured by the government in the allocation of capital services, fertilizers, and improved seeds. But the allocation of the government agricultural budget between state and peasant sectors was not based on their actual and potential contribution to agricultural output. Out of the total distributed for agricultural development during the period 1984/85-1988/89, 67 percent was

channelled to state farms, and only 29 percent to the peasant sector and the balance 8.1 percent for agricultural research, training and statistics. Despite this support their contribution to total production has been marginal.

Ethiopian Agricultural development has been also severely constrained by the application of inappropriate and biased agricultural policies. Individual smallholders have been seriously affected by the government pricing, marketing, research, extension, credit, and input distribution policies. Prices of agricultural products offered to smallholders by state trading agencies have been too low compared to the free market prices. Prices paid to state farms and co-operatives were also higher than those paid to the individual peasant farmers. But the costs of farm inputs such as fertilizers were on the other hand increasing very rapidly over the same period and, therefore, did not encourage farmers to use improved inputs for increased production. Pricing policy has an impact on the utilization of improved inputs and increasing productivity. The socialized sector had also been accorded priority in the acquisition of modern inputs such as fertilizers, hybrid seeds, improved breeds, agricultural chemicals, etc. In view of the high price of fertilizer and the fact that state farms and producers' co-operatives have been given priority in receiving fertilizer it can hardly be surprising that few individual peasants are applying fertilizer. Limited availability, and untimely delivery of farm inputs also have detrimental effect on agricultural and food production. The cumbersome marketing organization involved in moving agricultural inputs usually result in failure to provide the right type of inputs at the right time.

Smallholders' incentive to increase production and productivity has also been dampened by the excessive state interventions and the vigorously enforced compulsory delivery quotas for farmers of agricultural commodities. Such marketing practices have eroded the will of small scale farmers to increase production. Incentive involves the creation of economic environment conducive for agricultural development. Small farmers have also had no access to basic credit in order to utilize such inputs as agricultural chemicals and improved seeds. Past agricultural credit policies were biased in favour of state farms and co-operatives and except for some fertilizer loans, smallholder private farmers had no access to official credit. The extension services, the taxation system and other public services were also not conducive for smallholder agricultural development.

A related problem for smallholders was the insecurity on land holding created by distorted government agricultural policies. Although land was allocated to a household for private cultivation retention of an allotment for a specified person over time has not been guaranteed. As population pressure increases and new households are formed

land was redistributed to accommodate new families. Moreover, smallholders have been uncertain over their land as co-operatives were able to claim the best quality land in the peasant associations. The land holding system in addition to reducing productivity has also eliminated incentives for peasants to invest in land. The system did not stimulate peasants to invest in medium or long term land improvements. In general, farmers' inability to sell, lease and mortgage and more importantly the constant redistribution of land has created feelings of insecurity.

The decline in total agricultural production in the country cannot be solely attributed to natural problems, institutional bottlenecks and biased government policies. Other problems which could explain the low productivity level relate to the performance of the economic agents i.e., the farmers themselves. The performance of the farmers together with their modern technology usage was analysed by measuring the production capacity. The sampled farmers from Baso and Worana sub district were classified into fertilized and unfertilized farms depending whether the farm used fertilizer or not. The analysis was done for the two regions separately using the whole farm approach at first and then for the different farm size groups. Moreover, a disaggregated crop specific analysis was undertaken for the major crops grown in each region. The most important factors that were assumed to influence the level of technical efficiency have also been identified. While this micro level study is based on only two regions, and one therefore, need to exercise caution in generalizing from it, it does provide evidences for some tentative conclusions, which may well generalize to the highlands or to the Ethiopian scenario as a whole.

8.2 Conclusions

The findings of the analysis of technical efficiency at the whole farm level have indicated the existence of some degree of technical inefficiencies. The stochastic frontier production function analysis has shown that there are discrepancies between the observed and the frontier output levels and this discrepancy is mainly due to technical inefficiency and not caused by random factors which may be beyond the control of the farmer. With the breakdown of the error term into two components the one sided efficiency disturbance term was found to be important and was not swamped by the conventional stochastic error term. Since the factors under human control are represented by the one sided error term, the discrepancies between actual and frontier output can be minimized with better utilization of existing production technologies. On the average, Ada farms have been more than 93 percent technically efficient and the corresponding technical efficiency levels for unfertilized and fertilized farms in Baso and

Worana sub district have been 87 and 91 percent respectively. These results imply that the unfertilized farms in the Baso and Worana sub district display the lowest technical efficiency while those in Ada have the highest technical efficiency. For the sampled farmers as a whole output can be increased by about 10 percent at the aggregate level without additional costs to the farmers. In other words, the result means that actual (observed) output is about 10 percent less than the maximal output which can potentially be achieved from the existing level of inputs and technology. Gains in output of any magnitude stemming mainly from improvements in productivity are important to Ethiopia since the opportunities to increase farm production by bringing additional virgin lands into cultivation in the highlands are significantly diminishing at a fast rate while at the same time population pressure is on the rise. Some production gains can still be enjoyed by utilizing the existing inputs and technology more efficiently and by improving farmers' management abilities.

Several research findings have indicated that farmers with different operational holdings are not equally technically efficient in agricultural production. The analysis of the relationship between technical efficiency and farm size in this study indicated that the difference in technical efficiency between the small and large farms is insignificant. Both small and large farms in the study areas have similar levels of technical efficiency. So there are no compelling reasons to direct or target intervention and assistance to a particular farm group on technical efficiency considerations and there are no justifications to promote consolidation of smaller farms into large farms to improve technical efficiency or vice versa.

The hypothesis of a wider spatial variation in technical efficiency between the two regions has been confirmed by the findings of this study. Farmers in the more prosperous and more developed Ada sub district are operating on a higher frontier level than those in the less developed and distant Baso and Worana sub district. In other words there is a wider production gap between the best practice and the average farmer in Baso and Worana sub district than in Ada sub district. If resources are to be allocated to regions on the basis of technical efficiency then Baso and Worana sub district needs to be one of the areas which should receive priority.

The crop specific technical efficiency analysis showed that farmers are not equally efficient in the production of major crops. Although both wheat and teff farms in Ada sub district show deviations from the frontier output levels, the reasons for the variations are different for the two crops. The deviations are mainly due to technical inefficiency for teff farms whereas the variations in wheat production are caused more by random factors

than due to technical inefficiency. So it can be assumed that wheat farms are technically more efficient than teff farms in this sub district. This could reflect the preferential assistance accorded to the wheat crop in terms of research and other supporting services. The findings suggest that there is a limited scope to increase technical efficiency of wheat farms in Ada sub district from the existing inputs but the efficiency of teff farms can be increased by around 12 percent without any additional cost to the farmer. In the case of crops for Baso and Worana farms deviations from the maximum output level is caused by random factors than due to technical inefficiency for fertilized farms, while it is accounted by technical inefficiency for unfertilized farms. The possibility of raising crop production for unfertilized farms in Baso and Worana sub district using the current technology is higher than fertilized farms.

The variations in technical efficiency between different groups of farms were explained and analysed using a multiple regression analysis where several socio-economic variables which were hypothesized to influence technical efficiency have been considered. Secondary school education, oxen, time of fertilizer delivery, and extension contact are the most important factors influencing technical efficiency in Ada sub district. And in the case of Baso and Worana farms education, farming experience, number of oxen, credit availability, distance from market centre, and family size have been the most important determinants of technical efficiency of farmers. All these factors have important and significant implications on the performance of farmers and thus require due considerations in the design of future agricultural development policies and in the provision of public services.

The possibilities for increasing output only through the formulation of appropriate agricultural policies and only through efficiency improvement are limited and exhaustible. Production increase based on the mere expansion of the crop area at the constant level of technology is also limited in scope. Under such cases the output level can be increased by changing the production surface and by creating new production horizons. This can be achieved through technical progress which would shift the frontier outwards and allow farmers to operate at a higher frontier. The introduction of technical progress could shift the existing production function outwards. A change in the production function is the basis for a dynamic process of agricultural development. Therefore, the farm level modern technology usage and the major constraints to the expanded use of modern technology in the areas along with the important determinants of fertilizer consumption have been also investigated.

Utilizing the primary data collected from the two sub districts, it has been found that considerable differences in the pattern of modern technology use exist which could have led to regional variations in output and productivity growth. Although modern technology usage is not widespread in the country as a whole, on the average farmers in Ada sub district have had a longer experience in the use of modern technology such as fertilizers, agricultural chemicals, and improved seeds than most other regions of the country due to some specific reasons. The study has shown that all sampled farmers from Ada sub district have used at least fertilizer during the year considered. But less than 60 percent of the sampled farmers in Baso and Worana sub district have used mineral fertilizer, the most important modern technology during the season. The use of other modern technologies is not widespread in both areas because of scarcity, high price, lack of credit facilities, unawareness etc. Supporting public services such as extension activities and training programmes have been either biased towards the more prosperous and accessible regions or have had little impact because of the general absence or lack of technologies to be disseminated to farmers.

The results of the analysis of the factors explaining fertilizer consumption indicated that the farm level fertilizer use is influenced by a host of social, economic, institutional and demographic factors. It was found from the analysis that farm size, experience in the use of chemical fertilizers, off farm income, and age have significant impact on the intensity of fertilizer use in Ada sub district. These socio economic variables appear to have considerable influence on the intensity of fertilizer use or consumption among the households considered in the study. For the fertilized farms in Baso and Worana sub district, farm size followed by family size, adequacy of fertilizer, and distance from market centre have been the most important determinants of fertilizer consumption. Therefore, it seems reasonable to conclude that adequate provision of these services may substantially help to increase the usage of modern technologies like fertilizer in the agricultural production process and thereby raise production.

8.3 Recommendations

While it may be difficult to draw solid policy conclusions and definitive policy recommendations from an empirical study based on limited macro data and cross-sectional data covering only one production year, some observations can be made to guide future research studies and development strategies. Based on the observations made from the study the following general recommendations can be forwarded.

Given the significance of small scale agriculture in Ethiopia emphasis must be placed on smallholder peasant producers who are the largest segment of the rural population and are the major producers of agricultural and food products. In order to overcome the problem of declining agricultural production, the designing and implementation of an appropriate and comprehensive smallholders development policy which would have to include appropriate agricultural marketing and pricing polices is very crucial. Producers prices for agricultural products should be determined by demand and supply principles. In addition to an appropriate pricing and marketing policies, the provision of credit facilities, agricultural research, extension services, and infrastructural development are indispensable for these farmers. Above all farmers need to have security over the land they own and should be allowed to use it to grow annual or perennial crops or both. The issue of access to and control over the land is still central to the rate and condition under which agricultural production and rural life can be transformed to a capitalist process of production. Insecurity over the land hinders afforstation and conservation measures which is damaging, given the threat of environmental degradation facing the highlands. Holding back on the land ownership or tenure issues will also prevent a credit market from developing, which is one of the key elements for intensified agricultural growth. Redistribution of land should also be stopped to reduce the fragmentation of the land and farmers right to pass their holdings to heirs and the right to lease it or to work on it in partnership with private investors should be guaranteed.

An examination of the relationship between efficiency and various socio-economic variables had suggested that some strategies could be recommended to improve the technical efficiency and thereby the performance of farmers. There are strong evidences that farmers access to extension services and credit could improve technical efficiency of farmers. This analysis suggests that policies to improve extension services, training, and education would have to be considered seriously to improve the productive capacity of the farmers in the areas. Suitable extension, training, and demonstration programmes supplemented by active association of the research scientists with farmers can be helpful to increase the level of technical efficiency and output. Regional policies for strengthening the extension capabilities of national agricultural research centres through technical support and short and long term training programmes may also be important. Expansion of education in rural areas is also very crucial. The kind, type and the content of the education programme should be determined by the level of development in the area and the interest of the people. Both formal and informal education are important as long as they are integrated with each other.

The scope for directly increasing crop yields through the development and spread of technical packages relevant to the rainfed farming system of the highlands is great. Efforts are required to increase the availability of fertilizer to peasants in the highland as part of a package that are more location and crop specific. Use of fertilizer and agricultural chemicals should increase significantly than the present low level in the shortest possible time. To realize success in such exercises large investment in research, infrastructure, marketing and distribution network, extension, education, and credit facilities and other similar government programmes would be required. Research stations should be able to develop high yielding varieties of hitherto neglected subsistence crops like barley and teff. It is too expensive and time taking for the government to distribute inputs directly to farmers. Thus the participation of the private traders in the whole sale and retail levels in the input marketing is necessary and the government should follow up the distribution of these inputs only to areas that may not be attractive to private traders. Seeds of high yielding varieties tested for specific agro-ecological and environmental conditions must be made available to farmers in larger quantities through specialized seeds producing enterprises.

Good farming practices such as row planting practices, plant population control, weeding, fertilizer application and inter-cropping could be important improved crop management strategies that need to be considered. Intensification of improved agronomic practices such as crop protection, relay cropping, minimum tillage, alley cropping to supplement the biological and chemical technologies are required in order to raise agricultural production and be able to meet the needs of the society. Crop losses before harvesting and after harvesting are immense and need to be reduced. Economic and institutional measures need to be devised and applied to motivate farmers to carry out soil and water conservation measures to reduce further degradation of land. Although Ethiopia's agricultural production primarily depends on the development of rainfed agriculture, there is great potential for irrigation that has to be exploited. Improving oxen distribution between highlands and lowlands and within the highlands could also minimize shortage of oxen and, therefore, has to be considered.

The analysis on the factors influencing fertilizer use has shown that there are some important variables that influence the intensity of fertilizer use at the farm level. The finding implies that farmers can be persuaded or motivated to use yield increasing technologies such as fertilizer in an optimum manner if factors like education, timing of input distribution, infrastructure, and marketing are improved and co-ordinated. All play a significant role in promoting fertilizer use and transforming agriculture. So actions are needed to provide farmers with better extension services, education and training

programmes, as well as with public credit facilities to encourage them to use modern inputs and at the recommended levels.

Making institutional agricultural credit accessible to small scale farmers at the grass root level by using farmers associations such as service co-operatives would also enable them to acquire important modern production items. Given the low level of cash income farmers have at their disposal, the need for creating and expanding credit facilities for the acquisition of new production technologies becomes eminent. So increased availability of credit along with other services will contribute to improvements in efficiency and help to increase agricultural production. In order to overcome the shortage of oxen or draught power a credit scheme should be developed by which oxen loans would be made available for farmers. Co-ordination of rural development efforts at the different levels of administration and effective participation of target farmers in the development process are very essential. Increased involvement of the beneficiaries at the local or regional levels on prioritizing public investment in technical and physical infrastructure such as agricultural research, training, roads, transportation, irrigation etc., are needed if development efforts or programmes are to be fruitful.

KURZFASSUNG (GERMAN SUMMARY)

Einführung

Die Landwirtschaft Äthiopiens ist der wichtigste Sektor in bezug auf Produktion, Beschäftigung und Export. Das Potential für die landwirtschaftliche Entwicklung wurde bis heute noch nicht voll ausgeschöpft. Die landwirtschaftliche Produktion liegt hauptsächlich in der Hand von kleinbäuerlichen Subsistenzbetrieben, die mehr als 90% der landwirtschaftlichen Güter produzieren und dabei vorwiegend traditionelle Geräte und Techniken verwenden. Der landwirtschaftliche Sektor ist durch niedrige Produktivität im Vergleich zu anderen Sektoren gekennzeichnet; vier Fünftel der landwirtschaftlich aktiven Bevölkerung produzieren weniger als 50% der gesamten Produktion. Die Entwicklung der Agrarproduktion war in den letzten Jahren rückläufig, was verstärkt zu Nahrungsmittelknappheiten in Äthiopien geführt hat. Neben der geringen Produktivität sank die Agrarproduktion auch aufgrund von Problemen im institutionellen Bereich, insbesondere in den landwirtschaftlichen Dienstleistungsbereichen wie Kredit, Vermarktung, Inputversorgung und Beratung sowie aufgrund einer ineffizienten Agrarpolitik. Kleinbäuerliche Betriebe wurden bis vor kurzem durch die Agrarpolitik benachteiligt. Diese Diskriminierung hatte negative Auswirkungen auf die einzelbetriebliche Effizienz in kleinbäuerlichen Unternehmen und bewirkte einen kontinuierlichen Rückgang der landwirtschaftlichen Produktion. Das Landpachtsystem bietet den Pächtern keine ausreichende Bodenrechtssicherheit. Agrarpolitische Voreingenommenheit gegen kleinbäuerliche Betriebe ist nur ein Grund für die niedrige Produktivität in der Landwirtschaft und den Rückgang der Produktion. Zusätzlich zu den Hemmnissen, die durch die Agrarpolitik entstanden sind, kann der Rückgang der landwirtschaftlichen Produktion auf wenig effiziente Produktionsmethoden zurückgeführt werden, wie in vielen empirischen Studien nachgewiesen wurde.

In den letzten zwei Jahrzehnten wurde die äthiopische Wirtschaft zentralistisch gelenkt, was im besonderen einen weitreichenden Einfluß auf die Leistungen im kleinbäuerlichen Bereich hatte. Gegenwärtig wird dieses System aufgegeben, die Agrarpolitik liberalisiert und ein marktwirtschaftliches System eingeführt, welches kleinbäuerlichen Betrieben erlaubt, frei über die Verwendung ihrer Ressourcen zu entscheiden. Die vorliegende Untersuchung des technischen Effizienzgrades von Kleinbetrieben ist deshalb eine dringende Aufgabe und von direkter Relevanz im Prozeß der Neuformulierung der

Agrarpolitik Äthiopiens.

Landwirtschaftliche Produktion kann entweder durch gesteigerten Ressourceneinsatz, durch Verbesserung der Effizienz oder durch technischen Fortschritt erhöht werden. Produktionssteigerung durch den erhöhten Einsatz von Betriebsmitteln ist in der gegenwärtigen Situation Äthiopiens schwierig. Daher hat die Verbesserung des Effizienzgrades und des technischen Wandels eine stärkere Bedeutung. Bei gegebenen Zielen würde Effizienz das Merkmal für die Wahl der Mittel sein. Die Untersuchung des Ausmaßes und der Bestimmung der Einflußfaktoren der Produktions- oder technischen Effizienz dient einer besseren Gestaltung von Beratung, Preis-, Agrarmarkt-, Kredit-, Produktionsmittel- und Bodenrechtspolitik.

Einer der wichtigsten und auch umstrittensten Ansatzpunkte in der landwirtschaftlichen Entwicklungspolitik ist die Existenz von Ineffizienzen in der landwirtschaftlichen Produktion. In diesem Zusammenhang steht die Hypothese von Theodore Schultz, "poor but efficient", die die Vorstellung beschreibt, daß kleinbäuerliche Betriebe zwar oft arm sind, aber effizient handeln. Die Annahme dieser Vorstellung führte bei der Politikformulierung häufig zum Angebot moderner Technologien und zu einer einseitigen Betonung neuer Investitionsprogramme und der Bereitstellung exogener technischer Inputs, anstatt mit Beratungs- oder Ausbildungsprogrammen auf weniger effizient wirtschaftende Betriebe einzugehen. Neue empirische Untersuchungen haben gezeigt, daß signifikante Ineffizienzen in kleinbäuerlichen Betriebe vorhanden sind und die Produktion und das Einkommen der Kleinbauern durch eine Verbesserung der Effizienz gesteigert werden kann, ohne exogene Technologien einzuführen.

Das Ziel dieser Arbeit ist die Untersuchung des technischen Effizienzniveaus von kleinbäuerlichen Betrieben im zentralen Hochland Äthiopiens und der Möglichkeiten der Produktionssteigerung. Damit soll ein Beitrag geleistet werden, die großen und wachsenden Ernährungsdefizite im Land zu verringern. Die Erkenntnis, daß kleinbäuerliche Betriebe im Durchschnitt nicht das "Frontierniveau[1]" der Produktion erreichen, und die Analyse der Gründe für Ineffizienzen ist erforderlich, um bestimmte Maßnahmen definieren zu können, die bei der Lösung der Probleme helfen können. Für die Politikanalyse ist es wichtig zu wissen, wie weit ineffizient arbeitende landwirtschaftliche Betriebe gleiche Merkmale teilen. Es ist anzunehmen, daß die

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1 Der Begriff Frontierproduktionsniveau wird im folgenden im Sinne von maximal möglicher Produktion bei gegebenen Mitteleinsatz verwendet.Die Frontierproduktionsfunktion ist die Produktionsfunktion maximalen Outputs bei gegebenem Mitteleinsatz.

landwirtschaftliche Produktionssteigerung mittels Flächenausdehnung und/oder technischer Effizienzsteigerung früher oder später erschöpft sein wird. Darüber hinaus haben die am effizientesten wirtschaftenden Betriebe bereits ihr Frontierniveau hinsichtlich Produktionsertrag erreicht. In dieser Situation werden andere Strategien notwendig sein, um die Ressourcenproduktivität zu erhöhen. Der Einsatz moderner Technologien in kleinbäuerlichen Betrieben stellt eine solche Strategie dar. In der vorliegenden Arbeit wird das Ausmaß der Anwendung moderner Technologien analysiert, um die wichtigsten Probleme bei der Verwendung dieser Technologien durch kleinbäuerliche Betriebe zu zeigen. Darüber hinaus ist die Bestimmung der Intensität des Einsatzes moderner Technologien eine weitere wichtige Aufgabe dieser Studie.

Die Literatur bietet unterschiedliche analytische Methoden zur Messung technischer Effizienz landwirtschaftlicher Betriebe, unter denen der Produktionsfunktionsansatz eine zentrale Rolle spielt. Innerhalb des Produktionsfunktionsansatzes wird die Frontierproduktionsfunktion mittels verschiedener Frontiermessungen, die wiederum mit dem Produktionsfunktionansatz konsistent sind, geschätzt. In dieser Arbeit wurde eine stochastische Frontierproduktionsfunktion angewandt. Dieser Ansatz wurde deshalb gewählt, weil er erlaubt, den Zufallsfehler in zwei Komponenten zu zerlegen: in technische Ineffizienzparameter und andere statistische Zufallsfaktoren.

Im Zentrum dieser Arbeit steht eine Felduntersuchung, die in zwei Regionen im zentralen Hochland Äthiopiens durchgeführt wurde. Für die Befragung wurden insgesamt 192 kleinbäuerliche Betriebe aus zwei Unterdistrikten ausgewählt; befragt wurden 99 Betriebe aus dem Unterdistrikt Baso und Worana, der 120 km vom Verwaltungs- und Marktzentrum Addis Abeba entfernt liegt, und 93 aus dem Unterdistrikt Ada, welcher 45 km von Addis Abeba entfernt ist. Die ausgewählten Betriebe des Unterdistrikts Baso und Worana wurden in zwei Gruppen klassifiziert, eine Gruppe von Betrieben, die chemische Düngemittel einsetzen und eine zweite Gruppe ohne Düngemitteleinsatz. Daten über die verschiedenen Aktivitäten für die Erntesaison 1992/93 wurden im Verlauf eines Jahres in vier Befragungperioden durch Interviews erhoben. Die stochastische Frontierproduktionsfunktion wurde mittels der Statistiksoftware LIMDEP geschätzt.

Ergebnisse

1) Die Ergebnisse der Frontierproduktionsanalyse haben gezeigt, daß das Effizienzniveau der kleinbäuerlichen Betriebe im Unterdistrikt Ada (generelle Düngemittelverwendung) etwa 6 Prozent unter dem maximal möglichen

Ertragsniveau liegt. Von den Betrieben im Unterdistrikt Baso und Worana haben nur ein Teil Düngemittel benutzt. Die Betriebe mit Düngemitteleinsatz lagen 9 Prozent und die ohne Düngemitteleinsatz 13 Prozent unter dem Frontierertragsniveau. Diese Ergebnisse deuten darauf hin, daß das tatsächliche Ertragsniveau im Durchschnitt mehr als 10 Prozent kleiner als das Frontierertragsniveau ist. Dies bedeutet, daß die gleichen Betriebe bei 100 Prozent Ausnutzung ihres gegebenen Mitteleinsatzes das Ertragsniveau zwischen 6 und 13 Prozent steigern könnten. Die Betriebe im Unterdistrikt Ada haben ein höheres technisches Effizienzniveau, da sie über eine bessere Infrastruktur und mehr Erfahrungen mit modernen Produktionsmitteln verfügen.

2) Die Ergebnisse dieser Arbeit zeigen, daß die Diskrepanzen zwischen dem tatsächlichem und dem Frontierertragsniveau hauptsächlich durch technische Ineffizienzen beeinflußt werden und nicht durch zufällige Faktoren, die nicht durch den Betrieb kontrolliert werden können. Mehr als 80 Prozent der Diskrepanzen zwischen dem tatsächlichen Ertragsniveau und dem Frontierertragsniveau für die Betriebe im Unterdistrikt Ada besteht aufgrund von technischer Ineffizienz. Das nicht optimale Ertragsniveau der Betriebe im Unterdistrikt Baso und Worana, die Düngemittel benutzt haben bzw. die keine Düngemittel eingesetzt haben, läßt sich zu 77 bzw. 87 Prozent durch technische Ineffizienz erklären. Dies bedeutet, daß es Möglichkeiten gibt, mit den gegenwärtigen Technologien, die Produktion von kleinbäuerlichen Betrieben zu steigern, wenn die Ineffizienzen verringert werden können, ohne exogene Innovationen einzuführen.

3) Vergleichend läßt sich erkennen, daß die kleinbäuerlichen Betriebe im Unterdistrikt Ada technisch effizienter produzieren als die Betriebe im Unterdistrikt Baso und Worana. Die Betriebe im Unterdistrikt Baso und Worana, die keine chemischen Düngemittel einsetzen, haben den niedrigsten individuellen technischen Effizienzgrad im Vergleich zu den anderen Gruppen. Einzelbetrieblich gesehen liegt das technische Ineffizienzniveau zwischen 1,4 und 20,7 Prozent im Unterdistrikt Ada. Die technische Ineffizienz für die Betriebe im Unterdistrikt Baso und Worana, die Düngemittel eingesetzt haben bzw. die keine Düngemittel eingesetzt haben, reicht von 1,6 bis 32,2 Prozent und 2,7 bis 43,2 Prozent. Dies bedeutet, daß das technische Effizienzniveau der Betriebe im Unterdistrikt Baso und Worana stärker variiert als bei Betrieben im Unterdistrikt Ada.

4) Das technische Effizienzniveau zwischen kleinen und großen Betrieben zeigt keine signifikanten Unterschiede, d.h. die Betriebsgröße ist kein Faktor, der das

Effizienzniveau signifikant beeinflußt. Ausgehend vom Effizienzkriterien gibt es für Entwicklungsprogramme keinen Grund, sich auf die eine oder andere Gruppe zu konzentrieren. Insbesondere zeigt dies, daß die Orientierung der Förderung auf Kleinbetriebe hin keine Wachstumsverluste bedingen muß.

5) Die produktspezifische Analyse zeigt, daß die Betriebe in beiden Regionen und für alle Nahrungskulturen mit den eingesetzten Technologien unterhalb des Frontierertragsniveaus bleiben. Der Vergleich zwischen verschiedenen Getreidearten zeigt, daß die Betriebe im Ada Unterdistrikt Weizen effizienter produzieren als Teff[2]. Diese Ergebnisse reflektieren die staatliche und institutionelle Unterstützung insbesondere durch Forschung und Beratung für den Weizenanbau. Im Unterdistrikt Baso und Worana waren die Weizen produzierenden Betriebe effizienter als die Gerste produzierenden Betriebe.

6) Die Analyse der technischen Effizienz im interregionalen Vergleich zeigt, daß das Frontierproduktionsniveau der Betriebe im Unterdistrikt Ada höher ist als das der Betriebe im Unterdistrikt Baso und Worana. Damit wurde die Hypothese von einer räumlichen Variation der technischen Effizienz bestätigt. Prioritäten für öffentliche Unterstützung einer verbesserten Ressourcenallokation in kleinbäuerlichen Betrieben sollten im Baso und Worana Unterdistrikt liegen. Der weite Produktionsabstand zwischen dem "best practice"-Betrieb und dem Durchschnittsbetrieb kann insbesondere durch einen verbesserten Beratungsdienst, die Beseitigung von Marktproblemen und mit landwirtschaftlichen Ausbildungsprogrammen verringert werden.

7) Die Analyse der Determinanten von technischer Effizienz in den Untersuchungsregionen zeigt, daß bestimmte soziale, ökonomische und demographische Faktoren das Niveau technischer Effizienz beeinflussen. Die wichtigsten Parameter, die die technische Effizienz im Unterdistrikt Ada bestimmen, sind die zeitgerechte Düngemittellieferung, das Ausbildungsniveau der Bauern und der Beratungsdienst. Andere Faktoren wie die Entfernung vom Marktzentrum und die Anzahl von Zugtieren pro Familie sind ebenfalls bedeutend. Das Ausbildungsniveau und die landwirtschaftliche Erfahrung sind signifikante Variablen für Düngemittel anwendende Betriebe im Unterdistrikt Baso und Worana, während Ausbildungsgrad, Zugtiernutzung und Kreditmöglichkeiten die Hauptdeterminanten

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2 Teff (Eragrostis tef) ist ein Getreide, das nur in Äthiopien als Nahrungsmittel verwendet wird.

von technischer Effizienz in Betrieben ohne Düngemittelanwendung im Unterdistrikt Baso und Worana sind. Diese Ergebnisse deuten darauf hin, daß durch das Angebot von Ausbildung und geeigneten Beratungsdiensten, zusammen mit Kreditmöglichkeiten, die Effizienz der kleinbäuerlichen Betriebe im zentralen Hochland Äthiopiens gesteigert werden kann.

8) Mineraldünger ist das wichtigste moderne Betriebsmittel in den beiden Untersuchungsregionen. Beide Regionen unterscheiden sich stark hinsichtlich der Verwendung moderner Technologien. Aufgrund der Nähe und längeren Erfahrung haben alle Betriebe im Unterdistrikt Ada moderne Betriebsmittel verwendet, während nur wenige Betriebe im Unterdistrikt Baso und Worana dies tun.

9) Der Erfolg der Anwendung von Dünger und anderen modernen Betriebsmitteln setzt einen optimalen Mengeneinsatz voraus. Obwohl es nationale Empfehlungen für die Anwendung von Düngemitteln gibt, wenden viele Bauern andere Einsatzmengen an. Die Intensität der Anwendung moderner Betriebsmittel wurde am Beispiel des chemischen Düngers bewertet. Unter Verwendung der multiplen Regressionsanalyse wurden die Faktoren untersucht, die das Niveau der Düngeranwendung beeinflussen: das Alter der Bauern, die Erfahrung mit dem Düngemitteleinsatz, außerlandwirtschaftliches Einkommen und die Betriebsgröße waren die Hauptfaktoren im Ada Unterdistrikt, während im Baso und Worana Unterdistrikt die Größe der Anbaufläche, die Familiengröße und die Entfernung zum Marktzentrum einen signifikanten Einfluß haben. Eine Agrarpolitik, die auf die Steigerung der Anwendung von Düngemitteln oder anderer moderner Betriebsmittel zielt, muß diese Faktoren berücksichtigen und regionsspezifisch differenziert formuliert werden, um erfolgreich zu sein.

Schlußfolgerungen

Auf den Ergebnissen der Arbeit basierend können die folgenden Schlußfolgerungen gezogen werden, welche bei der Produktionsausdehnung relevant sind:

(1) Obwohl die Agrarreformen die feudalistischen Bodenrechtsstrukturen abgeschafft haben, fühlen sich heute noch viele Bauern unsicher bezüglich ihrer Rechte am Boden, den sie bewirtschaften und der weiterhin staatliches Eigentum ist. Gesichertes Bodenrecht ist ein wichtiger Bereich, der einer dringenden Lösung bedarf.

(2) Technische Ineffizienzen überwiegen in der Pflanzenproduktion und können durch eine angepaßte Beratung und eine Verbesserung des Bildungsniveaus der Bauern reduziert werden.

(3) Maßnahmen, die auf die Verringerung bzw. Beseitigung von Ineffizienzen zielen, sollten gebietsspezifisch auf die unterschiedlichen Ineffizienzniveaus und deren Bestimmungsfaktoren abgestimmt werden.

(4) Bei der Versorgung mit modernen Technologien wurden die wirtschaftlich stärkeren, leichter zugänglichen und besser entwickelten Gebiete bevorzugt. Es gibt einen dringenden Bedarf, auch den entlegenen ländlichen Gebieten eine gute Versorgung zu bieten.

(5) Im zentralen Hochland Äthiopiens sind integrierte Betriebsysteme sehr häufig, d.h. Pflanzen -und Tierproduktion existierten zusammen. Die Produktionszusammenhänge in integrierten Betriebsystemen sind sehr komplex. Deshalb erscheint es notwendig, mehr Forschung in Richtung von integrierten Betriebssystemen zu betreiben, um langfristig das Produktions -und Effizienzniveau der integrierten Systeme zu steigern.